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Fostering the reuse of knowledge in project based organizations



MARINE CONTRACTORS

Confidentiality applies to the Appendices

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Preface

Over the past six months I worked on my master thesis project at Heerema Marine Contractors on the topic of Knowledge Management, which proved to be a much more complicated and thus enjoyable topic than I initially expected. This project constitutes the final element of my master Management of Technology at the Technical University of Delft.

The aim of this research project was twofold. At first to dig deep in the scientific field of knowledge management and provide project based organizations with insight on what supports or hinders reuse of explicit knowledge during the front end development of projects, and secondly to provide project based organizations with a strategy to foster explicit knowledge reuse, aiming to improve value in projects. As a case study for this research the Technology department of HMC was used. The research project has provided the organization under study with specific recommendations for improvement.

My research in the field of explicit knowledge reuse, started with an in depth review of literature regarding what factors support or hinder reuse of explicit knowledge. Based on literature search findings a theoretical model was constructed. This model laid the foundation for the analysis in HMC, which revealed the areas of improvement. Afterwards, these areas of improvement formed the concrete objective of the strategy to foster reuse of explicit knowledge. The strategy consists of specific recommendations for improvement. For a more detailed overview of the research process and results, I refer the reader to the executive summary of this report.

This research journey came to a successful end due to assistance from my supervisors in TUDelft. Therefore I would like to thank professors Stephan Lukosch, Martijn Groenleer and Alexander Verbraeck, whose critically valuable comments helped me to make the right decisions in the whole research process. Also I would like to thank Tanja Buttler for her great insights in our regular meetings.

My interaction with the people of Heerema Marine Contractors, except the value that added in my research, it turned out to be a great lesson for me as a person. Both for his support during my research and especially for the valuable discussions, I would like to thank my supervisor in HMC, Victor Pegels. Moreover, I would like to thank Catherine Barney, whose support and critical comments increased significantly the quality of my research.

Finally, I would like to thank my family and friends for their great support during the whole period of my studies.

Panagiotis Anninos
Delft, August 2012

Executive Summary

Research context

In the contemporary business world, more and more organizations especially in the engineering domain structure their working processes around projects. These organizations are called project-based-organizations (PBOs) and have established distinct work processes to successfully execute the projects that they undertake. The working processes in the early phases of a project are quite important in adding value to the project, and are called Front End Development (FED) of projects. Knowledge Management is a practice that adds value in FED of projects, since knowledge is an important resource that provides PBOs with competitive advantage to survive in harsh competition. A knowledge management strategy to achieve learning across projects, is codification; converting tacit knowledge from people's minds, to explicit knowledge in documents. In a strife to increase value in their projects, PBOs are looking for ways to improve reuse of explicit knowledge in the FED of their projects: a practical problem. From a scientific point of view, a clear scientific mapping of the factors that support or hinder explicit knowledge reuse in the FED of projects, and what such a mapping entails for a strategy to foster reuse of explicit knowledge in PBOs in the engineering domain is not present yet. Therefore the main research question for this research is: *What factors support or hinder explicit knowledge reuse in the front end development of projects, and how can project based organizations in the engineering domain exploit them aiming to improve value in projects during their front end development?*

Research strategy

The selected approach in this research for improving reuse of explicit knowledge, is the identification and categorization of the factors that support or hinder reuse of explicit knowledge, and their respective exploitation. The design science research framework of (Hevner, March, Park, & Ram, 2004) is used to guide this research approach: exploration of the environment, development & evaluation of the designed artifact, and contribution to the knowledge base. The environment of the present research is the Technology department of Heerema Marine Contractors. To manage the research process, the principles of process management (De Bruijn, Heuvelhof, & Veld, 2010) are adopted; create an open and safe decision making process during the research. Following the design science research methodology leads to a rigorous research process, and ensures the relevance of the research for the environment under study. In the next sections of this summary, the results of this research are presented, highlighting the answer to the main research question, as well as the practical and the scientific contribution of this research.

Overview of research process

1. *Development of the theoretical basis of explicit knowledge reuse and influencing factors*

The first step of this research is the construction of the theoretical basis for the factors that support or hinder reuse of explicit knowledge. Initially, the map to categorize the factors was constructed and then an extensive literature review followed for the identification of the factors. The factors then inserted in

the developed map, and the result was the Theoretical Factorial Knowledge Reuse Model. This model was the basis for the development of the theoretical requirements for an unproblematic explicit knowledge reuse process. These requirements guided both the assessment of the current situation in HMC and the design of the strategy for improvement.

2. *Assessment of the current explicit knowledge reuse in HMC Technology*

Having constructed the theoretical basis and the requirements for an unproblematic explicit knowledge reuse process, the HMC Technology environment is explored. The assessment of the current situation in HMC aimed on the identification of the areas that require improvement regarding the reuse of explicit knowledge. To achieve that firstly a desk research in the company documents and the "Knowledge Management Upgrade" (KMU) project was done. A survey among the Technology department employees followed, aiming to cross examine findings, and to let employees give insight for the improvement needed. Triangulation of research methods contributed to clearer picture regarding the improvement needed in explicit knowledge reuse. The analysis indicated that major room for improvement exist in increasing employees "intention to reuse" explicit knowledge. Moreover, due to current technological initiatives in the company, the improvement focus was directed to the social and organizational sides of "intention to reuse". Finally, the opinion of the Technology Management was taken into account regarding the analysis indication and the improvement needed. Based on the desk research, the survey and the interview to Technology management, the factors that should be exploited in the improvement strategy were identified. These factors served as the basis for the development of the design requirements for the strategy to foster employees' intention to reuse explicit knowledge. Moreover, the principles that guide the KMU project were adopted to guide the design, aiming for increased fit in HMC Technology.

3. *Strategy design to foster intention to reuse in Technology HMC*

With the developed requirements and guiding principles to guide the design, the strategy to foster employees' intention to reuse in HMC Technology was devised. Initially, the solution space was generated, and then a morphological chart and the "Pugh" method were used to converge the solution space to a final selected design concept. The elements of this final concept were combined to develop the preliminary strategy design. This design was evaluated by the Technology Management for its acceptability, and the evaluation recommendations were integrated to the design. The result was the final strategy to foster employees' intention to reuse in HMC Technology, and is summarized below.

The strategy consists of three layers, namely the strategy foundations, the strategy layers and the strategy enablers. Knowledge Management governance mechanisms are the foundations upon which the strategy was built. These mechanisms are management's commitment and leadership, allocation of roles and responsibilities, monitoring and strategy risk management. As levers of the strategy to foster employees intention to reuse, were used the people management practices communication, training, formalization and recognition of knowledge reuse. Using elements from these levers, 5 KR enabling initiatives were constructed, which are supported by specific governance mechanisms. It is worth mentioning that KR initiatives will successfully enable people's intention to reuse explicit knowledge, only if they use people management levers' elements, and if they are supported by the KM governance foundations. These initiatives are summarized below:

1. *Lead reuse of knowledge in project teams:* This was achieved with the use of the KR Leadership Checklist, and Microtraining sessions for training on leading knowledge reuse through the Checklist. Aiming to strengthen leaders, external knowledge management practitioner certification is proposed.
2. *Promote knowledge reuse practice and benefits:* The use of KR Benefits Tree is proposed, which presents the benefits of KR for the individual, the project and the organization. Additionally, the use of KR success stories and the use of a HMC KM logo are proposed.
3. *Educate project team members:* A multi-training structure is proposed which includes KR mentoring, "Buddy" Microtraining coaching, short training sessions on knowledge reuse sources and systems, and job rotation.
4. *Recognize reuse of knowledge:* Recognition of KR practice is proposed through on the job informal praise, linking of knowledge reuse to annual performance assessment, and empowerment of employees through "Buddy coach" and "CoP leader" roles, as a result of knowledge reuse recognition.
5. *Facilitate knowledge flow in projects:* A process was created in the form of a Knowledge Flowchart. Key element in this process is the "Knowledge Plan", which includes the indicated knowledge that should be reused per project deliverable. KR Audits are proposed to ensure that this knowledge is actually used while working on the project deliverables.

The proposed strategy was then evaluated through a reflection on the design requirements to check whether an improvement is achieved in fostering employees intention to reuse. The final step was the development of a strategy implementation roadmap, to be used as a guideline by HMC Technology on the implementation of the strategy propositions.

4. Implications based on the HMC-Technology case

As a final step of this research, a reflection was attempted based on the HMC-Technology case, aiming to provide the rest project based engineering organizations with a perspective of the explicit knowledge reuse improvement process. In other words, a set of lessons were derived that can be of value to project based engineering organizations in the improvement of their explicit knowledge reuse processes.

Research result

The main question of this research was: *What factors support or hinder explicit knowledge reuse in the front end development of projects, and how can project based organizations in the engineering domain exploit them aiming to improve value in projects during their front end development?* Based on the answers to the research sub-questions, the main research question is answered:

- The identification and categorization of the factors that support or hinder reuse of explicit knowledge in the FED of projects should be done from an interdisciplinary point of view (technological, organizational, social) and per knowledge reuse sub-process.

- A successful exploitation strategy for these factors that will improve value in the FED of projects should be taken from an integrated point of view; the enablers of the knowledge reuse improvements should use elements from the strategy levers, and should be based on the strategy foundations.
- The improvement of explicit knowledge reuse should be an iterative process, rather than an implementation of an one shot solution.
- The design process of the explicit knowledge reuse improvement should be managed, aiming to cope with internal and/or external dynamics . Management of the process includes the creation of openness on the process and the results, and protection of involved parties' core values.

Practical and scientific contribution

This research has provided HMC Technology with insight on the improvement areas of explicit knowledge reuse, and with a specific strategy on how to foster employees' intention to reuse explicit knowledge. Therefore the practical goal of this research has been fulfilled. Recalling the scientific goal of this research, the answer to the research question fills the knowledge gap in literature regarding a scientific mapping of the factors that support or hinder explicit knowledge reuse in FED of projects, and the exploitation of these factors aiming to improve value in projects. The validity of this contribution is improved by the fact that a rigorous research process was followed. Nevertheless, the propositions are based on the single case of HMC. This fact limits the ability for generalization of findings and highlights the fact that the improvement process should be regarded more as a perspective rather than as a guideline for improvement.

Abbreviations

CoP	Communities of Practice
FED	Front End Development
HMC	Heerema Marine Contractors
KM	Knowledge Management
KMS	Knowledge Management System
KMU	Knowledge Management Upgrade project in HMC
KR	Knowledge Reuse
LL	Lessons Learned
MSD	Management System Documentation
PBO	Project Based Organization
PE	Project Engineer
P/SE	Project / Specialist Engineer
PM	Project Manager
PMS	Performance Management System
SE	Specialist Engineer
TAR	Tasks - Authorities - Responsibilities



1.1 Research motivation

1.2 Research objective

1.3 Research question and sub-questions

1.4 Research strategy

Chapter 1: Introduction to research

Introduction

In the contemporary business world, more and more organizations are organized around projects, especially in the engineering domain (Thiry, 2008). A project is defined in the second edition of the handbook of project based management (Turner, 1999) as " an endeavor in which human, financial and material resources are organized in a novel way to undertake a unique scope of work, of given specification, within constraints of cost and time, so as to achieve beneficial change defined by quantitative and qualitative objectives"

The organizations that their working processes are structured around projects, are called project-based-organizations (PBOs). The present research aims to study PBOs related to engineering domain, which means that the research object will be an organization that works on projects that aim on technological artifacts.

PBOs have established distinct work processes to successfully execute the projects that they undertake. These work processes constitute the life-cycle of projects. Turner (2008) distinguished the 4 project phases during the life-cycle of a typical project, namely the "proposal and initiation (concept and feasibility)", the "design and appraisal", the "execution and control" and the "finalization and close out".

According to Bosch-Rekveldt (2011), the early phases of a project are quite important in adding value to the project and are called Front End Development of projects. By early phases it is meant those ones that include all the business processes that will create a complete picture of the project, and will enable the PBO to execute the project successfully.

Good project definition in the front end development of projects can add significant value to a project (Hutchinson & Wabeke, 2006). Knowledge management is one of the so called *value improving practices* that provide input and add value to the standard activities and deliverables during the front end development (IPA, 2009a). More specifically, knowledge from past projects is seen in literature as an

important resource for future projects (Disterer, 2002), and management of such knowledge can provide PBOs with competitive advantage (Argote & Ingram, 2000; Argyris, 1991).

1.1 Research motivation

As explained above, knowledge is an important resource for projects. Knowledge exists in two forms; tacit and explicit. Tacit knowledge is connected with the context it was created and exists in people's minds while explicit can be articulated and communicated to other people in formal, systematic language (Nonaka & Takeuchi, 1995). Managing explicit knowledge consists of several processes which are distinguished to knowledge creation (creation/ acquisition, refinement and storage) and knowledge reuse ones (storage sharing/transfer, and utilization)(King, 2009; Markus, 2001). The final reuse process, utilization, includes multiple dimensions, meaning that knowledge can be used in multiple ways by the same user (Chung & Galletta, 2012).

Both academics (Disterer, 2002; Newell, 2005; Williams, 2008) and practitioners (KPMG, 2003) identified the processes of explicit knowledge reuse as problematic. In literature, the factors that cause problems in reuse processes and the factors that facilitate them are also proposed. However, there is hardly any attempt in literature to map those factors and provide PBOs with a systematic strategy to foster reuse of explicit knowledge by exploiting those factors.

Therefore, a knowledge gap is identified in literature that is addressed in the present research. The gap is found at the lack of mapping of the various factors that support or hinder explicit knowledge reuse, and at the lack of a strategy for fostering reuse of explicit knowledge in PBOs, by exploiting those mapped factors.

For illustrative purposes of this research, Heerema Marine Contractors (HMC) is used. HMC is a leading offshore contracting company that provides innovative solutions to almost all major companies in the oil and gas industry. Aiming to be prepared for its challenging envisaged future, HMC strives for continuous improvement of its services. Reuse of the explicit knowledge that is generated or acquired during projects is a factor that leads to continuous improvement. Therefore, the aim of this thesis to foster the reuse of explicit knowledge, is of high value for the organization.

Having in mind the knowledge gap in literature and its relevance for the PBOs in the engineering domain, the practical and scientific problem statements of this research are formulated below:

Practical problem statement

Project based organizations are often not exploit fully the reuse capabilities of explicit knowledge from previous projects. There seem to be some factors that influence explicit knowledge reuse in front end development of projects. It is expected that proper manipulation of those factors can have a positive influence on explicit knowledge reuse and as a result on improving value in projects during their front end development.

Scientific problem statement

A clear scientific mapping of the factors that support or hinder explicit knowledge *reuse in the front end development of projects, and what such a mapping entails for a strategy to foster reuse of explicit knowledge in project based organizations in the engineering domain is not present yet. This is an important knowledge gap in the research field that focuses on knowledge reuse.*

1.2 Research objective

Aiming to address the problem statements that identified and presented above, the research objective can be formulated as such:

The objective of this research is to provide project based organizations with insight on explicit knowledge *reuse during the front end development of projects, by mapping the factors, and by designing a strategy to foster explicit knowledge reuse by exploiting those factors, aiming to improve value in projects.*

This objective entails a scientific goal that aim to contribute to the scientific body of knowledge and a practical goal that aim to provide organizations with certain recommendations for action:

- *Scientific goal*
  This research aims to contribute to the scientific knowledge base by proposing a scientific mapping of the factors that influence explicit knowledge reuse, and by proposing a strategy to foster explicit knowledge reuse by exploiting those factors, aiming to improve value in projects during their front end development.

- *Practical goal*
  This research aims to provide project based organizations with insight on reuse of explicit knowledge, by giving recommendations on how to manipulate the factors that influence explicit knowledge reuse in the front end development of projects.

1.3 Research question and sub-questions

Research question

The central research problem addressed in this thesis can be stated in the form of research questions. These questions will steer the researcher in the whole research period towards the direction of addressing the research problem. Based on the research objective formulated above, this thesis aims to answer the following **main research question**:

What factors support or hinder explicit knowledge reuse in the front end development of projects, and how can project based organizations in the engineering domain exploit them aiming to improve value in projects during their front end development?

Research sub-questions

The above stated research question is kept generic in purpose, to cover the whole area of the problem. Afterwards, nine research sub questions are formulated. These sub-questions are in fact more manageable questions, which, taken together, will enable the answering of the main question. Moreover, they will steer the research to stay on track and they serve as a basis for the methodology and planning of the research. The questions are formulated below and are structured in four categories:

Project-based organizations in the engineering domain

1. Theories on explicit knowledge reuse processes and factors
- **1.1.** How can the factors that influence the reuse of explicit knowledge be mapped?
- **1.2.** What are the factors that influence explicit knowledge reuse in front end development of projects proposed in literature?
- **1.3.** What are the theoretical requirements of an unproblematic explicit knowledge reuse process?

Specific/Business Case: Technology Department of Heerema Marine Contractors

2. Assessment of current situation regarding reuse of explicit knowledge in the organization under study
- **2.1.** What are the areas of improvement in current explicit knowledge reuse in FED of projects by the Technology department of HMC?
- **2.2.** What is the importance of the factors that influence the reuse of explicit knowledge?
- **2.3.** What are the design requirements and guiding principles for the strategy to foster reuse of explicit knowledge in the Technology department of HMC?

3. Design of strategy to foster reuse of explicit knowledge
- **3.1.** What strategy should the Technology Department of HMC deploy to foster explicit knowledge reuse?
- **3.2.** How can the developed strategy be implemented in the Technology department of HMC?

4. Based on the HMC-case, what value can be extracted for the rest project-based organizations in the engineering domain?

1.4 Research strategy

A certain research methodology should be used while carrying out the proposed research. In that way it is ensured that the problem will be addressed successfully. Hevner et al. (2004) described a conceptual framework that guide researchers to understand, execute and evaluate design research. The conceptual framework consists of three main blocks, namely the environment, the design science, and the knowledge base. The environment "defines the problem space in which the problem of interest resides". The knowledge base provides the research with "scientific raw material with which the design will be accomplished". The design science "addresses research through the building and evaluation designs that are created to meet the identified business need in the environment" (Hevner et al., 2004).

Scientific rigor in the design research is achieved initially by applying existing theories and methodologies and afterwards by contributing with the design to knowledge base. On the other hand practical relevance is achieved by identifying a practical problem and designing a solution for an existing organization. An illustration of the design science research framework is displayed below.

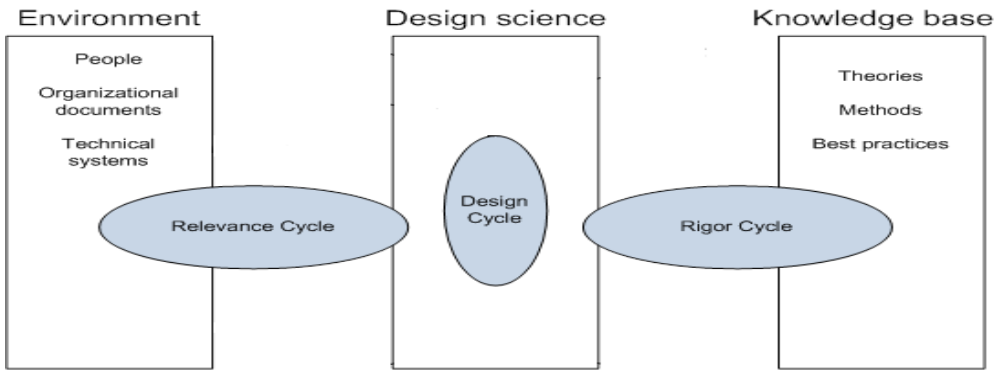

Figure 1 – Generic research framework for design science research (Hevner & Chatterjee, 2010)

The research methodology for this thesis is developed based on the guidelines presented in that paper (Hevner et al., 2004) and consists of six main steps that are in line with the research sub questions that are presented in the previous section.

First methodological step of this research is the description of the scope of the problem in the environment under study. Since Technology department of HMC was chosen as appropriate case, a discussion with department's management results a specific scope with clearly defined boundaries for this research. More specifically in this phase it was decided that the thesis will focus on the factors that influence explicit knowledge reuse in the FED of projects.

The **second** methodological step includes extensive desk research in the scientific body of knowledge to identify the scientific knowledge gap regarding knowledge reuse. In this step the framework to map the factors that influence explicit knowledge reuse is created. This map answers *sub-question 1.1*. Then, an extensive literature research follows, aiming to identify the factors that are proposed in literature. These factors are categorized based on the developed map and together with the map construct the theoretical factorial knowledge reuse model. The latter is the answer to *sub-question 1.2* of this thesis. Finally, based on that theoretical model, the theoretical requirements of an unproblematic explicit knowledge reuse process are defined. Those requirements answer *sub-question 1.3* of this thesis.

The **third** methodological step consists of the gap analysis in the selected organization under study. The analysis includes the assessment of the current situation in the Technology department of HMC regarding reuse of explicit knowledge in FED of projects. The assessment is done through desk research in the company's documents and a survey among the employees, aiming to cross examine the information. The assessment reveals the areas for improvement in current explicit knowledge reuse in the company, and thus answers *sub-question 2.1*. The survey among the employees results also to the importance of the factors that influence explicit knowledge reuse according to the opinion of the employees and thus answers *sub-question 2.2* of this thesis. The gap analysis is completed by taking into account the opinion of management for the improvement needed.

In the **fourth** methodological step, the functional requirements and the guiding principles of the desired design are developed based on the areas of improvement that identified by the gap analysis. These requirements and guiding principles answer *sub-question 2.3*. Furthermore, the solution space is generated, and the guiding principles are used to select one among the design alternatives in a semi-structured discussion with an HMC knowledge management expert. The selected design alternative is further detailed and the result is the preliminary design. This step concludes with an evaluation of the preliminary design. The evaluation is done through a semi-structured discussion with a knowledge management expert within HMC. The recommendations for improvement are incorporated to the final detailed design. This final detailed design answers *sub-question 3.1* of this thesis.

In the **fifth** step, certain recommendations for implementation of the final design to the organization will be made. These recommendations answer *sub-question 3.2* of this thesis and also close the loop of relevance of this research.

The **sixth** step of the research method closes the loop of scientific rigor of that research. In that phase, the value of the design for other project based organizations is discussed, and thus *sub-question 4* is answered. The value is ensured by the verification of the propositions in practice and the use of scientific knowledge at the initial stages of this research.

An illustration of the above mentioned steps is displayed in figure 2 below:

Research framework

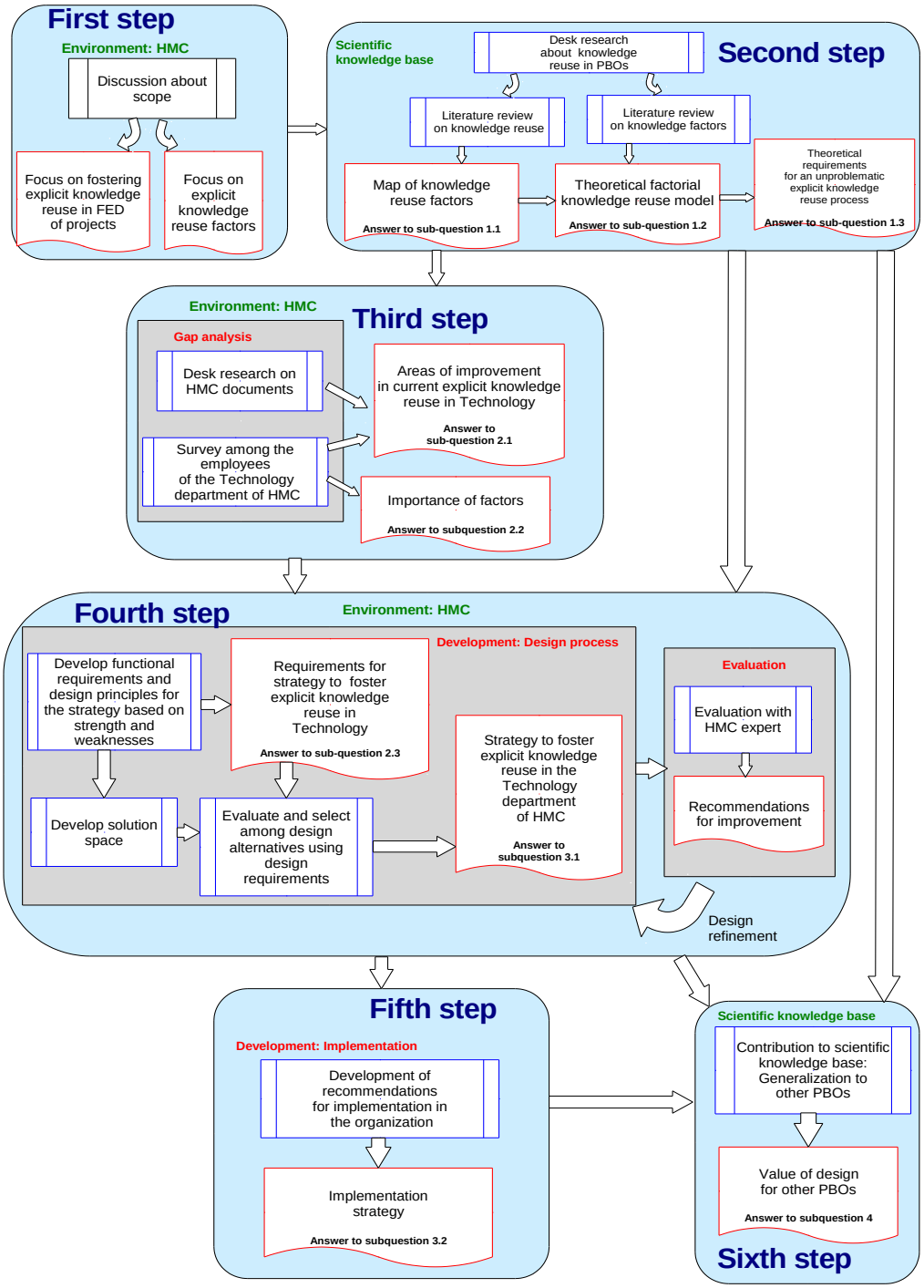

Figure 2 – Research framework based on Hevner et al. (2004)

Before closing this sub-chapter, a crucial remark concerning the management of the research approach should be made. The research within HMC regarding the improvement of knowledge reuse, includes both external and internal dynamics. The external dynamics are created from parties outside HMC in the oil and energy industry, with more and more oil companies requiring knowledge management practices from offshore contractors for contract awarding. On the other hand, internal dynamics for this research exist within HMC, due to the internal project for upgrading knowledge management practices in the company, which continuously transmutes the problem and objective that this research project aims to address.

In this highly dynamic environment, a project management approach for the research would be impossible; therefore, there is a need for process management approach (De Bruijn et al., 2010) for the research. According to the authors, for such an approach it is important to involve the relevant parties in the various research steps. Recalling the research methodological steps that presented above, both engineers and managers are involved in the research process aiming to create openness. By involving the Technology engineers in the survey, a sense of urgency is created for improvement of knowledge reuse practices. On the other hand, by actively involving knowledge management experts in the design process, the sense is created that the design is the result of a negotiation process. The sense of urgency and negotiation, as well as openness in the decision making of the research process are key elements of a process management approach (De Bruijn et al., 2010).

However, openness is not without risks for the involved parties (De Bruijn et al., 2010). For that reason, the authors propose that it is crucial to create a safe process, in which the parties' core values are protected. Aiming for protection of corporate core values, reassurance regarding confidentially of corporate information is given to the HMC knowledge management experts in the semi-structured discussions. De Bruijn et al. (2010) mentions corporate information as an important value that should be protected aiming to keep management onboard in the improvement process. Finally, an anonymous survey is used for the analysis of the current situation instead of personal interviews, aiming for confidentiality of engineers' opinions about the improvement needed in the current situation.

Conclusion

In this chapter the research strategy of this thesis was defined. After a short introduction in the scientific area of projects and their front end development, the motivation for this research was presented. The motivation concluded with the specific practical and scientific problem statements that are addressed in this thesis. Aiming to address the research problems, the research objective was presented in section 1.2, based on which, the following research question is formulated in section 1.3:

What factors support or hinder explicit knowledge reuse in the front end development of projects, and how can project based organizations in the engineering domain exploit them aiming to improve value in projects during their front end development?

Nine research sub-questions were developed afterwards, the answers of which will lead to the answer of the main research question. Answering the research sub-questions is based on a specific research framework. To construct such a framework, the "design science" methodology that proposed by Hevner

et al. (2004) was adopted. This framework provides the researcher with a specific methodology consisting of six steps that ensure successful answer of the research question. Finally, for the management of the research process, the principles of process management were adopted (De Bruijn et al., 2010).

To conclude, the report of this research consists of 11 chapters which are structured in 4 main phases: Orientation, Exploration, Development and Reflection. An overview of the report structure, the related chapters, and the research sub-questions that are answered in the chapters is presented in table 1 below:

Orientation	Exploration	Development	Reflection
Chapter 1 Introduction to research	**Chapter 3** Factorial Knowledge Reuse Model *Research question 1.1* *Research question 1.2* *Research question 1.3*	**Chapter 6** Generation and evaluation of design concept alternatives	**Chapter 10** Implication of research based on HMC-Technology case *Research question 4*
Chapter 2 Context of KR in FED of projects	**Chapter 4** Introduction to the HMC-Technology case	**Chapter 7** Preliminary design of strategy to foster intention to reuse explicit knowledge	**Chapter 11** Thesis conclusions and reflection
	Chapter 5 Assessment of current explicit knowledge reuse in FED of projects by Technology *Research question 2.1* *Research question 2.2* *Research question 2.3*	**Chapter 8** Preliminary design evaluation and final strategy design *Research question 3.1*	
		Chapter 9 Roadmap for implementing the strategy in HMC Technology *Research question 3.2*	

Table 1 – Overview of the report structure, related chapters and the research sub-questions



2.1 Projects and Project-Based-Organizations
2.2 FED of projects
2.3 Knowledge and Knowledge Management
2.4 Knowledge Reuse

Chapter 2: Context of Knowledge Reuse in FED of projects

Introduction

In this section the context of knowledge reuse in Front End Development (FED) of projects is described. Initially project based organizations (PBOs) are introduced and then the FED phases of projects are explained. Knowledge management is identified as a practice that adds value to FED of projects, and is distinguished among knowledge creation and knowledge reuse processes. The latter are mentioned in literature as a tricky task.

2.1 Projects and Project Based Organizations

In the contemporary business world, more and more organizations are organized around projects, especially in the engineering domain (Thiry, 2008). A project is defined in the second edition of the handbook of project based management (Turner, 1999) as:

> " an endeavor in which human, financial and material resources are organized in a novel way to undertake a unique scope of work, of given specification, within constraints of cost and time, so as to achieve beneficial change defined by quantitative and qualitative objectives"

From this definition, three characteristics can be identified that all projects have in common. The first is their temporary nature. Secondly, it is the fact that they are bounded to certain constraints and thirdly that they are created aiming to perform a specific scope of work.

The organizations that their working processes are structured around projects, are called project-based-organizations (PBOs). Examples of PBOs can be found in almost all industries like oil & energy industry, aeronautics, car, IT, offshore etc. The present research aims to study PBOs related to engineering domain, which means that the research object will be an organization that works on projects that aim on technological artifacts.

Projects can be incorporated within an organization in three major forms (Meredith & Mantel, 2010). The first form according to the authors is when projects are part of the functional divisions of the organization. The second form is the pure project organization form, in which the projects are separated entities from the parent organization that have their own technical and administrative staff. The communication between the project entities and the parent organization is done through periodic progress reports. The third and most common organizational form in PBOs is the one that combines feature from both previous forms, the matrix organization. Matrix organization can vary from "strong matrix" to "weak matrix", depending on whether it is closer to pure project organization or functional organization respectively. Between these two extremes is the balanced matrix. In such an organizational form, employees are organized in functional groups and are involved in one or more projects, resembling project work to that of external contractors. According to McNamara (2006) the principle behind the matrix organization forms is that project work quality is increased (Barney, 2011). The matrix organizational form of projects in a simplified form is displayed in the figure 3 below:

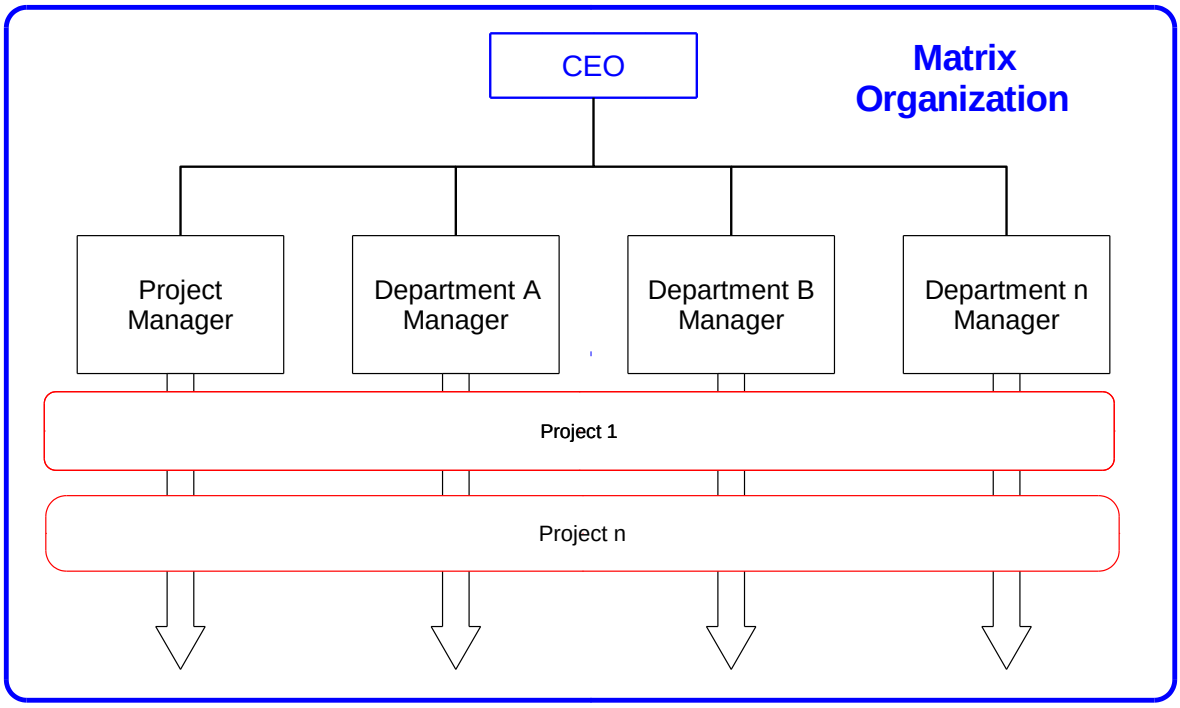

Figure 3 – Simplified version of a matrix organization

After having explained how projects are housed within the parent organizations, it is time to describe the organization of the projects themselves. After a project is assigned to the PBO, a project team that focus on the objectives of the project (Meredith & Mantel, 2010) is created, with a lifetime equal to project lifetime (M. Ajmal, Helo, & Kekäle, 2010). The organizational set-up of that team may vary across projects, since each project has unique needs and objectives, but in general there are standard roles within the team that needs to be respected. According to Barney (2011), within a project team of a PBO, two different groups coexist and cooperate. The first group is the engineering one that performs all the

technical work and is coordinated by the Project Engineer. The second is the control group, which controls the project in terms of budget and schedule and is coordinated by the Project Controller. Both the Project Engineer and the Project Controller report to the Project Manager, who is in charge of the general overview of the project. Figure 4 below displays the high level organizational set-up of projects in PBOs in the engineering domain:

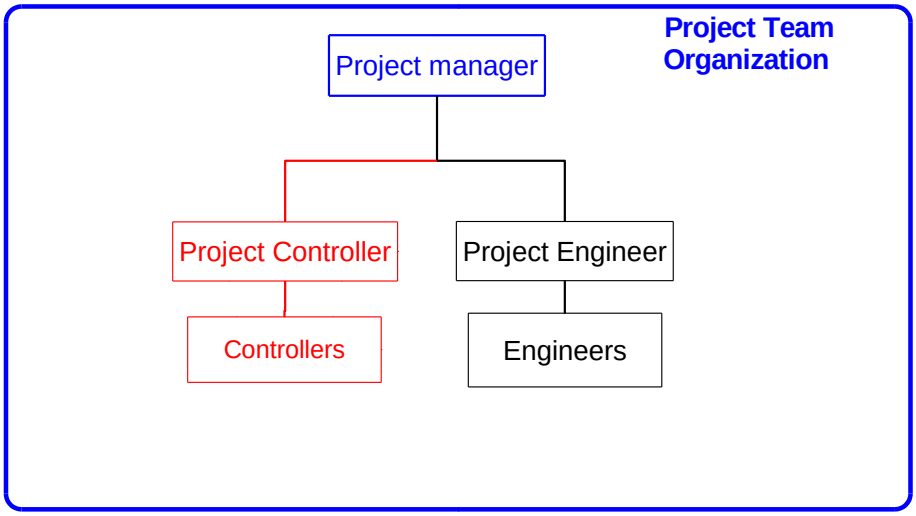

Figure 4 - Organization of Project Teams in the engineering domain

2.2 Front end development of projects

PBOs have established distinct work processes to successfully execute the projects that they undertake. These work processes constitute the life-cycle of projects. Turner (2008) distinguished the 4 project phases during the life-cycle of a typical project, namely the "proposal and initiation (concept and feasibility)", the "design and appraisal", the "execution and control" and the "finalization and close out".

According to (Bosch-Rekveldt, 2011), the early phases of a project are quite important in adding value to the project and are called Front End Development of projects. By early phases it is meant those ones that include all the business processes that will create a complete picture of the project, and will enable the PBO to execute the project successfully. In literature, different names are used from the different authors for the phases that constitute FED. The table 2 below displays the different names that are used to describe the FED of projects (Bosch-Rekveldt, 2011):

Terminology for Front End Development phases in literature			
Sources			
(Bosch-Rekveldt, 2011)	FED 1	FED 2	FED 3
(Turner, 2008)	Concept	Feasibility	Design
(Morris & Hough, 1987)	Pre – feasibility	Feasibility	Design
(De Groen, Dhillon, Kerkhoven, Janssen, & Bout, 2003)	Define business case	Do conceptual design	Do basis engineering
(IPA, 2009a)	Appraise	Select	Define
(Hutchinson & Wabeke, 2006)	Identify and assess	Select	Define

Table 2 – Terminology for Front End Development Phases in literature

During the FED phases, the complete picture of a project is sketched through answers on questions concerning the why, what, when, where, and who about a project (IPA, 2009a). Although the business processes that answer such questions may differ across organizations and projects, a rough description of each FED phase and the related business processes is attempted below.

In the first FED phase are included all those processes that define what the team is trying to do (Merrow, 2011). Examples of business processes included in this phase are the translation of business objectives to required project performance, the organizational set up of a project team, the initial project planning and an initial project risk identification (Bosch-Rekveldt, 2011).

During the second FED phase, all the processes that are included aim to identify the optimal choices to meet the project objectives and to select those choices. Examples of business processes in this phase are the selection of specific technologies, the definition of the resources that are needed for the project, the cost and revenue assessments and the identification of critical operations and risks (Bosch-Rekveldt, 2011).

Finally during the third FED phase, the chosen alternatives are elaborated and defined to a level of detail that is sufficient for the next phase, i.e. the execution of project. Examples of business processes in this phase are the final estimations of costs, revenues and risks, the final planning and scheduling of execution operations and the freeze of concepts.

The FED of projects require special research attention, because according to Hutchinson & Wabeke (2006) the value that is added during the FED phases is of major importance for the overall project value. In figure 5 is displayed the influence of FED phases on the value of a project:

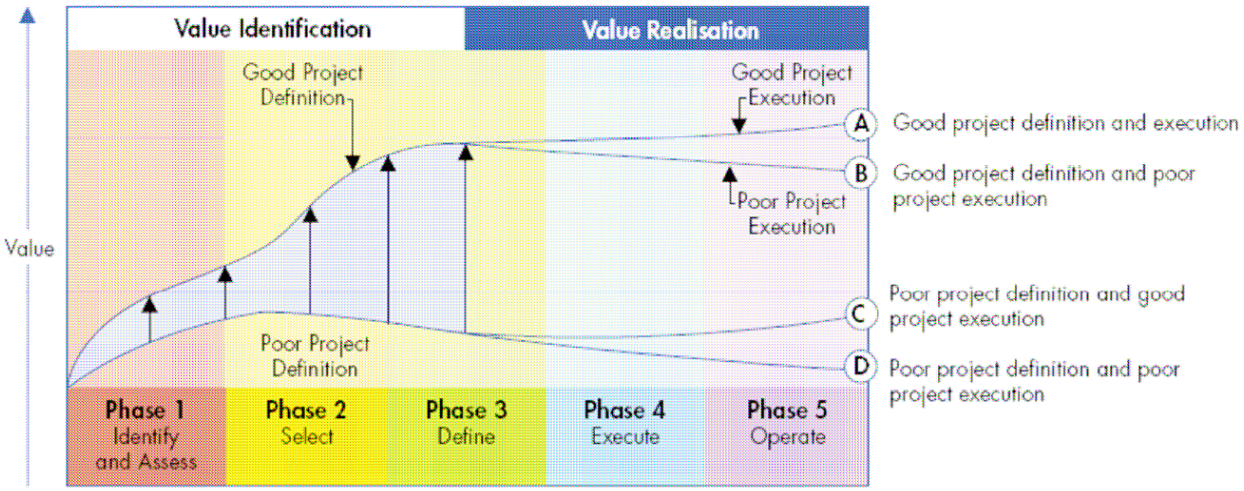

Figure 5 - Influence of FED phases on project value (Hutchinson & Wabeke, 2006)

According to Hutchinson & Wabeke (2006) good project definition (by definition) adds a lot more value to a project compared to poor project definition. Although poor project execution possibly leads to a bigger devaluation of the project than shown in the figure (Bosch-Rekveldt, 2011), still the influence of front end development of projects is high.

To ensure a good project definition, project based organizations can use the so-called *value improving practices*, which are those activities during the front end development that provide input and add value to the standard activities and deliverables (IPA, 2009b). In literature, knowledge management is mentioned as one of those value adding practices (NAP, 2009), while in some cases (CII, 2009), Lessons Learned is specified as an example of knowledge management practice that adds value in the FED of projects.

Managing knowledge is a practice that adds value in projects, as knowledge from past projects is stated in literature as an important resource for the development of the following projects (Disterer, 2002). Other authors mention that knowledge management is a quite important practice for PBOs as it provides them with competitive advantage to survive in harsh competition (Argote & Ingram, 2000; Argyris, 1991). For those reason, the concept of knowledge and the practice of managing knowledge are dealt frequently in literature. In the following section, the concepts of knowledge and learning in projects are explained, and then an elaboration on the concept of knowledge management is attempted.

2.3 Knowledge and Knowledge Management

As mentioned in the previous section, knowledge management (NAP, 2009) is stated in literature as one of the value improving practices in the FED of projects. In this section, knowledge and learning in projects are explained, followed by a closer view on knowledge management.

Knowledge and learning in projects

In the process of explaining the concept of knowledge, any description that misses to explain the relation with data and information is incomplete. Ackoff (1989) explained in his study the concepts and relations of data, information and knowledge. According to the author, data is any "raw" symbol that has no meaning. Information is data with a meaning, which is given by a relational connection of the raw data. Knowledge is information, whose content is useful, in the sense of knowing the context that this information can be used. The definition of the concepts above is supported also by the European Committee for Standardization (CEN, 2004).

Nonaka & Takeuchi (1995) in their fundamental work for knowledge "the knowledge creating company", identified two types of knowledge, namely the tacit and the explicit. According to the authors, the first is knowledge that is connected with the context it was created and exists in people's minds. Therefore it is difficult to formalize and communicate it to others. On the contrary, explicit or codified knowledge can be articulated and communicated to other people in formal, systematic language. Also it is easy to document it and store it for future use.

Based on those two types, Nonaka & Takeuchi identified 4 conversions of knowledge. The first two, socialization and combination, are conversions to the same type. When people interact and share their experiences, then new tacit knowledge is created from the tacit knowledge of the participants in the interaction. On the other hand, when different bodies of explicit knowledge are combined then this process is known as combination.

When people convert their knowledge from tacit form to explicit then this process is known in literature as externalization of knowledge, while the opposite process, i.e. from explicit to tacit is known as internalization of knowledge (Nonaka & Takeuchi, 1995; Thorogood & Tejay, 2010). These two processes constitute the life cycle of knowledge in projects (Thorogood & Tejay, 2010). The authors proposed a high level cycle, which starts with the process of externalization of project knowledge that is done by the knowledge producers, and continues with the process of internalization of knowledge which is done by knowledge consumers that use the past experience in their new case. When new knowledge is created in the new case, the cycle starts again. The life cycle of projects that proposed Thorogood & Tejay (2010) is presented in figure 6.

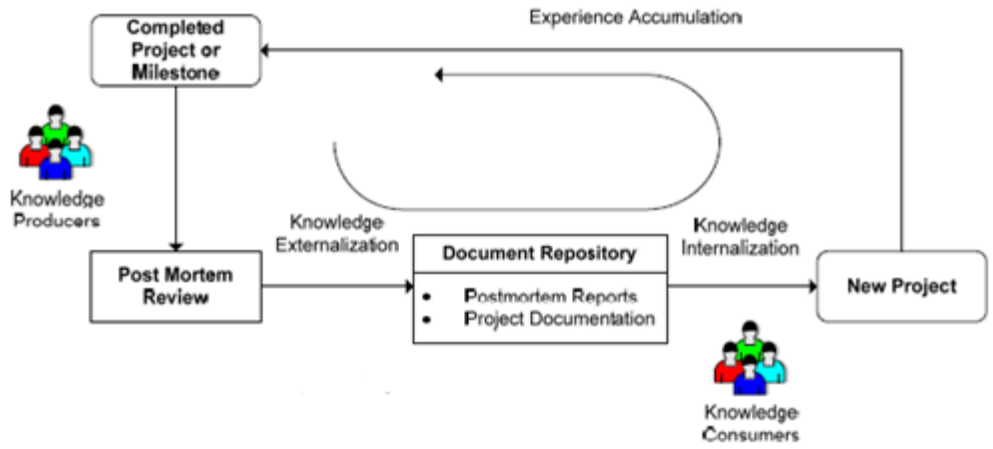

Figure 6 – Life cycle of knowledge in projects (Thorogood & Tejay, 2010)

Knowledge, in both forms, is the basic determinant of project teams' ability to prepare and execute a project with success (Lam & Lambermont-Ford, 2010). While working on projects, the team members are confronted with issues that need to be addressed. In those cases, the project teams either create new knowledge or use existing knowledge that was created in previous projects and is available to them. The knowledge that is created in projects is distinguished in three types (Kasvi, Vartiainen, & Hailikari, 2003):

1) Technical knowledge, which is knowledge concerning the product its parts and the related technology
2) Procedural knowledge, which is knowledge concerning producing and using of the product and acting in a project
3) Organizational knowledge, which is knowledge concerning collaboration and communication in a project.

Using knowledge from previous projects is known in literature as cross-project learning (M. Ajmal et al., 2010; Barney, 2011). To be more specific, cross project learning takes place when knowledge that is created in a project (mostly tacit), is articulated (converted to explicit) and communicated to another project team that uses it to address issues in their case currently or in future. Cross-project learning shows that an organization has learned from previous experience (Barney, 2011).

Although knowledge is stored in norms, procedures, rules and forms of the organizations (March, 1991), organizational learning is not something that comes naturally. Argyris (1991) notes that although organizational learning is more and more an important determinant of market success, organizations don't seem to learn simply because "most people don't know how to learn yet". On top of that the temporary nature of projects, makes cross project learning an even more difficult process. Due to these difficulties, knowledge has to be managed in PBOs in order for cross-project learning to be achieved. In fact, King (2009) suggested that organizational learning is the goal of knowledge management. Therefore managing knowledge is quite important for PBOs as it will provide them with competitive advantage to survive in harsh competition (Argote & Ingram, 2000; Argyris, 1991).

Knowledge management

The outcomes of projects are not only the final delivered products or services, but also the generated technical, procedural and organizational knowledge from the project (Kasvi et al., 2003). PBO's are actually "knowledge intensive" organizational structures (Barney, 2011; InFocus, 2012). The life cycle of knowledge in projects consists of the processes of externalization and then internalization of knowledge. When this cycle happens across projects then this cycle represents also cross project learning.

A strategy for cross project learning in PBOs that follows that processes, is codification (Williams, 2008). According to that approach, the knowledge that is created in a project, which is basically in tacit form in the minds of project teams, is externalized and thus converted to explicit knowledge, which is documented and stored in a repository. In a later phase of the same project or in a future project, that explicit knowledge may be retrieved from a project team and recontextualized, i.e. used in a new case. The idea behind this strategy is that explicit knowledge can be effectively and efficiently shared (Herschel, Nemati, & Steiger, 2001). Moreover, codification is useful when experts' interaction is too consuming, when experts find that they are staring to lose a certain skill or knowledge, or when is a net loss of experts from an organization (De Bruijn & De Bruijn, 2010).

The strategy that is presented above is in other words a way to manage knowledge in projects. An exemplary definition of Knowledge Management (KM) is given by Erik Andriessen in the book of Verburg, Ortt, & Dicke (2006):

> *"Knowledge management is the process of systematic organizing and managing knowledge processes, such as identifying knowledge gaps, acquiring and developing knowledge, storing, distributing and sharing knowledge, and applying knowledge."*

Within this definition one is easy to identify the different processes that KM is consisted of. Towards the same direction, King (2009) proposed the KM Process Model, which explain the relations of the different processes. In the figure below, the processes of explicit KM and their relation is displayed. The figure is adapted and from King (2009), by excluding the tacit KM processes and is presented in figure 7 below.

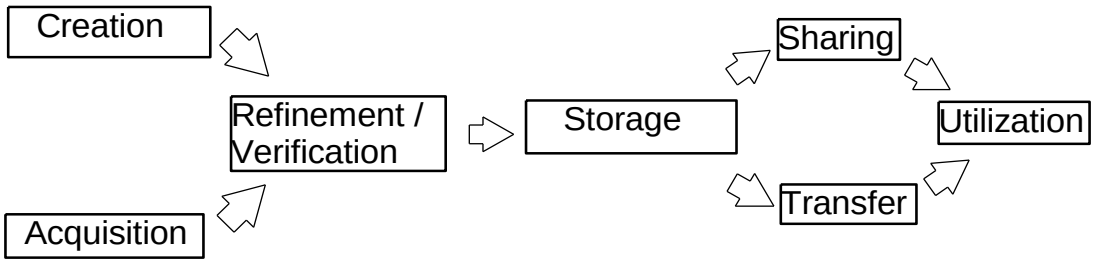

Figure 7 – Knowledge Management process model (adapted from King, (2009)**)**

Once the knowledge has been created or externally acquired, it is reviewed and refined by the related experts, and then stored in an electronic repository or physical archive. Once it is stored, knowledge can

be shared or transferred to the knowledge user for application to a new case. Transfer and sharing describe two similar processes that differ only in terms of the focus and purpose of communication. Transfer describes the process that a sender communicates with a known receiver to pass knowledge (Schwartz, 2006). Sharing on the other hand is a less focused dissemination of knowledge to anyone that might be interested and that is unknown to the sender (Schwartz, 2006).

The knowledge management processes above are related to the knowledge conversion processes. Markus (2001) categorized the knowledge processes to knowledge creation (creation/ acquisition, refinement and storage) and knowledge reuse ones (storage, sharing/transfer, and utilization). During creation of knowledge all four knowledge conversion processes may take place. However, when the created knowledge is in tacit form (socialization, internalization), in order for it to be stored, the created knowledge should be externalized and thus converted to explicit form. During the reuse of knowledge, and more specifically in the utilization phase, the knowledge user "recontextualizes" the knowledge. This is in fact internalization of knowledge from the knowledge user. As mentioned earlier, the externalization followed by the internalization of knowledge, are the two phases of the knowledge life cycle in projects.

2.4 Knowledge Reuse

Knowledge from past projects is an important resource for future projects (Disterer, 2002), and management of such knowledge can provide PBOs with competitive advantage (Argote & Ingram, 2000; Argyris, 1991). Looking from this perspective, the focus of knowledge management is more on exploitation of knowledge than to exploration of knowledge (March, 1991). The exploitation of explicit knowledge, or in other words the reuse of existing explicit knowledge consists of sharing or transferring and then applying the stored knowledge as explained above.

Nevertheless, both academics (Disterer, 2002; Newell, 2005; Williams, 2008) and practitioners (KPMG 2003) identified barriers in the explicit knowledge reuse processes, and thus characterized those processes in PBOs as problematic. The factors that are related to creation or overcoming of the barriers are presented in the next chapter. However, before exploring those factors, it is crucial to elaborate more on the concept of explicit knowledge reuse, by describing the different activities that are included in this process.

Knowledge reuse situations and activities

Markus (2001) in her study towards a theory of knowledge reuse, identified four types of knowledge reuse situations. The types are distinguished based on the knowledge re-user and the purpose of knowledge reuse. The principle to distinguish different knowledge re-users is the distance that people that reuse knowledge have from people that produced that knowledge. To be more specific, the four types are the shared work producers, the shared work practitioners, the expertise-seeking novices and the secondary knowledge miners (Markus 2001). Shared work producers are the producers of knowledge for their own reuse later. An example of such type is physicians that that review prior entries

in patients' medical records. Shared work practitioners are people that do work in similar settings, and thus they produce knowledge for each other's use. An example of such type is oil field maintenance workers that occupy the same roles in different settings or locations. Expertise-seeking novices are people that occasionally need knowledge and because of that rare need they do not create it themselves. An example of this type is customers that contact a firm's technical support experts to ask questions. Finally, secondary knowledge miners are those who search for knowledge of other people to analyze and create new knowledge from that analysis. An example of that type is analysts in banks that work on data mining to come up with new knowledge about customers or products.

Markus (2001) identified also four activities that take place during the knowledge reuse process for all types of knowledge reuse situations. The first activity is the definition of the search question by the knowledge recipient and is regarded as crucial for the success of knowledge reuse (Markus, 2001). The second activity involves the process of searching for expertise and the third is the process of assessment and selection among the search results. As final activity the author identified the application of knowledge, or as he calls it the "recontextualization" of knowledge that was captured, codified, and stored in a repository. Recalling the knowledge reuse processes that are presented above (search for stored knowledge, sharing/transfer, and finally utilization of the knowledge), the reuse activities of Markus (2001) can be related to those reuse processes. Figure 8 below illustrates the relation:

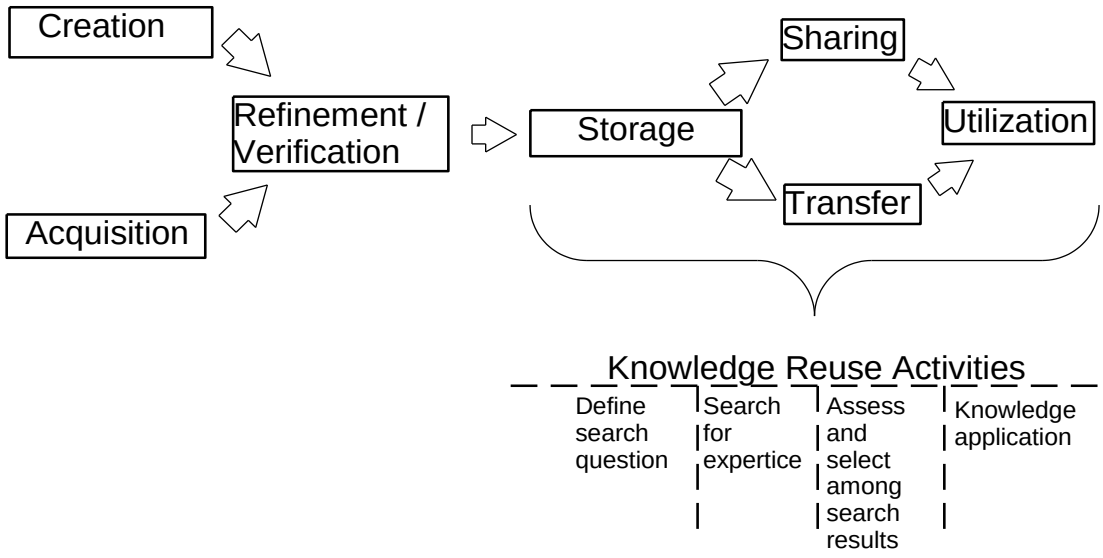

Figure 8 - Phases of the knowledge management model and relation to knowledge reuse activities (King, 2009, Markus, 2001)

Factors that support or hinder the reuse of explicit knowledge exist in all reuse activities. However, before searching in literature for those factors, it is crucial to elaborate on the final activity of reuse, i.e.

utilization of knowledge in projects. An explanation of the concept of knowledge utilization and the dimensions that it involves follows in the next section.

Knowledge utilization dimensions

The last knowledge reuse activity, knowledge utilization or application, is a concept that underlies several dimensions. The concept utilization grasps the way in which the knowledge user applies a knowledge object.

In literature, three dimensions along which knowledge can be utilized are discussed, namely "conceptual use", "affective use" and "innovative use" (Chung & Galletta, 2012). The authors proposed that conceptual use takes place when the thinking perspective of the knowledge re-user is shifted without a necessary change in his behavior. In other words, when the knowledge user uses a knowledge object his current knowledge base expands by adding that shift to its current mental structure. Markus (2001) mentioned that re-users use knowledge in such a way aiming to approximate the knowledge of experts.

The second dimension is the affective use, which captures the extent to which the knowledge re-user applies knowledge to develop positive feelings about an already made decision or in other words to provide ad hoc justification to a decision (Chung & Galletta, 2012). Markus (2001) identified such a utilization of knowledge, when decisions need to be revisited and the re-users recall reasons for that. Liu et al (2008) also identified that dimension of knowledge utilization, when re-users aim to support their decisions.

Finally behavioral use takes place when use of a knowledge object results to direct change in re-users behavior, decision or practices (Chung & Galletta, 2012). The authors identified that along this dimension knowledge can be used either incongruently or congruently. Congruent use of knowledge for replication is studied by Markus (2001), Szulanski, (2000) and Kulkarni, Ravindran, & Freeze, (2007), while incongruent use of knowledge is studied by Majchrzak, Cooper, & Neece, (2004), Faniel & Majchrzak (2007) and again Kulkarni, Ravindran, & Freeze, (2007).

Behavioral use of knowledge in projects

Learning across projects is more and more an important determinant for PBOs' survival in harsh competition advantage (Argote & Ingram, 2000; Argyris, 1991). However, learning from past projects to the benefit of future projects, presents major challenges. Prusak (1997) and Prencipe & Tell (2001) mention that organizations fail consistently to learn from past projects, i.e. they tend to "reinvent the wheel" and to repeat mistakes (Disterer, 2002). On the other hand, Milton (2010) mentions that learning across projects is achieved only if the experience from past projects is applied in a new project or in the organizational processes. In other words, he states that application of a lesson of past experience entails change in personal or organizational behavioral.

Juxtaposing these two literatures, continuous improvement, and avoidance of reinventing the wheel and repeating past mistakes in PBOs are achieved through changes of personal and/or organizational

behavior in new projects after reuse of knowledge. This action-based use of knowledge leads us to focus on behavioral utilization of knowledge during the front end development of projects.

Conclusion

In this chapter the context of knowledge reuse in FED of projects was discussed. Firstly, projects and project-based-organizations were presented, as well as the importance of front end development phases in the value of projects. During FED, knowledge management practices are mentioned as important value improvement practices. However, literature states that reuse of existing knowledge is a tricky task. The factors that cause the difficulties in reuse of explicit knowledge are discussed in the next chapter. The present chapter concluded with a discussion about the knowledge reuse activities and a further elaboration of one of them, knowledge utilization. Among the three dimensions of knowledge utilization, it was decided to focus on the behavioral use of knowledge in projects.



3.1 Knowledge reuse process
3.2 Knowledge reuse elements
3.3 Relation of knowledge reuse process with KM aspects
3.4 Map of knowledge reuse factors
3.5 Theoretical factors that affect knowledge reuse
3.6 Theoretical Factorial Knowledge Reuse Model
3.7 Theoretical requirements

Chapter 3: Factorial Knowledge Reuse Model

Introduction

In the previous chapter, the context of knowledge reuse in FED of projects was explained. Moreover, the fact was introduced that explicit knowledge reuse process in PBOs is found to be problematic by both academics (Disterer, 2002; Newell, 2005; Williams, 2008) and practitioners (KPMG 2003). Therefore, in this chapter, a literature research is presented concerning the factors that support or hinder the reuse of explicit knowledge.

Initially the map to categorize the theoretical factors is created using the concepts of knowledge reuse process (Markus, 2001; So & Bolloju, 2005), and knowledge reuse aspects (Barney, 2011; Jashapara, 2004; Orlikowski, 1992; Van der Brink, 2003) and elements (Szulanski, 2003). This map answers **research question 1.1** of this thesis. Then, an extensive literature search follows that identifies the knowledge reuse factors according to literature. These factors are inserted to the developed framework, and that, constructs the theoretical factorial knowledge reuse model. The model is the answer to **research question 1.2** of this thesis. Finally, based on the factors contained in the theoretical factorial knowledge reuse model, a list of requirements for an unproblematic explicit knowledge reuse process is developed. These requirements answer **research question 1.3** of this thesis.

3.1 Knowledge reuse process

In chapter 2, the stages of knowledge management were explained, based on the description of different authors in literature. Markus (2001) in her paper described also the sub-stages or activities that are involved in the knowledge management stages. According to that paper, the final stage of

knowledge management, knowledge reuse, is composed of four distinct activities. These activities are the definition of the search question, the process of searching for expertise, the process of assessment and selection of the appropriate expertise from the search results and finally the application of knowledge.

Nevertheless, Markus (2001) departs for her exploration of knowledge reuse from the point that the knowledge recipient has already decided to reuse knowledge, or at least to search for existing knowledge. So & Bolloju (2005) go one step back and examine also the intention of the (potential) knowledge recipient to reuse knowledge, taking into account the determinants of the intention to perform the behavior of knowledge reuse.

For the objectives of this thesis, So's & Bolloju's intention to reuse and Markus' reuse activities construct the complete *process* of knowledge reuse. As mentioned in the previous chapters, one of the objectives of this thesis is to explore the factors that hinder or support knowledge reuse. For this purpose So's & Bolloju's intention to reuse and Markus' reuse activities will be used to categorize the factors, aiming to understand which factors affect the intention and the four activities and find also interrelationships of those factors, in the sense that some factors may support or hinder more than one reuse activities or both the intention and the reuse activities.

Intention to reuse		Define the search question	Search for expertise	Assess and select among search results	Apply knowledge

Table 3 - Process of knowledge reuse (Markus, 2001; So & Bolloju, 2005)

Before closing this section it is important to note that "technology push" approaches to knowledge management (Fan, Feng, Sun, Feng, & You, 2005) are excluded from these thesis, since according to literature (Wiig, 1997) the future of knowledge management seem to rely more on "demand pull" approaches.

3.2 Knowledge reuse elements

The overall picture of knowledge reuse is completed if the elements that are involved in knowledge reuse are taken into account. Szulanski (2003) indicated 4 elements, namely the source, the content, the context and the recipient of knowledge. The source of knowledge is the person, team or organization that produced the knowledge. By content, it is meant the knowledge itself that is to be reused, and the context is the environment within which the reuse of knowledge takes place. Finally the recipient of knowledge is the person, team or organization that uses the knowledge. In those four elements defined by Szulanski (2003), a fifth is added by Markus (2001). That fifth element is called knowledge intermediary and is the one that makes all the relevant preparation, in order for the knowledge to be reused like the indexing, cleaning, structuring etc. of knowledge. In addition, the knowledge intermediary is the one that conducts the dissemination and in general the transfer of knowledge.

For the context of this thesis, two remarks should be made. The first remark is related to the knowledge intermediary, which for the case of explicit knowledge can be performed by information technologies. In other words, for the case of electronic repositories, by knowledge intermediary it is meant the communication channel that the recipient uses to get the content that he/she is searching for, and the information system that automatically organizes the content in the knowledge repositories. For the case of traditional archives those roles are conducted by people.

Recalling the focus of this research, a second remark should be made regarding the "source" knowledge element. Since the focus of this thesis is on fostering the reuse of explicit knowledge and on the factors that support or hinder it, the factors related to the source will only be addressed in this thesis if they influence the content. To be more specific, from the reuse point of view, explicit knowledge is assumed to be already produced and codified by the source. In that sense, source is seen as a determinant of the quality of knowledge content. For that reason, it should be clearly stated that for the context of this research, the factors that are related to the source will be addressed as factors that influence the content and its quality.

After the integration of the elements sources and content for the purpose of this research, it should be mentioned that all elements of knowledge reuse are involved in the knowledge reuse process and thus they are directly related to the factors that hinder or support knowledge reuse. In other words, factors are related to the content, context, recipient and intermediary elements.

3.3 Relation of knowledge reuse elements with knowledge management aspects

Based on Orlikowski's (1992) propositions about influence and interaction among people, technology and organizations, Van der Brink (2003) proposes those three entities as the key factors for managing knowledge. Towards the same direction Jashapara (2004) and Barney (2011) identify the technological, organizational and social aspects of knowledge management as determining factors for the success of a knowledge management system.

By closer observation of the theoretical concepts of knowledge reuse elements and knowledge management aspects, it can be said that the knowledge reuse elements of Szulanski (2003) and Markus (2001) are much in line to the distinction of knowledge management aspects. When looking knowledge reuse from the technological aspect then the elements knowledge content, and intermediary are the dominant ones for successful knowledge reuse. When studying knowledge reuse from the social perspective, then the knowledge recipient is the dominant element. Finally, context is the key element when knowledge reuse is studied in light of the organizational aspect. The key element(s) of knowledge reuse in each aspect of knowledge management are displayed in figure 9.

Aspect of knowledge management	Key element(s) of knowledge reuse
Technological	Content, Intermediary
Social	Recipient
Organizational	Context

Figure 9 - Link between knowledge management aspects and knowledge reuse elements

3.4 Map of knowledge reuse factors

In the previous sections the knowledge reuse process and the knowledge reuse elements and aspects are presented. The fact that the knowledge reuse elements are involved in the knowledge reuse process, gives the idea to develop a framework to categorize the various factors that exist in literature. To be more specific, the factors can be categorized based on the part of the knowledge reuse process that they affect and the element and aspect of knowledge reuse that is involved.

The map is in fact a matrix that categorizes the rows based on the knowledge reuse aspects and the columns based on the parts of the knowledge reuse process. Therefore in each cell will be inserted factors that affect a specific knowledge reuse element and a specific part of knowledge reuse process.

Categorizing the factors in that way will not only provide us with a clearer overview of the factors but will reveal also the interrelationships of factors with the different parts of knowledge reuse processes. For instance, there may be cases that specific factors affect more than one parts of the knowledge reuse process. These cases will be identified using that map, by observing the common factors in the different cells of the map.

To conclude, this map has three main functions. Firstly, it will provide us with a clear overview of the various factors that support or hinder explicit knowledge reuse. Secondly, it will reveal the interrelationships of the factors with the different parts of the knowledge reuse process. Figure 10 below displays the map that answers **research question 1.1** of this thesis:

		Knowledge reuse process				
		Intention to reuse	Definition of search question	Search process	Assess and select search findings	Application of knowledge
Knowledge reuse aspects and elements	Technological - content intermediary					
	Social - Recipient					

	Organizational - Context					

Figure 10 – Map to categorize knowledge reuse factors

In the next section, this map will be used to categorize the factors that several authors proposed in literature. After the literature research, the found factors will be inserted to the map.

3.5 Theoretical factors that affect knowledge reuse

The framework that is presented in the previous section was created with the objective to be used for categorization of factors, so we can have an overview of the various factors that support or hinder explicit knowledge reuse according to the authors in literature. Therefore in this section a literature search for the various factors in the literature is conducted, which is organized and presented based on the developed framework. Therefore, three sections of literature research follow, related to the technological, organizational and social aspect of knowledge reuse.

The factors that identified in this literature search were retrieved predominantly from journal articles and papers that were retrieved from renowned scientific databases such as Elsevier, Science direct, Wiley Online Library and Emerald Insight.

To conclude, several papers were examined for factors that influence or support knowledge reuse. The process of searching stopped when there was a feeling of repetition of the same concepts with similar names. That can be proved by the fact that the majority of factors are mentioned in more than one scientific paper.

Factors on the technological aspect

Numerous studies in literature have identified a broad range of factors that should be addressed in order for existing explicit knowledge in organizations to be exploited with success. Although many researchers (M. M. Ajmal, Kekäle, & Takala, 2009; Damodaran & Olphert, 2000; Liebowitz, 1999) state that the supporting or hindering factors of knowledge are mostly related to people and processes than technology itself, that doesn't mean that the technological factors should be neglected.

The **richness of available explicit knowledge** in the electronic repositories or archives of an organization is considered as a promoting factor of reusing explicit knowledge according to Damodaran & Olphert (2000). Another important technological factor is the **quality of content** (Chung & Galletta, 2012; Wu & Wang, 2006)**.** The higher the quality of arguments in the knowledge content, the more

probable is that the knowledge recipient will select a knowledge object for reuse and the easier will be for him to apply it in the new context. However, knowledge quality is a high level concept and can be further operationalized. In the process of assessing and selecting among the search findings, knowledge quality can be perceived as *timeliness of information, consistent representation of the information* (Tongchuay, 2008), *indexing* and *sufficient context description*, i.e. metadata of the information (Wu & Wang, 2006a). While applying the knowledge in the new case, quality can be perceived as *concise representation, completeness, correctness, practicability* of information, as well as *ease of information manipulation* (Tongchuay, 2008; Wu & Wang, 2006a). Availability of *sufficient context description* is important also during the application of selected information.

Quite important facilitator of knowledge reuse is also the **ease of access** to explicit knowledge. Watson & Hewett (2006) state that the easier it is for the knowledge recipient to access the knowledge that he/she desires, the more frequent he/she will be engaged in knowledge reuse. In line with Watson & Hewett, Szulanski (2000) talks about the barrier of arduous relationship, meaning the difficulty of communication between the knowledge recipient and the location of explicit knowledge. Therefore, ease of access can be found as a facilitator for the process of searching itself.

Nevertheless, ease of access is also a high level concept that can be further operationalized. For the cases that explicit knowledge is located in an electronic repository, and the accessing of knowledge is performed through an information system, Damodaran & Olphert (2000) see *user friendliness* of the information system as an important facilitator of easy accessing of explicit knowledge. (Wu & Wang, 2006b) and Damodaran & Olphert (2000) proposed that *acceptable accessing time* of information is a determinant of easy accessing, together with *relevance of search results*, in terms of how important and helpful they are for people's work (Wu & Wang, 2006b).

Factors on the organizational aspect

Managing knowledge is a procedure that is concerned mainly with people and organizational processes (M. M. Ajmal et al., 2009; Damodaran & Olphert, 2000; Liebowitz, 1999). Therefore, the organizational environment under which reuse of explicit knowledge takes place, is an area that factors are identified by various authors in literature.

The organizational structure of PBOs compared to the normal business entities, creates barriers to knowledge reuse, since they don't have a permanently defined structure with well-established working routines to enable them naturally absorb and then reuse created or acquired knowledge (M. M. Ajmal et al., 2009; Liebowitz, 1999). Therefore according to the authors, the lack of organizational memory due to the temporary feature of project teams, can be confronted with special management initiatives on **standardizing knowledge reuse** at the beginning of projects. The management initiatives can be realized by an *official company procedure* that standardize the inputs used in a project task, and *benchmarking standards* (M. M. Ajmal et al., 2009) that determine how reuse of existing explicit knowledge will be utilized. Moreover, is should be noted that managers have the power that is needed to enforce

organizational change (Van der Brink, 2003). Therefore, *enforcement* of usage of the related standards, procedures and guidelines encourages standardization of knowledge reuse.

Nevertheless, an official company procedure might not be adequate, without sufficient **commitment of organization's management** and **leadership** towards knowledge reuse (Argyris, 1991; Yeung & Holden, 2007). In other words, project team members are influenced positively on their decision to engage in knowledge reuse when top management communicates regularly its commitment on knowledge reuse and when the project head is leading the reuse process.

So & Bolloju (2005) find in their study using the theory of planned behavior (Ajzen, 1991) that project team members are influenced towards reusing knowledge not only by leadership, but also by **subjective norm**. By that concept the authors mean the fact that project team members tend to reuse knowledge more when they feel social pressure on performing this behavior. Therefore, the more the organization exerts social pressure to the employees, the more the practice of reusing explicit knowledge will be dispersed among the employees.

Another important organizational factor according to literature (Damodaran & Olphert, 2000; Majchrzak, Neece, & Cooper, 2001) is **organizational culture** towards reusing existing knowledge. Supporting culture towards knowledge reuse is seen as an important organizational enabler which should be taken into account (Majchrzak et al., 2001) when studying knowledge reuse. Ruggles (1998) support this view with his study, where 431 executives in both USA and Europe mentioned that organizational culture is the most important factor concerning knowledge reuse. At the project team level, the project/departmental manager should *cultivate a knowledge reuse culture by transmitting regularly appropriate values and beliefs* to the team members (M. M. Ajmal et al., 2009). At the organizational level, the authors propose that *recognition of the practice, as well as rewards linked to knowledge reuse* in the company should encourage people to be engaged in explicit knowledge reuse activities.

Damodaran & Olphert (2000) identified that business drivers such as client's pressure is an important organizational enabler of knowledge reuse. However, the business driver should be totally clear to the project team to facilitate knowledge reuse. Therefore **communication of client's pressure** for learning from past projects is an enabler of explicit knowledge reuse practice.

Another organizational determinant of knowledge reuse is **training** of people on performing the practice (Watson & Hewett, 2006). The argument of the author is based on Pinder (1997), who proposes that if people are asked to engage in a practice that they do not know, they are less likely to perform successfully that practice. Therefore, Watson & Hewett (2006) proposes that training on knowledge reuse, increases people's intention to engage in such a practice.

Finally, Wiig (1997) proposed that by emphasizing the responsibility of employees for knowledge related activities within their area of work specialization, ensures application of most competitive knowledge to the work practices. Therefore, making project team members **accountable** for reusing of explicit knowledge from their field of expertise, facilitates application of knowledge in projects.

Factors on the social aspect

In the context of knowledge reuse, the social aspect of reuse is directly related to the recipient of knowledge. Numerous studies identified factors that hinder or support knowledge reuse, which are related to the perceptions, culture and capacities of the individual or team that is involved in reusing knowledge.

The **values and norms** that the **individual** has regarding knowledge reuse can influence not only the motivation to reuse but also the process of assessing and selecting among the search results. So & Bolloju (2005) find in their study that an *individual's attitude on reuse*, or in other words an individual's negative or positive belief about reuse, influences his/her intention to be engaged in such behavior. On top of that, Majchrzak, Neece, & Cooper (2001) added that the personal openness of an individual on examining both available *direct solutions and indirect analogies* from a *broad set of knowledge sources* to obtain the knowledge that is sought, is an important facilitator.

In addition to the norms and value system of the individual or team, the personal perceptions is another area of supporting or hindering factors. The perception of the individuals or team about the ease or difficulty of reusing available explicit knowledge can be a major facilitator or barrier of knowledge reuse (So & Bolloju, 2005). According to the authors, the **perception of effort** required to *find* and *apply* explicit knowledge influences negatively the intention to reuse.

Another personal perception of the individual that affects the reuse of explicit knowledge is their **perception about the existence of a performance gap** (Majchrzak et al., 2004, 2001). In their studies, the authors note that individuals mentioned that the more they felt that they are bounded to *limited experience,* and/or *time constraints* the more they tend to engage in the process of knowledge reuse. Furthermore, the perception of the project team members *about required risk reduction* in the project they are involved is a supporting factor on their decision to be engaged on knowledge reuse.

Watson & Hewett (2006) identified another factor, regarding individuals' **trust on the knowledge** that exists in the knowledge repositories. The author proposes that intention to reuse knowledge is a matter of recipient's trust on whether the existing knowledge is *correct* and *timely*. In other words, the greater the individual's belief is that the results value pays off for the effort and time spent, the more he/ she will be engaged in knowledge reuse. Szulanski (2000) and Ajmal et al. (2009) added recipients' trust on the *reliability of the knowledge author* as an important factor in the assessment of search results.

Watson & Hewett, (2006) and Damodaran & Olphert (2000) added that, what is important, isn't only the value of explicit knowledge itself, but also the **personal added value** that the individual gains from engaging in the process. Therefore the clearer the perceived personal added value that is gained from the individual or team when reusing explicit knowledge, the more motivated he/ she is to be engaged in that process.

The third area of social factors is the capacity of knowledge recipients to perform certain knowledge reuse tasks. Markus (2001) indicated the task of **defining the search question** as one of major importance for the reuse of knowledge. In her attempt to create a theory on knowledge reuse, she

mentioned that the capability of knowing what question to ask is a characteristic that distinguishes experts from novices.

Regarding the capacity of knowledge recipients, Majchrzak et al. (2001) and Chua, Lam, & Majid (2006) propose also that in the process of assessing and selecting among the search results, *the ability to identify usefulness* of the found knowledge is critical to encourage knowledge reuse. Towards the same direction, Szulanski (2000) in his study about stickiness of knowledge, added that **absorptive capacity** of recipients is of major importance in the process of knowledge reuse. By absorptive capacity the author means not only the ability of the recipient to identify and assess value but also to apply knowledge.

In the same paper (Szulanski, 2000) except absorptive capacity of recipients, their **retentive capacity** is also mentioned as an important factor. By the concept retentive capacity, Szulanski aims to address the ability of recipients of knowledge to routinize practices (M. M. Ajmal et al., 2009) the reuse of explicit knowledge in their work.

Last but not least factor found in that literature search is the **familiarity of knowledge recipients with the knowledge management system (KMS)** (Majchrzak et al., 2004; Watson & Hewett, 2006).The authors propose in their studies that the more *familiar are the recipients with the searching tools*, the easier the searching process becomes. Moreover, they proposed that the more *aware they are of what knowledge is available*, the more motivated they are to reuse and the easier will be the search process.

3.6 Theoretical Factorial Knowledge Reuse Model

In the previous sections the literature search about the technological, organizational and social factors that support or hinder knowledge reuse is presented. At this point the developed map will be used to categorize the factors that are presented above.

The map that was developed in previous section of this chapter is basically a 2-dimension matrix that interrelates the knowledge reuse process (Markus, 2001; So & Bolloju, 2005) with the knowledge reuse aspects of a knowledge management system (Barney, 2011; Jashapara, 2004; Orlikowski, 1992; Van der Brink, 2003). The developed map together with the factors from literature, construct the theoretical factorial knowledge reuse model, which is the answer to **research question 1.2** of this thesis.

Each factor is located in the appropriate cell based on the description of the authors regarding the knowledge reuse element (Szulanski, 2003) that is involved and thus the knowledge reuse aspect (in previous section knowledge reuse elements and aspects were linked) and the part of knowledge reuse process that is affected by the corresponding factors. In total 20 distinct factors are inserted in the map, most of which are further operationalized.

Six of those 20 factors are located in more than one cell according to literature. That means that there are interrelationships of the factors with knowledge reuse parts, or in other words that those factors affect more than one parts of knowledge reuse process. This is important for that thesis, because knowing such interrelationships might save time and effort in the design of the strategy to exploit those factors. The model in table 4 includes the factors and a brief description of how they influence knowledge reuse. The factors that exist in more than one cell are presented with bold:

Table 4 – Theoretical factorial knowledge reuse model

		Knowledge reuse process				
		Intention to reuse	Definition of search question	Search process	Assess and select search findings	Application of knowledge
knowledge reuse aspects	Technological	Richness of explicit knowledge in repositories (Availability of explicit knowledge is a promoting factor of reusing)		Ease of access (*User friendliness* of the information system facilitates searching *Relevance of search results:* The information provided should be important and helpful for user's work *Accessing time*: Acceptable accessing time of information, increases searching)	**Knowledge quality** (*Timeliness*: Timeliness of information facilitates selection *Consistent representation*: Consistency of words and phrasing facilitates selection *Indexing*: The clearer the knowledge indexing the easier it is to assess search results *Availability of context description*: Context description help user understand what is being accessed)	**Knowledge quality** (*Concise representation*: Brief and to the point representation of information facilitates application *Completeness* of information facilitates application *Correctness* of information facilitates application *Ease of manipulation*: application is facilitated when information can easily be adjusted *Practicability* of information facilitates application *Availability of context description*: Context description help user apply information to work)

		Knowledge reuse process				
knowledge reuse aspects	**Organizational**	**Standardization of knowledge reuse** *(*An *official process* and its *enforcement* in the projects by managers support reuse*)* Management commitment influences positively employees' decision to engage in reuse Leadership by project heads encourages intention to reuse Subjective norm (Social pressure on reuse influence positively people's decision to engage in such practice) Organizational culture (Cultivation of reuse culture by *Project* or *Departmental Manager transmitting reuse values*, is a positive determinant of knowledge reuse) *Recognition of reuse* as well as *reward schemes linked to knowledge reuse* influence positively people's intention to engage in such practice) Communication of client's pressure to the employees influences positively their intention to reuse Training of employees on reusing, influences positively their intention to engage in such a practice				**Standardization of knowledge reuse** *(Benchmarking standards* in the company facilitates utilization*)* Responsibility / Accountability in project teams for reuse facilitates utilization

		Knowledge reuse process				
knowledge reuse aspects	**Social**	**Individual's values and norms** (Individual's *positive attitude* increases his intention to reuse) Perception of effort (Perception of *effort on finding* and *on applying* explicit knowledge influence negatively the intention to reuse) Perception of performance gap (Perception of • *tight time project constraints* • *limited experience* • *required risk reduction in project* support intention to reuse) **Trust on knowledge** (Intention to reuse is a matter of user's trust that information are • *correct* • *timely)* Perceived personal added value *(personal/team gain* increases intention of the user to engage in reuse) Retentive capacity (the ability to routinize reuse encourages people's intention to engage in reusing) **Familiarity with KMS** *(awareness of knowledge* availability supports the intention to reuse)	Capability to define search question: (User's ability to know what to search encourages reuse)	**Familiarity with KMS** *(awareness of knowledge* availability facilitates the searching process *familiarity with searching tools* facilitates the searching process)	**Individual's values and norms** (Individual's *openness for* examining both *direct solutions and indirect analogies* from a broad set of *knowledge sources* increases selection) **Trust on knowledge** (Individual's trust on the *reliability of author* facilitates selection) **Absorptive capacity** (Individual's ability to *identify usefulness)*	**Absorptive capacity** (Individual's *ability to apply* is critical for successful reuse)

3.7 Theoretical requirements

In previous section of this chapter, the factors that support or hinder the reuse of explicit knowledge according to authors in literature are found. The factors are also categorized according to the developed map, based on the different part of the knowledge reuse process that they affect and also based on the aspect of knowledge reuse that is involved.

Recalling that the factors explain the creation or overcoming of the barriers that create problems to reuse of explicit knowledge, it is realized that exploitation of these factors are also the requirements for an unproblematic explicit knowledge reuse process.

These requirements are used as guidelines to assess the current situation and thus identify the strengths and weaknesses of explicit knowledge reuse in Heerema Marine Contractors, which is the chosen PBO for illustrative purposes of this thesis. For that reason, a code is assigned in each of the requirements, so we can refer to them in the next chapters. Table 5 with the list of requirements, the related codes and the factors from the theoretical knowledge reuse model is displayed below, and answers **research question 1.3** of this thesis.

Table 5 – List of requirements for an unproblematic explicit knowledge reuse process

	Requirement / Factor	Requirement description	Reference code
Technological	Ease of access	Navigating in systems aiming to find explicit knowledge should be supported by a user friendly information system, which provides the user with relevant search results about information that can be retrieved in acceptable time.	L_T1
	Richness of explicit knowledge	The electronic repositories and physical archives should contain sufficient explicit knowledge from previous projects.	L_T2
	Knowledge quality	The explicit knowledge should be of high quality.	L_T3
Organizational	Standardization of knowledge reuse	Reuse of explicit knowledge should be standardized by an official process and by benchmarking standards on application, while the usage of both should be enforced by managers.	L_O1
	Management commitment	Management should be committed to reuse of explicit knowledge.	L_O2

	Leadership	Project/Departmental managers should lead reuse of explicit knowledge by example.	L_O3
	Subjective norm	Social pressure should be exerted to the project team members by the organization concerning reuse of explicit knowledge.	L_O4
	Organizational culture	A knowledge reuse organizational culture should be cultivated through communication of KR values as well as recognition and rewarding of KR practice.	L_O5
	Communication of client's pressure	Client's pressure to learn from past mistakes should be communicated to the project team members.	L_O6
	Training	The organization should train project team members on reusing explicit knowledge.	L_O7
	Responsibility / Accountability	In projects teams, people should be made accountable for reusing of explicit knowledge from their field of expertise.	L_O8
	Individual's values and norms	Project team members should have a positive attitude on knowledge reuse and be open to examine both direct solutions and indirect analogies from a broad set of knowledge sources.	L_S1
Social	Perception of effort	Project team members should perceive finding and applying explicit knowledge as a balanced process, between effort and gains.	L_S2
	Perception of performance gap	Any performance gap, in terms of tight time project constrains, required project risk reduction or limited experience, should be emphasized in the project teams.	L_S3
	Trust on knowledge	Project team members should trust that available explicit knowledge is correct, timely and originated from a reliable author.	L_S4
	Perceived personal added value	The personal/team gains from reusing explicit knowledge should be clear to the project team members.	L_S5
	Retentive capacity	Project team members should be able to make reusing explicit knowledge a routine.	L_S6

	Familiarity with KMS	Project team members should be aware of the available explicit knowledge and also should be familiar with the searching tools.	L_S7
	Capability to define search question	Project team members should be able to define exactly what they search for.	L_S8
	Absorptive capacity	Project team members should be able to identify usefulness of explicit knowledge and also be able to apply it.	L_S9

Conclusion

In this chapter, the results of literature research concerning the factors that support or hinder explicit knowledge reuse were presented. Prior to the literature research for the factors, a map was developed that aims to categorize the factors that are proposed in literature. This map answers **research question 1.1** of this thesis. The map and the found theoretical factors constructed the theoretical factorial knowledge reuse model which answers **research question 1.2** of this thesis. Last but not least, a list of theoretical design requirements for the desired strategy was developed that also aims to guide the assessment of the current situation in the organization under study concerning knowledge reuse. The list of requirements for an unproblematic explicit knowledge reuse process answer **research question 1.3** of this thesis. The selected organization under study, Heerema Marine Contractors, is presented in the next chapter.



4.1 The company

4.2 HMC's organizational structure

4.3 Technology Department

4.4 Technology Department's vision and relevance of research

Chapter 4: Introduction to the case - HMC and the Technology Department

Introduction

Heerema Marine Contractors (HMC) is a leading offshore company that provides innovative solutions to almost all major companies in the oil and gas industry. Starting in 1948, the company has gained enormous experience in transportation and installation of offshore oil drilling platforms. Aiming to continue its remarkable past successes the company focuses on exploiting that experience.

In this chapter, HMC's history and organization are presented. Special focus is given to the Technology department of HMC, which is chosen for illustrative purposes of this research. For this reason this chapter concludes with the vision of Technology department for the future and the relevance of this research for the chosen project based engineering organization.

4.1 The company

Starting operations in Venezuela in 1948, Heerema Marine Contractors gained through the years relevant experience in the offshore operations and is currently a leading company in the industry. During its early start years, the company specialized in the construction and installation of drilling platforms for the oil industry. The first platform installed in Lake Maracaibo.

The following years, from the early sixties till the late seventies, are characterized as HMC's pioneering years. The company shifted its focus to the oil and gas fields of the North Sea. The difficult weather conditions in the area, especially the winter months, made operations even more challenging. However, making use of the growing capacity and stability of the crane vessels, provided HMC's clients with major financial advantages. The advantages came from the ability to build bigger structures onshore, which entailed less risk in the offshore executions.

With a demand for further increase of the lift capacity of the crane vessels, HMC made a breakthrough movement, introducing to the industry the first "semi-submersible" vessels, Balder and Hermod. The

new vessels with an initial lift capacity of 5400 ton and with an important part of the hull able to be submersible, were bigger and less sensitive to waves. This fact together with their increased lift capacity and their dual-crane feature made HMC the industry leader that was able to execute installations that previously required one summer season, in less than six weeks (Technology HMC, 2009).

Currently, HMC is operating three of the world's largest semisubmersible vessels, the Balder and Hermod, whose lift capacity was upgraded from 5400 mT to 8100 mT, and Thialf, which was acquired after a joint venture with McDermott, and whose lifting capacity is 14200 mT (Technology HMC, 2009).

In the new century, the industry shifted its focus to more deepwater constructions in more remotely located areas and of course HMC rapidly responded to the industry's demands by transforming SSCV Balder to a deepwater construction vessel (DCV), capable of performing construction and pipe-lay operations to a water depth up until 3000 meters. On top of that, HMC aiming to strengthen its position in deepwater construction ordered the construction and is ready to operate its fourth vessel in 2013, the "Aegir". The new vessel is also a DCV that is capable of executing complex infrastructure and pipeline projects in ultra-deep water and has sufficient lifting capacity to install fixed platforms in relatively shallow water (HMC, 2012a).The assets of HMC and a brief explanation of their capacities are presented in figure 11.

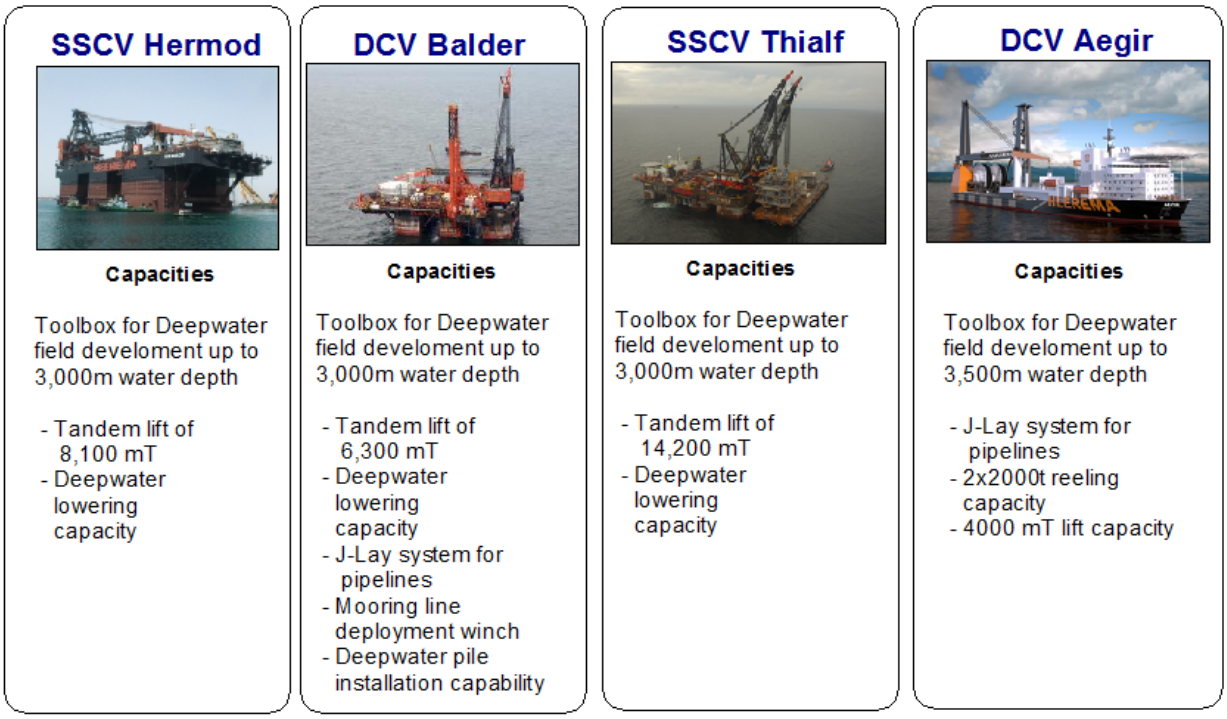

Figure 11 – Assets (vessels) of HMC

For over than sixty years, HMC delivers breakthrough offshore solutions to its clients in the oil and gas industry. During its lifetime, the company has built its reputation and expertise in the following fields (Technology HMC, 2009):

- Installation of fixed platforms
- Installation of floating structures in deepwater
- Installation of deepwater infrastructure consisting of subsea structures, pipelines, inline structures, flowlines and umbilicals
- Installation of deepwater moorings
- Installation of integrated decks using float-over techniques
- Decommissioning and removal of platforms

Aiming to deliver projects in the above mentioned fields safely, on time and within budget, HMC is a leading project-based organization in the offshore industry with a challenging vision for the future. With its past full of successes and an even more promising future, the company aims:

"By any measure, to be and to be recognized as the best offshore construction contractor in the world in carefully selected segments and regions of the market"

Although, HMC's vision is indeed a challenging one, the past and present successes of the company prove that challenge and the name Heerema are synonyms in the offshore industry.

4.2 HMC's organizational structure

HMC's operations in the construction of platforms for the oil and gas industry are organized around projects. For that reason, HMC has the organizational structure of a project based organization. As mentioned chapter 2, project based organizations follow a matrix organizational format, which is a combination of the functional and pure project organization (Meredith & Mantel, 2010).

HMC's functional organization consists of several departments which all are actively involved in the different phases of projects. In figure 12 below, the different departments of HMC and their involvement in the project phases are displayed.

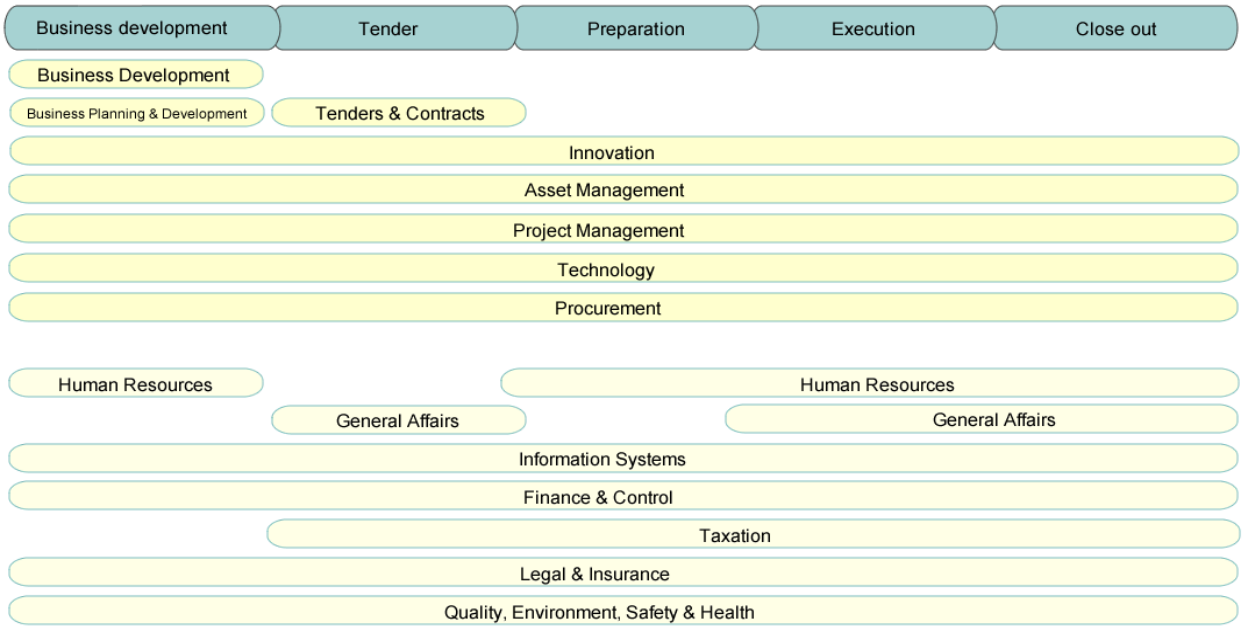

Figure 12 –Departments of HMC and their involvement in the project phases (HMC, 2012b)

In parallel with the functional organization of HMC, a project team is set up whenever a new contract is won by HMC. The project team is self-contained unit that organizes itself according to the project objectives (Meredith & Mantel, 2010). In the case of HMC, this doesn't mean that the project team members are separated from the rest organization during the project, as it might be the case that employees work part-time in more than one project. In figure 13, a typical project team in HMC is displayed.

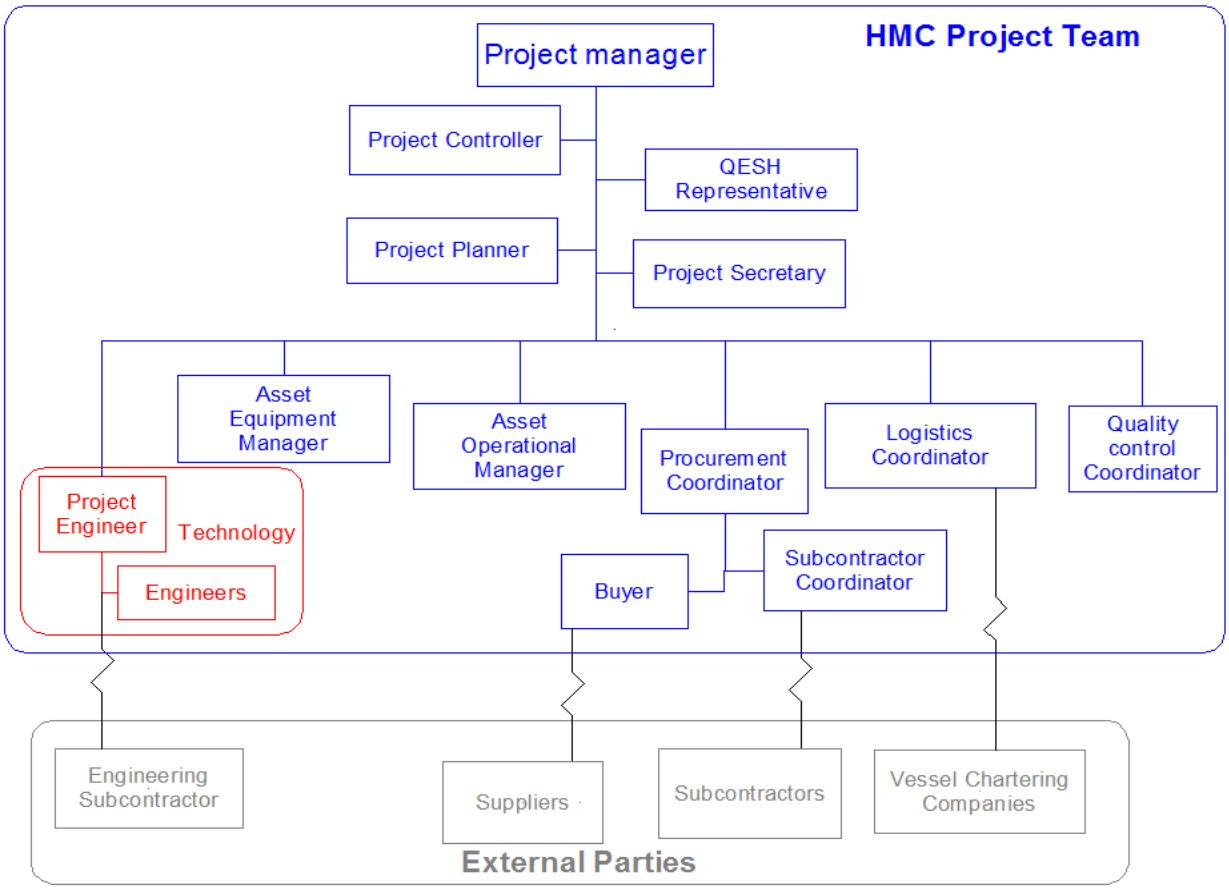

Figure 13 – Typical project team in HMC (Barney, 2011)

4.3 Technology Department

The present research is conducted within the biggest (in terms of people) HMC department, Technology, whose goal is to support HMC's tenders, projects and business development (Technology HMC, 2009). The main objective of Technology department is to deliver value driven engineering solutions in the front end development of projects and provide support for the execution of these solutions. Therefore, the department is organized around six different engineering groups, namely the fixed and floating structures (FIX/FLO), the platform decommission and removal (PDR), the subsea infrastructures and pipelines (SIP), the Specialist Engineering Services (SES), The Drawing Office (DO) and the Innovation & Development. The first three groups work on the core Technology Products, while the rest provide

relevant services, by consolidating know-how, setting technical standards and driving the development of new standards. Figure 14 displays the engineering groups of technology department.

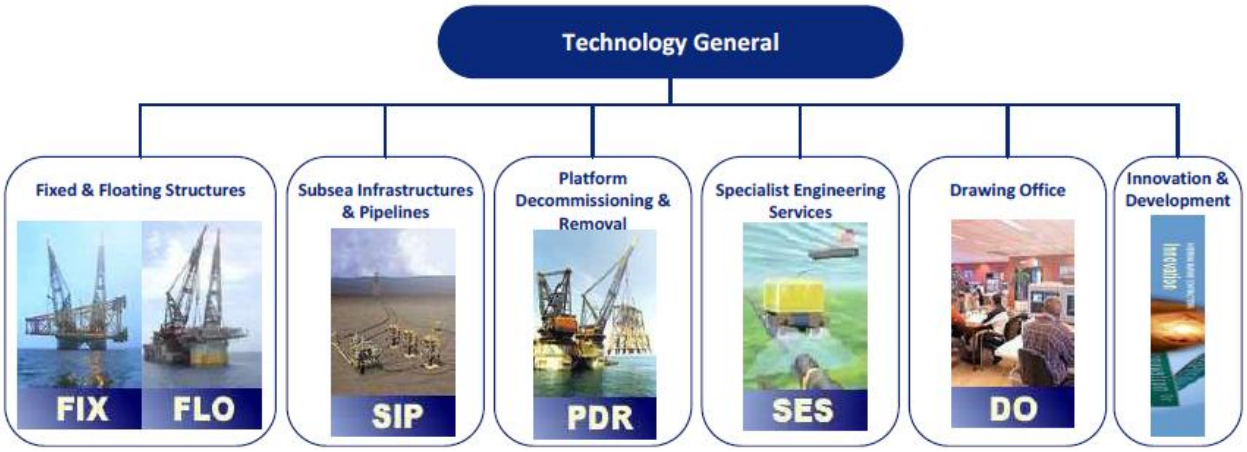

Figure 14 – Engineering Groups of the Technology department (Barney, 2011)

As the objective of this thesis is to foster explicit knowledge reuse during the front end development of projects, the focus of this thesis is directed on reuse of explicit knowledge in the Technology Products (FIX/FLO, PDR, SIP). Each of the three engineering groups is responsible for the development of projects related to its core product.

4.4 Technology Department's vision and relevance of research

Traditionally HMC had the role of subcontractor in the various projects that it was involved. However, recently the company undertook the role of the main contractors in projects, which means that the company is faced with more complex issues and increased responsibility towards its clients. Technology department aims for continuous improvement of its services so it can be to be ready to successfully support HMC's future complex operations and the new vessel that is about to be added in company's fleet (Technology Department HMC, 2012). The department's goal is "to maintain and develop a Technology organization that executes the work safely, effectively, efficiently and according to the plan; that it is flexible and has an important role in the first steps of educating the workforce and future management for the whole HMC organization(Technology Department HMC, 2012).

Within the Technology department an abundance of documents are generated during and after projects, which include the explicit knowledge created or acquired in past and current projects. Reuse of that knowledge guarantees continuous improvement of Technology services. As it stated in Technology Department's vision (2012): "Continues improvement is ensured through a dedicated focus on technology and know-how development. This includes learning from previous experience as well as introducing new know-how."

Having that in mind and aiming to develop a strategy for fostering explicit knowledge reuse during the front end development of projects in PBOs, Technology department of HMC seems to be an appropriate

case for illustrative purposes of this research. On the other hand, relevance and importance of the research for the organization is guaranteed, bearing in mind the department's desire to continuously improve its services in supporting HMC in its complex current and future operations.

Conclusion

In this chapter, the chosen project based engineering organization for illustrative purposes of this research was presented. After a brief introduction to HMC's history, the organization of the company was explained. As a project based organization, the functional departments of the company coexist with the project teams that are created for each specific project. The biggest (in terms of people) department of HMC is Technology, which is the main engineering services provider of the company.

Aiming to be prepared for supporting HMC in its challenging envisaged future, Technology department strives for continuous improvement of its services. Reuse of the explicit knowledge that is generated or acquired during projects, is a factor that leads to continuous improvement. Therefore, this thesis is also of value for Technology, by aiming to develop a strategy to foster the reuse of explicit knowledge.



5.1 Assessment method
5.2 Desk research
5.3 Survey
5.4 Areas of improvement in current explicit knowledge reuse
5.5 Reflection on analysis and scoping of improvement
5.6 Technology Management's view
5.7 Design requirements
5.8 Strategy within scoped improvement

Chapter 5: Assessment of current explicit knowledge reuse in FED of projects by Technology

Introduction

In this chapter the assessment of current explicit knowledge reuse in FED of projects by Technology is presented. For the assessment, the requirements for an unproblematic explicit knowledge reuse process that presented in sub-chapter 3.7 are used. In the light of those requirements the areas for improvement in the current situation are identified. These areas for improvement are used later in this chapter in the development of the requirements for the next step of this thesis; the design of a strategy to improve reuse of explicit knowledge.

5.1 Assessment method

The analysis of the current situation regarding reuse of explicit knowledge from past projects in the organization under study is an important step before designing the strategy to foster reuse of explicit knowledge. To assess the current situation, a triangulation of research methods is selected. More specifically, two methods will be used, aiming to cross examine what is currently the case in Technology.

The first method is desk research in the company's documents. The desk research delineates the current situation concerning reuse of explicit project knowledge during FED of projects. In that step, documents are analyzed from the Management System Documentation (MSD) and Knowledge Management Upgrade (KMU) project. MSD is an HMC intranet site that includes the documentation for all organizational processes of the company that guide its operations, while KMU is the internal HMC project for upgrading knowledge management practices. That project has generated abundant

information regarding current knowledge management practices in HMC and thus its findings are highly relevant for the present research. During the presentation of the desk research analysis, references to the requirements for an unproblematic explicit knowledge reuse process are made where appropriate, using the reference codes that presented in sub-chapter 3.7.

The second method is a survey among the employees of the Technology department, in which they are asked to fill in a questionnaire. The questionnaire addresses issues concerning the factors that influence currently the reuse of explicit project knowledge in the front end development of projects. Furthermore, the respondents are asked to rate the importance of the various factors that influence reuse of project knowledge. In that way, based on the employees' responses we will get insight on the importance of factors for the improvement strategy.

The findings of the desk research together with the results of the survey analysis provide us with the complete picture of the factors that influence currently the reuse of explicit project knowledge in the company, and thus giving valuable input to the design of the strategy. To be more specific, based on the comparison of the desk research and survey findings to the requirements that presented in sub-chapter 3.7, the improvement gap that should be addressed by the desired strategy is identified. Based on that improvement gap the functional requirements of the desired strategy will arise.

5.2 Desk research

Management System Documentation (MSD)

To assess the current situation regarding explicit knowledge reuse in FED of projects by the Technology department, the Management System Documentation intranet site was reviewed. MSD provides up-to-date access to the documentation that describes the HMC Management System. That documentation describes all organizational business procedures that should be followed by HMC employees during the company's operations.

Within the MSD site, the Business Process Management (BPM) is described, which presents the core business processes per department and per project phase. For each business process, the input, the responsibility assignment matrix (RACCI chart), the deliverables and the procedure is defined. By input it is meant the required explicit knowledge resources that are needed in the process. The RACCI chart defines the roles of participation that are assigned in the process (Responsible, Accountable, Consent, Consult, Informed). The deliverables describe the output of the process and the procedure is the document that guides the process.

By paying attention to the processes, the inputs and the roles that are described in the BPM, we can identify what is currently formalized in the organization regarding reuse. The detailed analysis of the organizational business processes is presented in appendix A (confidential). A summary of the key conclusions is presented below.

From the review of the business processes, it is concluded that explicit knowledge reuse is not currently formalized by an official process or input (L_O1). Moreover, during the set-up of the project team, the

members are not found to be made officially accountable for reuse of explicit knowledge related to their field of expertise (L_O8). Overall, it can be said that knowledge continuation culture in the company shows room for improvement (L_O5), meaning that there is room for improvement in cross project learning and also in minimization of knowledge loss due to retirement or leave of employees from the organization.

On the other hand, the Technology employees are found in Barney's (2011) study to recognize the use of existing knowledge as a good starting point for the project (L_S1), and realize the personal/team gains that this practice entails (L_S5). Furthermore, project team members are found to be quite capable of internalizing the explicit knowledge and turn it into their own know-how (L_S9), even though training on knowledge reuse is not officially supported by the MSD business processes (L_O7). An explanation for that might be that Technology employees are educated engineers that hold at least a bachelor degree.

Knowledge Management Upgrade Project (KMU)

KMU is an internal HMC project that aims to upgrade current knowledge management practices in the company (HMC, 2012b). To achieve its objective, KMU follows a specific strategy. Briefly, this strategy begins with the definition of KM and the mapping of the current situation and then the desired situation is defined. Next, the gap between current and desired situation is analyzed. Based on this gap an implementation strategy for improvement is designed (HMC, 2012b).

The analysis of the KMU documents regarding the current situation includes, among other things, a wealth of information for the reuse of project knowledge currently in the company and for initiatives already taken for the improvement of the current situation. Given also the fact that KMU is originated from the Technology Department (although it is not isolated to Technology) (HMC, 2012b), the project findings are highly relevant for the present research regarding reuse of explicit knowledge during the FED of projects by Technology.

In essence, KMU is the substantial proof of HMC's initiatives to upgrade current knowledge management practices. In other words, KMU project shows the commitment of company's management to knowledge management (L_O2). The detailed analysis of the KMU project documents is presented in appendix A (confidential). A summary of the key conclusions is presented below.

The KMU workgroup identified initially some key challenges regarding the reuse of explicit knowledge. The first is the difficulty to determine what explicit knowledge to be managed (L_T2), and secondly how to make it easily accessible and available to the employees (L_T1). The third challenge is to turn top management's commitment from authorization to commitment of HMC employees (L_O2). As a quite important challenge is also recognized the increase of employees' understanding of what KM is and where it can be applied to the benefit of the project and of the individuals (L_S5) (HMC, 2012b). On the other hand KMU identified a strong culture of informal verbal sharing of knowledge in the company. This might counterbalance to some extent the challenges that presented above.

The first step of the workgroup towards the direction to address the difficulty to determine what knowledge should be managed, is the delineation of all knowledge assets that exist in the company. Among all these assets, the workgroup identified the explicit knowledge from past projects that exist in HMC. Overall, it is concluded that there is an abundance of documents that include explicit knowledge in the company (L_T2). The documents that include explicit knowledge are project documents but also documents that include codified knowledge from previous projects such as Lessons Learned. The abundance of such knowledge documents is in line with one of the findings of a previous study in the company regarding capturing knowledge (Barney, 2011), in which it is found that "employees in HMC do not show any strategic behavior on knowledge and are willing to share their know-how".

Trying to address the issue of how to improve availability and accessibility of explicit knowledge to the employees, the KMU workgroup described the information platforms and accessing tools that exist currently in the company (HMC, 2012b). Overall, it is concluded that there is room for improvement in the information platforms and accessing tools regarding their user-friendliness, completeness (L_T2) and categorization of documents (L_T3). Finally, it is important to mention, that the KMU workgroup identified that a part of project knowledge is externalized and written down but isn't shared as efficiently and effectively as it would be desirable among all relevant people within the company (L_T2).

Based on KMU findings and aiming to increase efficiency and effectiveness of project knowledge sharing, Technology department initiated the development of Xperia, a tool for searching similar projects, the improvement of Techknowledge (intranet site for Technology), and the development of a Lessons Learned (LL) database (L_T1, L_T2). At the moment that this research is conducted, improvement of Techknowledge is about to start, LL database is in a pilot phase and Xperia is a newly developed application that is still subject to constant input, and thus not all project data are included yet. Nevertheless, these "technological" initiatives are expected to improve sharing of explicit knowledge in Technology.

5.3 Survey

As mentioned in the beginning of this chapter, the assessment of the current situation concerning reuse of explicit knowledge during the FED of projects by the Technology department is done with triangulation of research methods. Therefore, besides the desk research in the company's documents, a survey among the employees of the department is done. In that way the information obtained from the two research methods are cross-examined and thus a complete picture of the current situation is obtained, giving valuable input to the design of the strategy. Moreover, the survey as research method is in line with the process management approach (De Bruijn et al., 2010) that is adopted in this research, providing the respondents with the opportunity of opinion confidentiality through anonymity. It is worth mentioning that also a sense of urgency is created to the Technology employees through the participation to the survey.

In this survey, the employees of the Technology department are asked to fill in a questionnaire concerning the factors that influence currently the reuse of explicit project knowledge in the front end

development of projects. The results of the survey together with the findings of the desk research answer **research question 2.1** of this thesis. Furthermore, the respondents are asked to rate the importance of the various factors that influence reuse of explicit knowledge. In that way, based on the employees' responses we will also get insight on the priority of factors for the improvement strategy. The results of the survey concerning the importance of factors answer **research question 2.2** of this thesis. Finally the respondents are asked to rank several areas that improvement should focus, aiming to get insight for the design of the strategy.

The survey questions are categorized in 6 sections. The first two questions include general questions about the respondent, and questions on frequency of using explicit knowledge. Sections 3, 4 and 5 include questions on the technological, organizational and social aspects of explicit knowledge reuse. The 6th section includes questions on importance of explicit knowledge reuse. The design of the survey, the survey invitation, introduction, questions, and detailed analysis can be found in appendix B (confidential). In the following sub-section a summary of the most striking survey results from the detailed analysis is presented.

5.3.1 Summary of survey results analysis

The questionnaire was active for 5 days in total and was distributed electronically to 211 employees of the Technology Products in total. 67 of them filled in the questionnaire, which makes a total response rate of 31.8%. Of these 67 responses, 38 are complete, while the rest 29 are incomplete.

"General Information" section

In this section general information about the respondents are presented. The respondents are mainly project/specialist engineers and engineers, which as explained in the desk research are mainly responsible for the work in the FED of Projects and thus our focus in that survey. The opinion of managers and other employees, such as the Technology Advisors, is of high value for this research and thus are taken into account. In the survey, respondents of all experience levels and Technology Products participated, which ensures that in this survey as most as possible different "points of view" are taken into account.

"Documented Information" section

In this section of the survey, it is aimed to find out the frequency that Technology employees use certain documents in the FED of projects and also the frequency of the locations / tools usage to find those documents.

A general comment is that only Set up & Work Preparation documentation is reused frequently. Reflecting on this finding, that happens possibly because Set up & Work Preparation documentation includes knowledge that is in visual forms (drawings) or in the form of step-by-step guidance (manuals), and therefore easily extractable knowledge compared to the rest documentation. Another explanation might be that reuse of such documents has been a common practice since the early years of the company and therefore it might be informally institutionalized in the FED of projects.

Moreover, from comments in the free text box about other means of reusing knowledge, such as *"Asking colleagues for their experience"* or *"talks with experienced persons"*, it is concluded that Technology employees prefer to obtain information directly from experienced people than from documents. This is in line with the finding of KMU project that there is a strong culture of informal verbal sharing of knowledge. KMU concluded that this is a strong point of the current situation, and this is in line with Barney's (2011) findings that employees believe that verbal sharing is a more effective way of getting knowledge than through the re-use of a document.

Concerning the locations and tools, the general comment is that top in frequency are Techknowledge (the intranet site for the Technology department), project folders and own storage. A reason for the high frequency could be that these tools contain information that people need on a day-to-day basis for their work. Moreover, it is striking the fact that people don't use frequently the Xperia and central search page tools for finding explicit knowledge from previous projects. Possibly this happens because they are newly introduced, which might implies that people need time to familiarize with tools and also that people need to be trained on how to use the tools and on what is the value of the tools for their work.

Reflecting overall on the findings regarding the frequency of explicit knowledge sources and tools usage, it can be said that currently Technology employees use tools to find information for their day-to-day project work, while they rely on other experienced employees for extracting knowledge from previous projects. Although this is a strong point of the current situation, room for improvement is found on reuse of explicit knowledge forms. Development of tools (Xperia, Central search page) for facilitating reuse of explicit knowledge, seems to need support by training people on how to use it and on what is its value for their work.

"Technological factors" section

In this section, it is aimed to find out the opinion of the employees regarding the knowledge quality and availability, and also the ease to access it currently. Quite striking is the fact that Technology employees believe that insufficient information is available, which contradicts with the indication of KMU that there is an abundance of documents that include explicit knowledge in the company (L_T2). Taking into account also the low frequency of tools and sources of explicit knowledge that was found in the previous section, it is concluded that there is room for improvement on employees awareness of explicit knowledge availability. Moreover, it is expected that improvements in Xperia, Techknowledge, and the development of the LL database will increase employees awareness of available explicit knowledge from previous projects.

Employees believe also that navigation in systems is difficult. This fact supports the implication of need for training of employees on how to use systems that identified in the "Documented Information" section.

A general comment about the aspects of knowledge quality currently is that it is observed a difference of opinions, and the "neutral" answers are high. Exception is the correctness of explicit knowledge, for which a clear majority agrees that current explicit knowledge is correct. An explanation for the

dispersion of opinions about the rest aspects of knowledge quality might be that some documents of explicit knowledge might be of high quality while others might not. Therefore, effort to set quality benchmarks for all types of documents seems to be required.

"Organizational factors" section

In this section the Technology employees asked to assess the presence of organizational aspects of knowledge reuse in the current situation and also assess the means that can be used to improve explicit knowledge reuse currently in the company.

A general comment about the opinion of the employees on the presence of organizational sub-aspects of knowledge reuse is that the "neutral' answers are high and convergence of opinions is not observed. Reflecting on this observation, this could indicate that either there is no clear organizational strategy communicated to the employees on this area or that the employees do not recognize it as such. Based on the findings of desk research, it is concluded that until the moment that this research was conducted the initiatives in Technology focused on improving reuse of explicit knowledge though technological facilitation. Therefore, room for improving reuse of explicit knowledge is identified, by initiatives that exploit the organizational sub-aspects of knowledge reuse.

Regarding the means that can be used to improve explicit knowledge reuse in the company, figure 15 presents that the respondents showed a strong preference for communication, training and recognition, while they seem to prefer less enforcing and rewarding as organizational means for improving reuse. A need for training is justified here after the indications that were find in the previous sections, due to low frequency of tools and perceived difficulty of navigation. Based on the observed non-convergence of opinions about presence of organizational sub-aspects and the employees' preference for communication, room for improvement is identified in the use of communication as an organizational strategy for improving reuse.

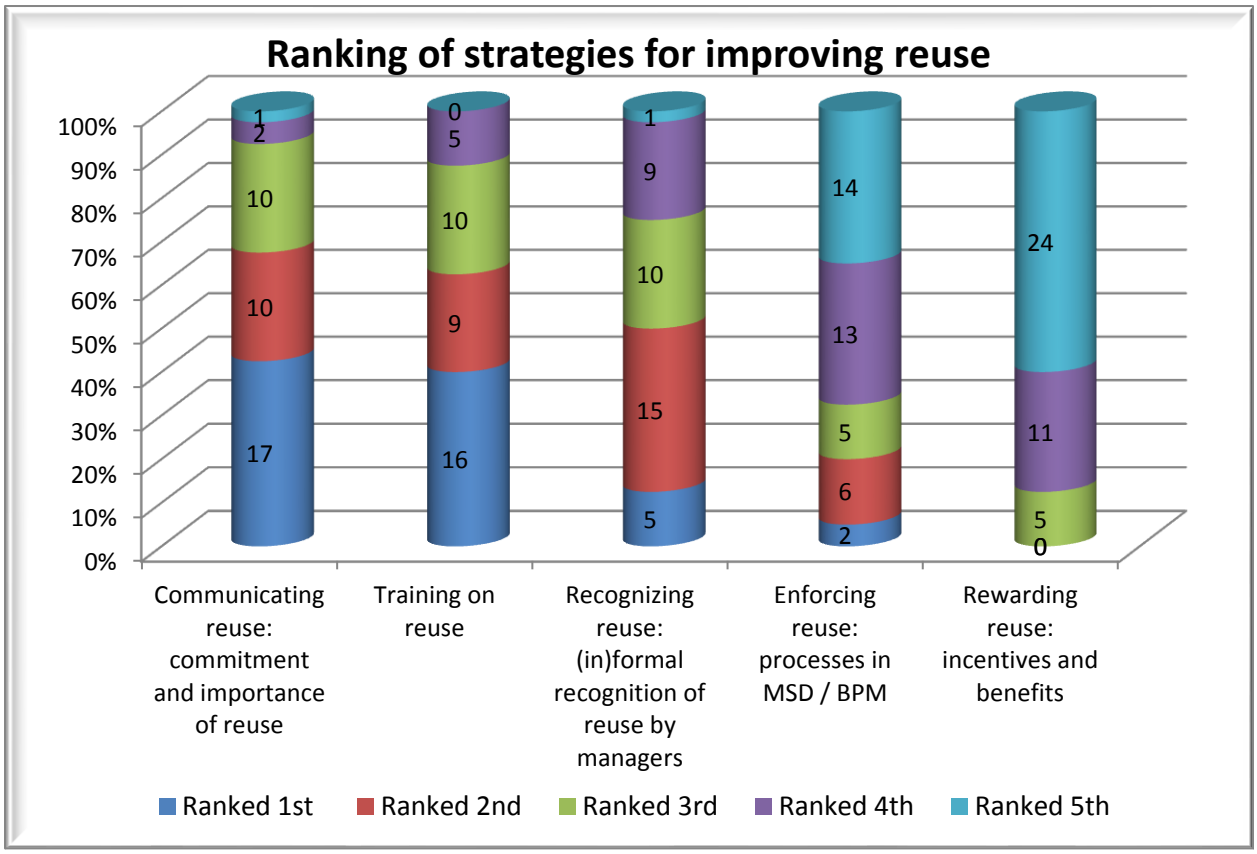

Figure 15 – Ranking of strategies for improving explicit knowledge reuse

"Social factors" section

In this section the Technology employees responded on questions about their current personal perceptions, motivations and capacities on explicit knowledge reuse. It is encouraging the fact that employees believe that they are capable on reusing explicit knowledge, which is in line with Barney's (2011) findings that project team members are quite capable of internalizing the explicit knowledge and turn it into their own know-how (L_S9). On the other hand it is striking the fact that employees believe that they are familiar with the tools and systems to search, but earlier in the survey they responded that some tools like Xperia and Central search page are rarely or never used. This might indicate that they employees are not aware of the existence of these tools, which justifies again the need for communication and training of reuse.

A clear majority of the employees found to realize the gains from reusing explicit knowledge. This was expected and justifies Barney's (2011) findings that employees recognize the use of existing knowledge as a good starting point for the project (L_S1), and that they realize the personal/team gains that this practice entails (L_S5). Nevertheless, a marginal majority believes that there is room for improvement in the effort that is required to find explicit knowledge. As strength can be seen the fact that the majority of the employees are found to be motivated to reuse explicit knowledge in cases of performance gaps in the FED of projects (L_S3).

Reflecting overall on the findings of the social factors section, it can be said that employees believe that they are capable and motivated to reuse, and that they perceive reuse as a value adding practice. These, at least imply that employees are receptive to initiatives regarding the improvement of explicit knowledge reuse.

"Reuse" section

In this section, respondents' answers are presented concerning the impact of explicit knowledge reuse in project performance, and the improvement needed in the current reuse. In general, the majority of the employees believe that reusing explicit knowledge prevents "reinventing the wheel" and repeating mistakes; facts that are in line with literature (De Bruijn & De Bruijn, 2010; Disterer, 2002). Moreover, the vast majority of the employees recognizes that there is room for improvement in reuse of explicit knowledge in the company as is shown in the following figure.

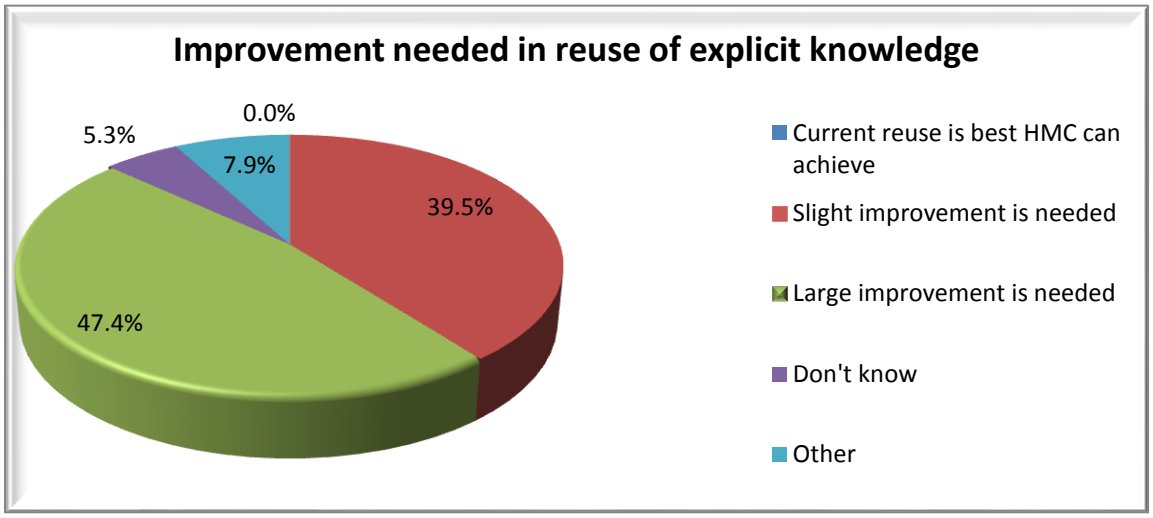

Figure 16 - Improvement needed in reuse of explicit knowledge

Finally, the respondents that selected the options "slight" or "large improvement is needed" in current reuse of explicit knowledge were asked to rank the three aspects of knowledge reuse, concerning the required focus of a strategy to improve reuse of explicit knowledge. The ranking of the three knowledge reuse aspects is presented in figure 17, where a contradiction between employees' beliefs and theory is presented.

To be more specific, according to the survey responses (Figure 17), Technology should be the first priority of the improvement strategy; on the other hand according to literature (M. M. Ajmal et al., 2009; Damodaran & Olphert, 2000; Liebowitz, 1999) supporting and hindering factors of knowledge are mostly related to people and processes than technology itself. The survey results might deviate from theory because the problems in Technology are easy to be identified, while deeper thought is required to identify problems in People and Processes.

Furthermore, it seems that employees are not yet aware of the initiatives that are already taken by Technology on facilitating searching for project information (Xperia) and on increasing knowledge

content quality (LL database with metadata). The latter was expected since the LL database is still in a pilot phase, while the former, firstly indicates that input to Xperia should continue, and secondly justifies once more the need for training on systems and tools to reuse.

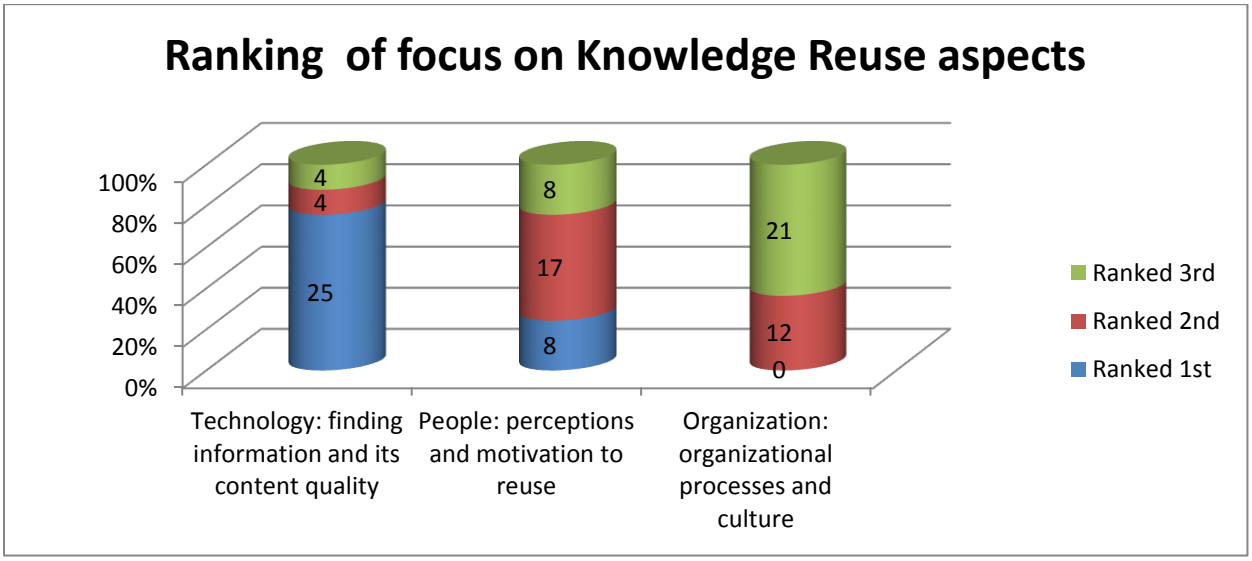

Figure 17 - Ranking of the knowledge reuse aspects in terms of focus that should be paid by the improvement strategy

5.4 Areas of improvement in current explicit knowledge reuse

In the previous sections the current situation regarding reuse of explicit knowledge in the company was assessed through desk research in the company's documents and through a survey among the Technology Products employees. For the assessment of the current situation were used the requirements for an unproblematic explicit knowledge reuse process that presented in table 5 in sub-chapter 3.7. During the analysis of the desk research findings and the survey results, the requirements reference codes of table 5 were used, in order for the reader to be able to refer and check the relevant theoretical requirement that is discussed.

During the assessment, based on what is prescribed by the theoretical requirements of table 5, it is found that some areas of the current situation of HMC need improvement. The detailed analysis of the areas of improvement in the current situation, and how exactly they identified can be found in appendix C (confidential), while a summary of that analysis is presented in tables, 7, 8 and 9 below. These tables include also the requirement name, the relevant KR Aspect and KR Process and the reference code that used in the analysis when the related discussion was made. These areas of improvement in the current situation answer **research question 2.1** of this thesis.

In tables 7, 8 and 9, the importance of the final overall conclusions is also presented, which is based on the employees' ratings. The detailed analysis of the importance rating of the conclusions can be found also in appendix C (confidential). For the importance rating the following codes are used:

U	Unimportant
MI	Moderately Important
VI	Very Important

Table 6 - Importance rating codes used by the employees in the survey

The importance of the requirements is the answer to **research question 2.2** of this thesis. Tables 7, 8 and 9 that summarize the assessment of the current situation are presented below.

Table 7 - Assessment table of the current situation about explicit knowledge reuse in Technology department of HMC (technological aspect)

KR Aspect	KR process	Requirement / Factor	Assessment result on the improvement needed in explicit knowledge reuse processes in HMC **BI:** Big improvement needed **SI:** Slight improvement needed **NI:** No improvement needed		Importance	Reference code
Technological	Search process	Ease of access	**SI**	**Overall conclusion:** Initiatives for improvement in accessing explicit knowledge are taken. Nevertheless, employees seem to need training, and the value of tools needs to be further communicated.	**VI**	L_T1
	Intention to reuse	Richness of explicit knowledge	**SI**	**Overall conclusion**: It is encouraging that people are willing to share their knowledge and therefore abundant explicit knowledge exists. Although initiatives are taken for improvement of sources, intention to reuse is hindered by the fact that availability of explicit knowledge is not sufficient yet.	**VI**	L_T2
	Assess and select search findings	Knowledge quality	**BI**	**Overall conclusion**: People's opinions about the quality aspects of explicit knowledge content related to assessment and selection of search results are dispersed. An explanation might be that some documents of explicit knowledge might be of high quality while other might not. Therefore, effort to set quality benchmarks for all types of documents is required.	**VI**	L_T3

	Application of knowledge		NI	**Overall conclusion:** People's opinions about the quality aspects of explicit knowledge content related to application of knowledge gives overall a positive indication. Clearly strong point of the current explicit knowledge content is correctness.	**VI**	

Table 8 - Assessment table of the current situation about explicit knowledge reuse in Technology department of HMC (organizational aspect)

KR Aspect	KR process	Requirement / Factor	Assessment result on the improvement needed in explicit knowledge reuse processes in HMC **BI:** Big improvement needed **SI:** Slight improvement needed **NI:** No improvement needed		Importance	Reference code
Organizational	Intention to reuse Application of knowledge	Standardization of knowledge reuse	**BI**	**Overall conclusion:** Reuse of explicit knowledge is not formalized in the official organizational processes of HMC. Also room for improvement in guidance of reuse is identified.	**MI**	L_O1
	Intention to reuse	Management commitment	**SI**	**Overall conclusion:** Commitment of top management to knowledge management isn't yet clear to the employees. Therefore, effort is required to turn top management's commitment to specific actions that are visible to the employees.	**VI**	L_O2
	Intention to reuse	Leadership	**SI**	**Overall conclusion** : Current situation in leadership seems to be good, but still some small effort should be devoted in spreading leadership of knowledge reuse in all project teams and decrease the amount of people that are still unsure of the practice.	**VI**	L_O3
	Intention to reuse	Subjective norm	**BI**	**Overall conclusion:** Improvement is needed on the use of social pressure as a mean to increase intention to reuse.	**MI**	L_O4

	Intention to reuse	Organizational culture	SI	**Overall conclusion:** Some effort should be devoted on strengthening the use of communication and recognition as means to cultivate knowledge continuation culture in the company. Rewards and incentives are not used currently according to the employees' opinion.	VI	L_O5
	Intention to reuse	Communication of client's pressure	SI	**Overall conclusion**: Improvement is needed on the use of client's pressure for learning as a mean to increase intention to reuse.	VI	L_O6
	Intention to reuse	Training	SI	**Overall conclusion**: Informal "on the job" training seems to be recognized by the employees in the current situation. Improvement is needed to formalize training in the organization, aiming to standardize training of employees on reuse importance and on use of systems.	VI	L_O7
	Application of knowledge	Responsibility / Accountability	SI	**Overall conclusion:** In project preparation, people state that they know who to contact for help in application. Although accountability isn't created formally within the project teams, people might use their personal contacts or Communities of Practice site to contact accountable people and get help in knowledge application.	VI	L_O8

Table 9 - Assessment table of the current situation about explicit knowledge reuse in Technology department of HMC (social aspect)

KR Aspect	KR process	Requirement / Factor	Assessment result on the improvement needed in explicit knowledge reuse processes in HMC **BI:** Big improvement needed **SI:** Slight improvement needed **NI:** No improvement needed	Importance	Reference code

Social	Intention to reuse / Assess and select search findings	Individual's values and norms	**NI**	**Overall conclusion:** People state that they recognize the problems that are related to non-reuse of explicit knowledge. Moreover they state that they are "open minded" when they actually search.	**VI**	L_S1
	Intention to reuse	Perception of effort	**BI**	**Overall conclusion:** Currently people state that the effort that is required on finding explicit knowledge is high, while effort for application is acceptable. Therefore it is concluded that improvement is needed in making people more capable on finding information.	**VI**	L_S2
	Intention to reuse	Perception of performance gap	**SI**	A clear majority of the employees are motivated currently to reuse explicit knowledge by the existence of gap between their capacities and the required ones for a successful project (expressed as increased project risk, limited experience or time pressure to deliver a project). Some room for improvement may be needed aiming to communicate stronger the existence of performance gaps.	**VI**	L_S3
	Intention to reuse / Assess and select search findings	Trust on knowledge	**SI**	**Overall conclusion:** People seem to trust that currently existing explicit knowledge is correct. Some effort still needs to be devoted to build trust on the employees that documents are up to date.	**VI**	L_S4

	Intention to reuse	Perceived personal added value	SI	**Overall conclusion:** Currently, it is encouraging that people recognize the gains from reuse practice. However, for making people actually reuse, improvement is needed on finding the right balance between creativity on new solutions and efficiency of reusing within the project teams.	VI	L_S5
	Intention to reuse	Retentive capacity	SI	**Overall conclusion:** Some improvement is needed in making use of all types of documents a routine for the employees.	VI	L_S6
	Intention to reuse	Familiarity with KMS	BI	**Overall conclusion:** Effort should be devoted to make people familiar with the relevant tools for project preparation and also to increase people's awareness on the availability of explicit knowledge.	VI	L_S7
	Search process					
	Definition of search question	Capability to define search question	NI	A marginal majority of the employees state that they know what they search. This is supported by theory where it is stated that people doing similar work in different settings (like engineers and PEs) have only minimal problems on defining what they search for.	MI	L_S8
	Assess and select search findings	Absorptive capacity	NI	**Overall conclusion:** Employees are found to be capable of both judging usefulness of knowledge and internalizing to their own know-how.	VI	L_S9
	Application of knowledge					

5.5 Reflection on current situation analysis and scoping of improvement

In the previous section, the areas that need improvement currently in the company regarding explicit knowledge reuse were presented. Before embarking on designing the strategy to foster reuse of explicit knowledge, by exploiting the factors that were indicated in the analysis as improvement-needed, a reflection is attempted on the analysis results.

Overall, it is observed that improvements are needed in all three knowledge reuse aspects (Technological, Organizational, Social). Looking at the KR sub-processes, improvements are found on a lot of factors in the "intention to reuse" KR sub-process. On the other hand, the second KR process "Definition of search question" in the current situation, was not found to require improvement; this fact was expected for the case of project team members, since literature indicates that people doing similar work in different settings (like engineers and PEs) have only minimal problems on defining what they search for (Markus 2001). In "Search process" it was found, that ease of access is currently being improved by the development of a LL database, the constant input to Xperia and improvements on Techknowledge intranet site, but still people's familiarity needs to be improved. In "Assess and select search findings" KR process, no improvement is needed on the factors of the social aspect, but improvement is needed on knowledge quality; the factor of the technological aspect. Finally, in "Application of knowledge" almost no improvement is needed in the current situation, except from the standardization of knowledge, where room for improvement in guidance of reuse is identified.

To conclude, current situation assessment analysis indicated "intention to reuse" KR sub-process, as the one where major room for improvement exist. It is encouraging though that initiatives in Technology department are currently improving the technological aspect of "intention to reuse" (richness of explicit knowledge), by constant input of data in Xperia, improvements on Techknowledge intranet site, and the development of a LL database. To conclude, taking into account that major room for improvements is identified during the analysis in "intention to reuse" and that current initiatives aim to improve its technological aspect, it seems that the strategy to foster reuse of explicit knowledge in Technology should focus on the social and organizational aspects of employee's intention to reuse explicit knowledge. Towards this direction contributes the fact that employees rated all factors related to "intention to reuse" as Very Important, with the exception of "standardization of knowledge reuse" and "subjective norm" that were rated as Moderately Important.

Nevertheless, according to Ajmal et al. (2009) "any knowledge management initiative that appears to be incongruent with the organization's strategic goals, is doomed to fail". Therefore, aiming to identify whether the analysis indication to focus on the social and organizational aspects of "intention to reuse" is in line with Technology management's view on improvement needed in the area of knowledge reuse, it is decided to make a discussion with a Technology Management representative. The discussion and the results are presented in the next section.

5.6 Technology Management's view on the improvement needed

Aiming to identify whether the analysis indication to focus on the social and organizational aspects of "intention to reuse" explicit knowledge is in line with Technology management's view on improvement needed, the leader of the internal HMC project "Knowledge Management Upgrade (KMU)", was

proposed by Technology Management as the most appropriate person to provide the researcher with the management's view. Therefore, a semi-structured discussion with the KMU project leader was done and the results are discussed in the present section.

Based on the company's strategic goals, the KMU leader was asked to express the opinion of the management about the analysis indication to focus on the social and organizational aspects of "intention to reuse". KMU leader was asked also to comment on the improvement needed in the areas of the "intention to reuse" theoretical requirements, aiming to identify management's view. Finally the KMU leader was asked to rate the importance of the requirements according to the management's point of view. In the section below, the discussion is presented.

5.6.1 Semi structured discussion with KMU leader

The discussion with the KMU project leader is structured among the following two thematic areas:

a) *Reflection on the analysis indication to focus on the improvement of social and organizational aspects of "intention to reuse"*

In this area the analysis results are presented, and the KMU leader is asked to reflect on them based on the strategic goals of Technology department.

b) *Commenting on the improvement needed in the area of the "intention to reuse"*

In this thematic area, the KMU leader was asked to comment on the improvement needed by reflecting on the theoretical requirements of "intention to reuse", and also to rate the requirements regarding their importance for improving reuse of explicit knowledge reuse in the company.

Reflection on the analysis indication

After presenting the areas of improvement that were revealed in the assessment of the current situation, a discussion with the KMU leader followed regarding the analysis indication to focus on the improvement of social and organizational aspects of "intention to reuse". The discussion is summarized in the key statements that made by the KMU leader and are presented below.

"All of the five sequential steps in the KR process are of equal importance. It is this chain of events that results in the effective & efficient re-use of explicit knowledge. However, due to the current initiatives within the organization on improving knowledge management practices, it is also management's opinion that the focus of the KR improvement strategy should focus in depth on the first step of the process: the intention to re-use. For the other four steps a list of requirements based on literature and the survey results will suffice."

Moreover, the KMU leader added that focusing on the social and organizational aspects is in line with their view, and these aspects are perceived as the ones where the key challenge lies. In the discussion, it was mentioned:

"We can develop new tools or improve our current tools, but without the challenging task of preparing our people and the organization to accept them, these tools will not be used sufficiently. Furthermore, to

management, commitment and governance are key to any knowledge sharing process: without these any strategy will be just another initiative which might be successful for a short time but will inevitably not be sustainable."

Then, the discussion was wrapped up and it was mentioned:

"To sum up, HMC's view for improvement is in line with analysis indication for devising a strategy to improve the re-use of explicit knowledge by focusing on the intention to re-use and the organizational & social factors related to ensuring this intention to re-use."

Commenting on the improvement needed

Afterwards, the KMU leader was asked to comment in detail on the improvement needed by reflecting on the theoretical requirements of "intention to reuse", aiming to identify any striking difference between the employees' and management's opinions on the improvement needed. Moreover, she was asked to rate the theoretical requirements regarding their importance for improving explicit knowledge reuse in Technology, aiming to find if there is any striking difference between employees' and management's perception of theoretical requirements/factors' importance.

In order to be able to do the comparison between the employees' and management's opinions, a gap analysis table (table 11) is created that aims to highlight any difference between the opinions on the current situation and summarize the improvement gaps that are identified. Table 11 includes the "intention to reuse" theoretical requirements for an unproblematic explicit knowledge reuse process that are presented in table 5 in section 3.7, categorized per knowledge reuse aspect. After scoping the improvement to the social and organizational aspects, the technological factor is excluded from the table. In table 11 are included the results of the current situation assessment and the importance rating of the employees. Finally, two columns on the improvement needed and the importance according to the management's point of view are included.

In the second part of this semi-structured discussion, the gap analysis table is introduced and the KMU project leader was asked to express the management's opinion in the relevant cells of the "Intention to reuse" gap analysis table. The KMU leader was prompted to use the scale that was used in the assessment tables 7, 8 and 9 for the improvement needed; i.e. she was asked to indicate whether big-, slight- or no-improvement is needed, and elaborating also on that indication. This facilitates the comparison between analysis results and management's view on improvement needed. Moreover, KMU leader was asked to rate the importance of the factors according to management's opinion. For the rating, she was prompted to use the same scale that was used in the survey among the employees. The importance rating codes and the colors that are used to indicate the improvement needed according to the analysis and according to management are shown in table 10 below:

U	Unimportant
MI	Moderately Important
VI	Very Important
BI	Big improvement
SI	Slight improvement
NI	No improvement

Table 10 – Importance rating codes and improvement indication colors used in the gap analysis table

The complete gap analysis table that includes the results of the assessment analysis from tables 7, 8 and 9 and the detailed comments about management's opinion can be found in appendix D. A summary of the gap analysis results is presented in table 11 below, where only the indication colors and codes are used for the sake of simplicity.

		Requirement / Factor	Analysis results on improvement needed	Employees' Importance	Management's opinion on improvement needed	Management's Importance	Reference code
	O	Standardization of knowledge reuse	BI	MI	BI	VI	L_O1
		Management commitment	SI	VI	SI	VI	L_O2
		Leadership	SI	VI	SI	VI	L_O3
		Subjective norm	BI	MI	SI	VI	L_O4
		Organizational culture	SI	VI	NI	VI	L_O5
		Communication of client's pressure	SI	VI	NI	MI	L_O6
		Training	SI	VI		VI	L_O7
	S	Individual's values and norms	NI	VI	NI	VI	L_S1
		Perception of effort	BI	VI	BI	VI	L_S2
		Perception of performance gap	SI	VI	NI	VI	L_S3
		Trust on knowledge	SI	VI	NI	VI	L_S4
		Perceived personal added value	SI	VI	SI	VI	L_S5
		Retentive capacity	SI	VI	SI	VI	L_S6
		Familiarity with KMS	BI	VI	BI	VI	L_S7

Table 11 - "Intention to reuse" gap-analysis summary table

5.6.2 *Reflection on the semi structured discussion results*

As mentioned earlier, literature highlights the importance of congruence of knowledge management initiatives with the organization's strategic goals (Ajmal et al., 2009). Reflecting on the discussion with the Technology management's representative, overall it can be said that there is commitment for improvement in the area of knowledge management. This was expected, since in sub-chapter 4.4 the strategic goal for continuous improvement of Technology services is highlighted, and that implies that Technology department is receptive to changes that aim on improvement of its services.

In the discussion about analysis indication for the strategy to focus on improvement of the "intention to reuse" KR process, it was encouraging to find out that Technology management also identifies room for improvement in that process.

Nevertheless, some differences were identified between the analysis results on the improvement needed in the current situation and management's opinion. An overview of these differences can be observed in table 11, by comparing the colors in the two relevant columns for each theoretical requirement. Overall, it is encouraging to see that no big difference is identified; i.e. there is no case where the analysis indicates a need for big improvement and management indicated no need for improvement or the opposite. Additionally, no big difference is identified in the importance ratings of factors.

Reflecting on the observed differences in the gap analysis table, it can be said that in all differences management believes that less improvement is needed compared to the analysis. Recalling that the analysis results are based to a great extent on employees' opinions, a possible explanation of the observed differences might be that employees tend to overestimate problems because it is part of their daily work, or that management might tend to underestimate problems.

5.7 Design requirements

In the previous sections the current situation was analyzed; the areas that need improvement were identified (**research question 2.1**) based on the theoretical requirements/factors. Moreover, the importance of these factors was indicated (**research question 2.2**). Afterwards, Technology management's view is compared to the analysis results on the improvement needed. The improvement needed is summarized in the gap analysis in table 11, and base on these gaps the requirements for the design of the strategy to foster "intention to reuse" in Technology department are developed in this section (**research question 2.3**).

As already mentioned, the analysis and Technology management's opinion on the improvement needed, are based on the theoretical requirements of intention to reuse that presented in sub-chapter 3.7. Based on the gap analysis in table 11, it is decided to use almost all these requirements on the design of the strategy to foster "intention to reuse". Only "Individual's values and norms" and "trust on knowledge" are excluded. The first is excluded since it was indicated both by analysis and management that no improvement is needed in this area, and the second, because during the discussion with the KMU leader it was found that there is already an initiative in place to increase employees' trust on

knowledge by adding the author and last update information on explicit knowledge documents (appendix D). In table 12, the design requirements are shown (R1-R12).

Aiming for designing a strategy that fits to Technology, it was also decided to use as guides in the design of the strategy, the principles that guide KMU project of HMC. Therefore, in table 12 are shown both the HMC specific guiding principles (G1-G13) and the requirements for the design that originate from theory (R1-R12).

Design Requirements	Reference code
The strategy to foster intention to reuse explicit knowledge should strive for a higher quality of explicit knowledge reuse by…	
…standardizing explicit KR by an official company process	R1
…making clear management's commitment on KR to employees	R2
…spreading leadership of KR in all project teams	R3
…systematizing employees peer pressure to reuse	R4
…cultivating a KR organizational culture	R5
…communicating client's pressure for learning to employees	R6
…systematizing training on reuse importance of KR, and on systems/sources for KR	R7
…balancing employee's perception between KR effort and gains	R8
…increasing communication of performance gaps to employees	R9
...communicating to employees the value of KR	R10
…making KR a routine for employees	R11
…increasing employees' familiarity with explicit knowledge sources and systems	R12
Guiding Principles	**Reference code**
A KM strategy should be…	
…appropriate, which entails…	
use of current processes and systems	G1
minimum resources required	G2
simplicity of design	G3
low threshold for participation	G4
balance between the effort required from the knowledge re-users , and the benefits gained	G5
embedding of KM activities in the project workflow	G6
scalable to the specific project/department at hand	G7
ability to monitor performance and link to performance of projects and organization	G8
use of the HMC tradition of verbal sharing	G9
minimum compromise of work flexibility	G10
…and acceptable, which entails…	
sufficient guidance for all to understand and be able to execute it appropriately	G11
thoroughness • sufficient standardization through HMC's management system • clearly assigned roles and responsibilities	G12
a clear strategy for user adoption & organizational embedding	G13

Table 12 – Design requirements and guiding principles for the strategy to foster intention to reuse explicit knowledge

List of requirements for the last four KR sub-processes

In the previous section the design requirements and guiding principles for the strategy to foster intention to reuse explicit knowledge are developed. In this section the design requirements of a strategy that focus on the other KR sub-processes are developed. After scoping the improvement, it is decided not to take them into account in the current design. Nevertheless, they serve as the base for future endeavors in the HMC for improvements on the KR sub-processes "definition of the search question", "search process", "assessment of search results", and finally "application of knowledge".

The requirements are developed based on the theoretical requirements for an unproblematic knowledge reuse process (table 5) and the needs for improvement that identified in the survey results (tables 7, 8, 9). The design requirements for a strategy that aims to improve the last four KR sub-processes are presented below.

As literature indicates, shared practitioners that do similar work in different settings (like engineers and PEs in HMC) have only minimal problems on defining what they search for (Markus, 2001). The analysis justified literature indication and thus it is concluded that there is no need for a strategy that focuses on improving people's ability to define their search question.

On the other hand the rest three KR sub-processes, were found to require improvement. Therefore, their improvement entails a strategy that…

- improves search process with the use of a user-friendly knowledge management system
- improves search process with the use of an effective and efficient search engine
- improves search process by increasing the familiarity of the employees on the searching tools
- improves assessment of search results by increasing quality of explicit knowledge with the use of quality benchmarks
- improves assessment of search results by increasing employees' positive attitude on knowledge reuse and their openness on examining both direct solutions and indirect analogies from a broad set of knowledge sources.
- improves assessment of search results by building trust on the employees that documents are up to date
- improves application of knowledge by standardizing guidance on reuse

Once again it should be mentioned that the requirements that are developed in the present section will not be used in the present research. Nevertheless, they form a basis for future improvement endeavors in HMC.

5.8 Strategy within scoped improvement

Having in mind the scoped improvement that is presented in the section 5.5, the objective of the design can be defined. The objective is to foster reuse of explicit knowledge by focusing on the intention to re-use KR process and the organizational & social factors related to ensuring this intention to re-use. The strategy to achieve that objective should fulfill the requirements that presented in table 12.

As is explained in chapter 1 of this thesis, the design framework proposed by Hevner et al. (2004) is used to guide this research. According to this framework, the design process entails the development of an artifact. The artifact in the case of this thesis is the strategy to foster the intention to reuse explicit knowledge.

During the design process, the solution space for the design is generated in the direction lines of the design variables. Then this solution space is demarcated into a set of suitable solutions, which is in fact the artifact. The selection of the suitable solution from the solution space is done based on the guiding principles for the design that presented in the section 5.7. For the generation of the solution space and the demarcation to the set of suitable solutions, a morphological chart is used (Dym & Little, 2009). The morphological chart is a table, the columns of which are the attributes of the design, or in other words the design variables, and in the rows are listed the available elements/means to materialize those attributes. The solution space consists of the various elements of all the design variables. The various alternative elements are generated based on a literature review, the propositions of the survey respondents for improvement of the current situation and the own ideas of the designer. Different design concept alternatives can be formed by combining the alternatives elements that are presented in a morphological chart. The evaluation and selection among the design concept alternatives is made using the "Pugh concept selection method" based on the appropriateness requirements for the design. The evaluation and selection process took place in an interactive discussion with the deputy Engineering manager of the FIX/FLO Technology product group, aiming to involve an experienced representative of the company in this crucial step of the design process. The generation and selection of the preferred concept is presented in chapter 6.

After the selection of a design concept alternative, these solutions are further combined and elaborated and thus form the detailed design. The detailed design consists of a set of improvement initiatives. It is important to mention at this point that the improvement focuses on initiative that can be realized in a short span of time and with relatively little effort. In other words, the strategy focuses on quick-win initiatives, which can be perceived as the first step of the improvement intervention cycle (Verschuren & Doorewaard, 2010). Therefore, the initiatives of the strategy should be perceived as the first run of an intervention cycle towards the direction of improving the intention to reuse of explicit knowledge, rather than an one-shot solution. The detailed design is presented in chapter 7. These quick wins will also give a sense of progress to the parties that are involved in the knowledge reuse improvement process. The latter is a crucial element in management of improvements on a process based approach (De Bruijn et al., 2010).

An important step before considering the detailed design as the final design is the evaluation. The evaluation is done in the light of the acceptability guiding principles (G11-G13) for the design that are presented in the previous section. The final evaluation was done through an interactive discussion with the Engineering Manager of the PDR Technology product group. Based on this evaluation the detailed design is refined. The refined detailed design is the final strategy for fostering intention to reuse explicit knowledge. The acceptability evaluation and the final strategy are presented in chapter 8. Finally, an implementation roadmap is developed for the developed strategy and is presented in chapter 9.

Conclusion

In this chapter, it was presented the assessment of current situation regarding explicit knowledge reuse in the FED of projects by the Technology department. For the assessment, triangulation of methods was used; a desk research in the company's documents and a survey on the Technology Products employees. The analysis revealed the areas that need improvement currently in the company regarding explicit knowledge reuse. The identified areas for improvement answered **research question 2.1** of this thesis and are summarized and presented in tables 7, 8 and 9. In the same tables the importance of the factors is presented, which is the answer to **research question 2.2** of this thesis.

Reflection on the areas that the analysis indicated room for improvement, resulted to the decision to focus on improvement of the social and organizational aspects of "intention to reuse" KR process. A discussion with KMU leader followed, aiming to identify the opinion of Technology management on the improvement needed. Based on the analysis results and management's opinion, in section 5.7 the requirements for the design of the strategy to foster intention to reuse are developed. In addition guiding principles for the development of the strategy were presented in that section. The requirements and guiding principles answered **research question 2.3** of this thesis.



6.1 Governance: strategy foundation
6.2 People Management practices: strategy levers
6.3 KR initiatives: strategy enablers
6.4 Generating the solution space for KR initiatives
6.5 Morphological chart
6.6 Design concepts generation
6.7 Evaluating design concept alternatives and concept selection

Chapter 6: Generation and evaluation of design concept alternatives

Introduction

Having in mind the scoped improvement that is presented in chapter 5, this chapter aims to present the generation of design concept alternatives and then their evaluation process, during which one alternative will be selected as the preferred one. Nevertheless, before embarking on the alternatives generation phase the foundations for the design should be laid. Moreover, the design variables should be selected before generating design ideas.

6.1 Governance: the foundation framework of KM strategies

As mentioned in the previous chapter, the objective of this design is to devise a strategy to foster explicit knowledge reuse by focusing on the "intention to reuse" KR process and the organizational & social factors related to ensuring this intention to re-use. In few words, the objective of this design is to devise a strategy of change of the organization's management regarding knowledge.

According to Milton (2010), "if any change to a new management system is to deliver value in the organization in the long term, then there needs to be a way of changing the culture, of making sure that the behaviors stay changed, the processes are carried out and the people do what they are supposed to do". In other words, any strategy of change within an organization (such as a knowledge management strategy) that aims to deliver value in a sustainable way should be governed. In line with Milton is also Zyngier, Burstein, & McKay (2006), who mentions that "the implementation of a knowledge

management strategy through a knowledge management governance framework ensures the delivery of anticipated benefits in an authorized and regulated manner".

According to Milton (2010), governance of any knowledge management strategy should have three main mechanisms. The first is top management's commitment and leadership. According to the author, a set of clear corporate expectations about what should be done is a cornerstone for the success of the strategy. Bell DeTienne, Dyer, Hoopes, & Harris (2004) agree with Milton (2010), stating that it is important for the head of the organization to be involved in the knowledge related practices. More specifically they mention "if the boss takes it seriously, the rest of the company will follow". Zyngier et al. (2006) confirm the propositions of the other authors, by the identification of the essential role of leadership for the governance of a KM strategy.

Except leadership and commitment of top management, Zyngier et al. (2006) proposed also the allocation of roles and responsibilities as an important element of KM governance. This is also the second mechanism identified by Milton (2010), who mentions that "if the roles and responsibilities are missing, nobody knows whether it is their job or not".

As a final mechanism, the author states monitoring and measurement of the KM initiatives (Milton 2010). The author mentions that if monitoring and measurement are missing, then the management is not aware whether the initiatives have been applied or working. Measurement is proposed also by other authors like Zyngier et al. (2006). The value of measurement for the governance of KM strategies is enclosed in an old adage, which sais "What you can measure, you can manage" (Skyrme, 2011).

Zyngier in a later work (2008) added a fourth mechanism of governance; risk management. In that study, the author concludes that "the operationalization of KM governance formalizes, locates and authorizes risk management as a structured response to the resolution of the cultural and structural risks and obstacles to KM strategy, and that it achieves this through developed capacity for analysis, articulation, strategic alignment and activity to address risks to effective, sustainable KM".

Based on the literature about the fundamental role of governance for the success of any KM strategy, it is decided to adopt the mechanisms of governance as the foundations on which our strategy is to be built on.

6.2 People management practices: the levers to increase people's intentions

Wong (2005) in his work about the critical success factors for implementing knowledge management indicated that many authors in literature have discussed the significance and roles of Human Resource Management in KM (Garavan, Gunnigle, & Morley, 2000; Robertson & Hammersley, 2000; Soliman & Spooner, 2000). In line with Wong, Cabrera & Cabrera (2005) proposed that people management practices can be adopted to facilitate knowledge related activities. The authors select the term "people management practices" instead of the traditional term "human resource practices", aiming to encompass all relevant practices that organizations can adopt to facilitate knowledge related activities.

People management practices term is used initially by Wright, Dunford, & Snell (2001) in his model of the basic strategic human resources management components.

Following the literature, for the purpose of our design, people management practices will be used as the levers of the strategy to foster individual's intention to reuse explicit knowledge. These levers will serve as the attributes of our design, providing the strategy with the structural elements that are needed to achieve the objective of "fostering individual's intention to reuse explicit knowledge". To be more specific the practices of communication, training, formalization, recognition and rewarding will be used. Below those practices are briefly explained.

Klein (1996) proposed that communication during the process of organizational change can have an important impact on the level of acceptance of that change by organizational participants. Therefore, **communication** of the importance and benefits of reuse is selected to be a design attribute for our strategy. Furthermore, Cabrera & Cabrera (2005) proposed that training and development stimulates individuals' behavioral intentions, by enhancing their self-efficacy levels. Therefore, **training** on how to perform the processes of explicit knowledge reuse or how to develop certain personality traits, is selected to be the second design attribute of our strategy.

Organizational processes describe the way that the various operations within the company are performed by the employees. Cabrera & Cabrera (2005) proposed that the way the work is designed in an organization, influences individuals' behavior towards knowledge activities. Therefore, **formalization** of knowledge reuse by adding knowledge reuse related activities in the organization's formal processes is the third design attribute of our strategy.

Finally, **recognition** and **rewarding** of performance are proposed by McDermott & O'Dell (2001) to be two practices that can be used by an organization to increase people's intention on performing a practice. However, at this point it should be mentioned that Fleming (2011) indicated that the more people are rewarded for performing a behavior (reuse) the more their intrinsic motivation declines. Therefore, it should be paid extra attention in the selection of elements from the rewarding design attribute for our strategy.

To conclude, the five design attributes that described above, supported by the governance mechanisms that described in the previous section, construct the base for the development of certain initiatives that will enable the "fostering of people's intention to reuse explicit knowledge. These enablers are discussed in the next section.

6.3 KR Initiatives: the enablers of intention to reuse

Building on the foundations and using the levers that described in the previous sections, we can construct a set of Knowledge Reuse (KR) initiatives that can be used as enablers of people's intention to reuse explicit knowledge. The overview of the design framework that is used for the strategy to foster intention to reuse explicit knowledge, is presented in figure 18 below and is purposefully displayed in

the format of a pyramid, aiming to stress the fact that it is only with the support of the governance mechanisms and the use of the levers' elements that the KR initiatives can be materialized.

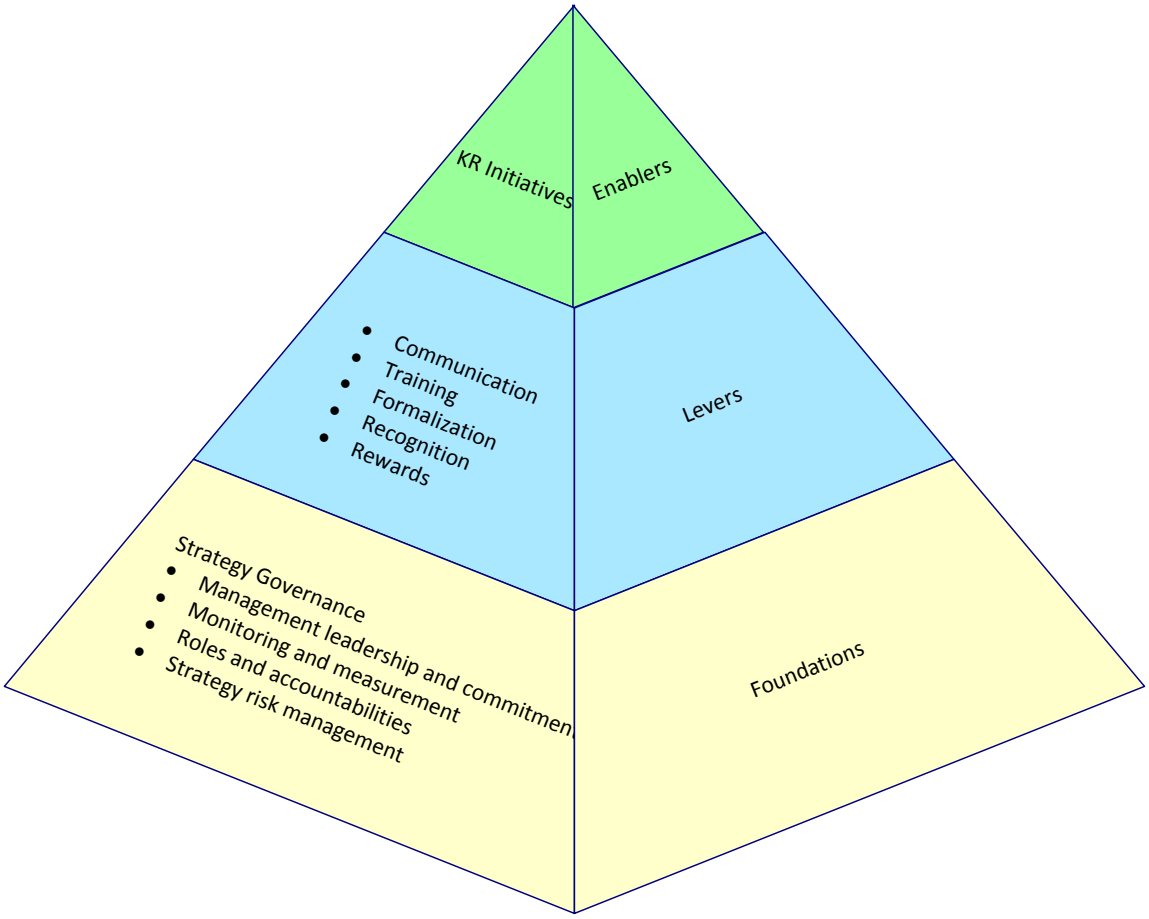

Figure 18- Overview of the strategy design framework

6.4 Generating the solution space of KR initiatives

As mentioned in the previous sections, elements from the five strategy levers will be used to construct the KR initiatives of the strategy to foster intention to reuse. Therefore, the strategy levers are considered as the attributes that the strategy should have. For each of the design attributes, several alternative elements or means can be identified that implement the design attribute. The total of the combinations of these elements construct the solution space, which contains all the potential solutions to the design problem (Dym & Little, 2009); the KR initiatives.

A handy tool to organize the generation of alternative elements for the attributes of the design is the morphological chart. This is a matrix that presents all information about the attributes and elements in a usefully organized and visually appealing format (Dym & Little, 2009). The required attributes are listed in the upper raw, while for each attribute the available elements are identified and listed in cells in the corresponding column. After having listed all available elements for all attributes, a design can be constructed by linking elements for each attribute. The selection and combination of the elements for each attribute is made based on the requirements of the design, based on the information that the designer has about the preference of the users over the attributes and finally based on common sense and heuristics like the one used by Barney (2011) "Group elements that are strongly related to each other, separate elements that are unrelated".

Below, the discussion about the various alternative elements for each design attribute is presented and finally the morphological chart is constructed. The alternatives are generated by searching in literature and over the internet, and also by designer own ideas. During the discussion over the alternative means, any possible advantages and/or disadvantages of the elements are also presented. A detailed table with the attributes' elements, advantages and disadvantages can be found in appendix E.

Communication

Communication within an organization can flow laterally or vertically, and the vertical communication can be further divided into downward or upward directions (Robbins & Judge, 2009). Communication flows downward when it flows from one level of a group to a lower level in the organization, and upwards when it flows in the other way. Lateral communication takes place when groups from the same level communicate.

Recalling the objective of this design, which is to foster intention to reuse, both types of vertical communication should be employed by the strategy, while lateral communication is not related. Downward communication is used to transfer to the employees the message that explains the benefits of knowledge reuse and that top management is committed to that practice. On the other hand upward communication is used to provide management with feedback about whether the initiatives of the strategy have been applied and working and thus help in the monitoring of the strategy.

A type of communication is when the team leaders in the organization communicate to their team members the benefits and importance of knowledge reuse. According to literature (Mayfield & Mayfield, 2002), leader communication is found to be a critical factor for superior worker motivation and performance. A mean to implement this type of communication is through a **leadership checklist** that is distributed to the leaders, helping them to keep track of their own performance regarding what and how the message of the KR benefits is communicated. The advantages of this mean is that it requires limited resources to create and distribute the list, it requires minimum time to implement and also targets to the majority of the employees as they are part of a project team. The disadvantage is that communication through leadership depends on the leadership traits of the leader, and if they are not sufficient then communication may fail. Therefore, it is required that the leaders should hold a

managerial position that ensures that they already have developed certain leadership traits to a minimum extent.

Another mean to communicate the message of KR benefits and importance is to spread **success stories**. This can happen either **verbally on the work**, or in a written form by devoting a **column in every issue of the company's internal journal** or in the **Communities of Practice (CoP) sites**. The first mean is more unstructured and less manageable than the other two. In other words, in the first case communication of the success story depends on the time available, the goodwill and the experiences of the people that are assigned with the responsibility to spread the stories. On the other hand, success stories in a column in company's journal or CoP sites requires that they are codified and stored in a database, which might not be the case in an organization. In that case, the first mean is the only alternative to spread stories. In general, success storytelling is an appropriate method for sharing tacit knowledge (S. Lukosch, Klebl, & Buttler, 2011) on the job and their advantage is that it is given to employees a tangible example of what knowledge assets are capable of, highlighting the value of knowledge reuse in practice (Taylor, 2006). The advantage of success stories in the CoP is that they can be related to the CoP specialty and thus the value is easier identifiable by the CoP members.

Another way of communicating downward the message of KR benefits is the KR benefits tree. This is an effective graphical tool to present the benefits of KR for the individual, the project and the organization, and also the interconnections of the three layer benefits (Skyrme, 2011). The **KR benefits tree** may be presented in an electronic format in the **CoP sites**, or in printed format in **posters** in the company offices. Finally the KR benefits tree may be sent through **emails**. The communicative power of graphical representation is the overall advantage of the KR benefits tree. Among the different means to communicate the tree, CoP sites requires the existence and active use of such sites, while posters are subjected to physical space limitations and are difficult to be updated once they are printed. However both are long lasting communication means. On the other hand, communication of the tree through email draws the attention of the employees for limited time due to the email features, but it can be slightly customized to communicate specific project benefits. Finally, the communication of the benefits tree through email is a mean that targets easily a lot of employees but for a limited time due to the email feature.

Another idea of fostering intention to reuse through communication comes from marketing and is the creation of a **KM logo**. This KM logo can be placed in the **CoP sites**, or used in **promotional material** like pens or cups. The basic communication principle behind the logo mean is the redundancy of message (Klein, 1996). In that sense it aims to create a clear sign that reminds to people the message of KR benefits (among other messages) that this sign carries, every time people see it. However, it is an indirect mean because it doesn't explain to people the message, and therefore may be used only in combination with other means that explain more directly the communication message.

A **booklet** can also be used to communicate to the employees the message of KR benefits and importance. The advantage of a booklet is that it provides the opportunity to thoroughly explain the communicated message and that it targets many people. However, it is a communication mean that lasts for limited time and thus the message can easily be forgotten.

Finally, a **KM blog** in the intranet site of the company can be used to communicate to the employees the message of KR benefits and importance. Through a blog the employees can be informed continuously about KR initiatives taken, give feedback on the initiatives and ask questions in case they are not convinced about the value of KR. The interactive feature of this communication mean is its main advantage. However, it requires resources for its implementation and operation as someone should be devoted to update its content and answers employees' questions.

Training

Training and development stimulates individuals' behavioral intentions, by enhancing their self-efficacy levels on how to perform the processes of explicit knowledge reuse. There are numerous methods of training, and they can be categorized based on whether they are implemented on actual work conditions or not. Therefore the training methods can be categorized to "on the job" and off the job".

On the job training methods

Microtraining is an approach that developed as a method of learning close to the workplace of the trainee, trying to avoid the thresholds that make other training approaches unproductive (De Vries & Brall, 2008; H. K. Lukosch, Overschie, Olsson, & de Vries, 2010). Microtraining is an informal method of learning that comprises a time span of 15-20 minutes for each learning occasion. This training approach consists of 4 steps that are made by the trainer and should be followed by the trainee. In the first step, the trainer starts actively by presenting the issue at stake. Secondly, an exercise or demonstration of the practice follows. The third step includes interactive discussion and feedback to the trainee. Finally, the fourth step includes the recommendations to the trainee on how to continue. One advantage of Microtraining is that it includes active trainee participation and feedback, which according to Read & Kleiner (1996) are important elements of an effective training method. Secondly the learning occasion can be decomposed in smaller parts, which will be addressed in several Microtraining sessions. However, it requires time for preparation and organization, as well as of devoting personnel for the trainer role.

Job rotation is a technique that was initially introduced to the organizations for purposes other than training. It includes the rotation of employees to different working positions in the company, aiming to minimize job boredom. However, job rotation can deliver significant training results as according to Wood (1999) it makes participants to become more flexible, eager to learn and self-motivated. The advantage of job rotation is that it is a rather simple technique with almost no preparation for implementation, but it increases management needs and may decrease employees' productivity.

One to one coaching is a technique that involves the creation of pairs of an experienced and an inexperienced person (coach and learner accordingly). That method aims to train people by an one-by-one guidance approach, within the workflow of the coach and learner. The method requires from the coach to organize the things that need to be done and then let the learner execute the things according to the plan. Kirwan & Birchall (2006) mention that coaching, is a method that gives fast results and is

quite flexible. The disadvantage is that it doesn't maximize the use of the trainer "by having him instruct more than one trainees at a time" (Read & Kleiner, 1996).

A solution to the coaching disadvantage is given by another method; **mentoring**. According to that method, the apprentice works close to a master, observing him to work. The objective of this method is to have the apprentice benefited by the coexistence with the master. This method is appropriate for the introduction of newcomers in the company. However, mentoring is a non-formalized method of training that requires the apprentice to be already eager to learn from the mentorship and the mentor to be ready to teach the practice by example.

Off the job training methods

Lectures is a common way of training people off the job, but according to Read & Kleiner (1996) it is a poor training tactic. The reason is that it lacks trainee involvement and lack of feedback to the trainee. On the other hand it is a way to transfer specific information to big audiences and can be used to give a general understanding of the training topic.

Computer based training is becoming more and more popular as technology progresses. This method is based on the collaboration of the trainee with a computer for the training. The advantage of computer based training is the standardization of the training product, which also makes monitoring and measurement of the training easier. On the other hand, it requires the development of the training computer system and also the feedback that is given to the trainee can only be predetermined.

Serious games is a relatively new training method that was used in the past only for entertainment purposes. Zyda (2005) defines serious games as a "mental contest, played with a computer in accordance with specific rules, that uses entertainment to further government of corporate training, education and strategic communication objectives". The advantage of this method is that it uses challenges through entertainment to motivate people to participate in the training. On the other hand the design and development of the game is considered as a tricky and costly task.

Finally, inclusion of knowledge reuse in the **induction training program** creates awareness of knowledge reuse importance and benefits to the newcomers. As a disadvantage of this mean may be seen the fact, that during the induction program, newcomers receive a big amount of new information and might not retain the importance of KR for the organization.

Formalization

Formalization can be used to add (or adapt existing) processes in the organizational structure of a company, aiming to provide people with official opportunities to think about or perform the reuse practice.

A mean to formalize reuse of knowledge is to create an official organizational process, which main objective will be **knowledge planning** (Skyrme, 2011). As input for this process should be used the project planning. Based on the planned activities for the project, specific types and sources of available

explicit knowledge should be indicated to serve as input for those planned activities. These types and sources of available explicit knowledge will form the knowledge plan. The knowledge plan should be distributed to the project team, which in that way will be aware of the existing knowledge that is available for reuse for the specific project activities that they should perform during the preparation of projects. The increase of awareness about knowledge availability is the main advantage of this mean. On the other hand, additional time should be devoted in the project planning phase.

A second mean of formalization is to **introduce non-reuse of knowledge as a risk** during the project risk assessment sessions. In that way, the project team is brought in the position to find internal team ways to mitigate that risk, and even if they decide to take the risk they are already aware of it which according to the survey respondents increases their intention to reuse explicit knowledge. The disadvantage of this mean is minor and can be limited to the possible increase of risk sessions complexity and duration.

Finally, a **knowledge input-output template** may be filled after the completion of each project activity (Skyrme, 2011). In that template it should be written down in blocks what knowledge has been used and what knowledge has been produced by a project team in each project activity. Additionally, potential users or uses of the produces knowledge should be written down. This mean has a short term and a long term advantage. In the short term it gives the opportunity to monitor what knowledge is actually been use in the project activities. In the long term it can be used in similar activities of future projects as a guide of what knowledge can be reused. The disadvantage is that it might be perceived as an additional workload by the project team.

Recognition

If people do not perceive reuse of knowledge as an integral part of their personal objectives and also they don't see a link to the their performance assessment, then there are high chances that only those that have a personal interest will be engaged in reuse of knowledge (Skyrme, 2011). Informal or formal recognition is a practice that makes explicit to people that reuse of knowledge is valued by the organization.

Knowledge reuse practice can be recognized by managers expressing their recognition to the people who have reused in an **informal personal praise** during the workflow. The advantages of informal recognition praise are that it has strong motivating effect, is simple and inexpensive. However, it is difficult to be monitored whether it actually happens in practice. Some critics of informal praise mention that for practices whose performance indicators are not objective (like in the reuse of knowledge), there are possibilities that employees perceive praise as unfair and manipulated by managers.

Informal praise can also be public in front of the employee coworkers. An idea to achieve the **informal public praise is to create a KR trophy** that will be placed by the project manager to the employees' desk that is recognized to reuse knowledge during the first project activity. For the next project activity, the recognized employee can decide which member of the project team should get the trophy next based on his reuse activity and so on. Informal public praise makes employees feel important in their eyes of their coworkers and that has strong motivating effect according to Nelson (2005).

More formal type of recognition takes place when managers **empower** employees by assigning **reuse leadership roles**, such as **mentoring more junior staff** and participate in **leading communities of practice** as proof of recognition. The advantage of this practice is also the strong motivating effect and the simplicity of implementation. Moreover, it is easier to be monitored.

Knowledge reuse practices can also be recognized by letting the employee that is recognized to reuse by his manager, to write an **article** about his reuse story that will be placed in the **company's internal journal** together with his photo Nelson (2005). The advantage of this recognition mean is both the recognition and respect that the employee receives from his fellows which is motivating for him, but also the publication of the success story that will motivate the rest employees to follow the practice of reuse.

Another formal type of recognition is the linkage of learning to personal development. This can happen by including **KR as a factor of the annual performance review** of employees by their managers. Another formal type of recognition is the placement of a **"recognition plaque" in each community of practice** homepage, which will be the recognition award to a CoP member for knowledge reuse activity. Finally, the reuse activity of project teams can be recognized by an official **"KR Project Team of the year" award**. In that way, the reuse activity will be stimulated also on the team level, and will encourage team members to help each other in the reuse process. It is good the award to be given in a special event by the CEO, aiming to increase the importance of the award for the organization. The advantage of these practices is their motivating effect, but on the cost of additional management needs.

Furthermore, it is worth mentioning that the motivating effect of the recognition **awards or certificates** is multiplied according to Nelson (2005), when they are **connected to a organizations strategic objectives**. In that way the award has a larger meaning to which more people can relate.

Finally, recognition can formally be achieved by **certificates** to knowledge practitioners by **external** certifying organizations. The advantage of this recognition type is that it attaches a special status on the practitioners, but it might entail cost and time to get the certificate.

Rewards

Extrinsic rewards have some motivating power according to Robbins & Judge (2009) and McDermott & O'Dell (2001) and thus it is decided to be included in the strategy. A common mean of extrinsic rewards is compensation for performing a practice either through **monetary** or **tangible rewards** (e.g electronic devices). While money or hi tech products might seem appealing to some people an **all paid participation to a conference** of their specialty might be more appealing to others (Skyrme, 2011). Furthermore, some companies have available courses and training programs (in-house or in cooperation with external educational institutions) in which their employees can participate. Each employee has a standard budget that the company may spend to pay his participation in the educational programs. That gives the idea to reward reuse of knowledge by **increasing the available budget** only for the employees that reused knowledge.

6.5 Morphological chart

In the previous section the various alternative elements of the strategy levers were presented. In this section a morphological chart is used to organize the various elements and is presented in table 13. Besides the organization of elements, the morphological chart is used to generate alternative design concepts, i.e set of KR initiatives that include elements of the strategy levers and are supported by the governance mechanisms. The generation of alternative design concepts is addressed in the next section.

Attribute	Communication	Training	Formalization	Recognition	Rewards
Element / mean	KR leadership checklist	Microtraining	Knowledge planning	Use of informal personal praise during workflow	Monetary or tangible rewards
	Success stories verbally on the work	Job rotation	Non reuse of knowledge in risk sessions	Informal public praise with KR logo trophy	All paid participation to conference
	Success stories in company's journal	One to one coaching	Knowledge input-output template	Assign mentoring junior staff reuse leadership role	Increase of the individual's budget for courses and training programs
	Success stories in CoP sites	Mentoring		Assign leading of CoP leadership role	
	KR benefits tree in CoP sites	Lectures		Article in company's journal	
	KR benefits tree in posters	Computer based training		Include KR in the annual performance review	
	KR benefits tree in emails	Serious games		Placement of "recognition plaque" in CoP homepages	
	KR logo in CoP sites	Induction program		"KR Project Team of the year" award	
	KR logo in promotional material			Connect awards with strategic objectives	
	KR Booklet			External certificates to knowledge practitioners	
	KM Blog				

Table 13 – Morphological chart including the design attributes and alternative elements to implement those attribute

6.6 Design concepts generation

Using the morphological chart, in this section three design alternative concepts are developed. Each concept is based on a principle idea and the combination of elements for the accomplishment of this idea is made based on the advantages and disadvantages of the elements, on the findings in the survey among the Technology employees, and finally on the heuristic used also by Barney (2011) "Group elements that are strongly related to each other, separate elements that are unrelated". Finally, common sense is used to combine elements that the one mitigates the disadvantages of the other(s).

The morphological charts that show the selected elements for each concept as colored cells can be found in appendix F. Below, the explanation of the reasoning behind the selection of the specific elements is presented for each concept.

Concept A – Project based interaction strategy

The basic principle behind this concept is the tradition of verbal sharing and communication in HMC among the employees during the preparation of projects (Barney 2011). Therefore, the selection process among elements that implement the design attributes is done based on the heuristic of grouping elements that entail human interaction during the project workflow.

Central role in the governance of this strategy concept has the Project/Specialist Engineer (P/SE), who is assigned with the important role of KR leadership in the project team. Therefore, P/SEs should be included in the strategy risk management sessions, as they would be the main feedback channel to monitor whether the KR initiatives work.

An important element of this strategy is the KR leadership checklist, which would be distributed to all PEs. In case the PE hasn't developed sufficiently the leadership traits to implement the checklist content, then he could be supported by the Project Manager (PM) and/or Engineering Manager (EM). The checklist would create a framework for the implementation tracking of other elements like the recognition through informal personal praise, and the communication of success stories. The support of the PM/EM to the P/SE for success stories examples or methods of personal praise is valuable. Moreover, the communication of the KR benefits customized for the project through email from the PM is a communication element that is employed in this concept. Due to the fact the KR benefits through email draws the attention of the project team members for limited time, promotional material with the KR logo could be used to remind to people the benefits of knowledge reuse. Moreover a booklet that explains further the benefits of reuse would be an important additional communication tool.

The fact the P/SE has the central communication role this concept, makes him appropriate for being mentor for the employees in the project workflow. The selection of mentorship as the basic training method in this concept, is based on the fact that mentorship maximizes the number of team members that can interact with the P/SE mentor during the project workflow. Additionally, EMs could be the mentors of P/SEs and therefore have a two layer mentorship. Job rotation can be used as an additional training method to increase employees' eagerness to learn and thus mitigate the disadvantage of mentoring.

Mentoring of more junior staff can be further delegated by the P/SE to the senior engineers as a recognition of senior engineers' reuse performance. Also the initiation of informal public praise recognition by the PM through a KR trophy, is a way to give the appropriate recognition the required importance. To make the reuse recognition more objective, KR would be added as a factor to the employees' annual performance review by their Engineering Managers. Finally, in order to boost the human interaction regarding team members' peer help regarding knowledge reuse, the "KR project team" award is also deployed in this concept. Additionally, the award could be connected to HMC reputation strategic objective.

Formalization of the KR in the project business processes could assist the role of P/SEs as a KR leader in the project team, by giving him the opportunity to show to the team members that his actions are congruent with his/her sayings. Moreover, knowledge planning, discussion of KR in the project risk sessions and the process to fill the knowledge input output template would serve as opportunities in the project workflow for the P/SE to communicate with the team about KR. However, the knowledge planning and the risk sessions should be chaired by a senior knowledge manager. Finally, in this concept all three elements of rewarding attribute are found to be incongruent with the basic principle of human interaction in the project workflow and thus are not included.

Concept B – Communities of Practice based interaction strategy

As was mentioned in previous chapters, engineers and project engineers in HMC can be characterized as shared practitioners that do similar work in different settings, according to Markus' (2001) categorization of re-users that presented in sub-chapter 2.4. Dalkir (2011) added that shared work practitioners are peers who share a profession and can be members of the same community of practice. That gives the idea to make Communities of Practice (CoP) the basic knowledge management platform, where the strategy to foster reuse will be based upon.

Wenger, McDermott, & Snyder (2002) in their work regarding cultivating Communities of Practice (CoP), described these communities as "a group of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis". According to the authors, cultivating communities of practice is the keystone of an effective knowledge management strategy.

Therefore, tailoring KR benefits and initiatives to each CoP specialty is the basic principle of this concept. Tailoring the strategy to each CoP specialty is expected to have greater influence to CoP members, which are experts with common interests that influence each other. In other words, the triggering of "Intention to reuse" may spread quicker if it is initiated from the places that these experts with common interests meet. The selection process among elements that implement the design attributes is done based on the heuristic of grouping elements that entail CoP activity.

Central role in the governance of this strategy concept has the CoP leading team, who is assigned with the important role of KR leadership in the specialty community. Therefore, CoP leaders should be included in the strategy risk management sessions, as they would be one of the feedback channels to

monitor whether the KR initiatives work. The second monitor channel would be the CoP activity, which can be measured in terms of explicit knowledge documents downloads.

The benefits of KR would be communicated through a KR benefits tree presented in the CoP sites. The benefits tree may be customized to include additional CoP specific benefits. Moreover, success stories related to the reuse of specialty knowledge may be presented in the bulletin board of each CoP site. The CoP central webpage would be the appropriate place to place the KR logo, as it is a webpage with many views from the CoP members. Finally, links to a KM blog may be placed in the CoP central webpages. The objective of a KM blog would be to inform employees about KR initiatives taken, let them give feedback on the initiatives and ask questions in case they are not convinced about the value of KR.

Responsible for the operation of the CoP site would be the CoP leader, who would be supported by a steering team. The members of that steering team may be selected based on members' CoP activity and thus perceived as recognition award. The members of the CoP leading team may assist also the operation of the KM blog.

Among the "success stories employees" from all CoP sites, one could be selected to write an article in the company's journal as a mean of recognition. The article would be about the employee personal perception on the importance of KR for his profession and for the organization. Another recognition element would be to place "recognition plaques" with the recognized employees photo in the CoP central webpage. The plaque would be the recognition award for reusing knowledge in the project that the employee works. Placing the recognition award to the CoP cite will communicate the recognition beyond the project team borders. Additionally, the recognized employee may be rewarded with an all paid participation to a conference related to the specialty of the CoP.

In the present concept, training would be off the job. On line lecture videos informing CoP members about KR benefits and importance may be placed within the CoP sites, aiming to be available for all employees regardless their location. Moreover, computer based training in the form of instruction videos for the tools that are used to find explicit knowledge may be placed in the CoP sites.

The elements of formalization are not directly related to the basic principle of this concept to make the CoP the basic knowledge management platform. However, knowledge planning, discussion of KR in the project risk sessions and knowledge input-output template are considered initiatives with only few drawbacks, but with many advantages and thus are deployed by this concept. In this concept, knowledge planning may be the product of a meeting among the CoP leaders of the related specialties to the project.

Concept C – Educational strategy

The idea for this concept is given by the comment of an employee in the survey, who said that "what needs to be done is to teach employees to reuse knowledge". Therefore, the selection process among elements that implement the design attributes is done in this concept based on the heuristic of grouping elements that boost employees' learning on both leading the KR process and performing it.

Central role in the governance of this strategy concept has again the Project/Specialist Engineer (P/SE), who is assigned with the important role of KR leadership in the project team. The significant difference in this concept is that PE would be trained for leading KR. Their participation in the strategy risk management sessions is important in this concept, as they would be the main feedback channel to monitor whether the KR initiatives work.

As a result the KR leadership checklist is also in this concept an important element. The checklist should be distributed to the PEs and Microtraining sessions should be organized to train the P/SEs on how to develop and implement the KR leadership traits in practice. The checklist content would be decomposed to malleable parts, each of which would be addressed in separate Microtraining sessions. Moreover, in the Microtraining sessions the P/SEs may learn on how to communicate verbally success stories during the workflow. For the Microtraining sessions of the leaderships traits, a behavioral psychologists would be hired, while the success stories training sessions may be given by a senior Advisor. Additionally, a KR booklet may be used to assist the communicative work of PEs and further explain the benefits of KR to the employee. Due to the fact that the KR booklet draws the attention of the employees only for limited time, posters in the office building may be used, aiming to communicate continuously the KR benefits through the benefit tree.

Training is a crucial educational mean and thus special attention is paid to the training elements in this concept. Except Microtraining sessions for the P/SEs, one to one coaching of the P/SE with the senior engineers in his team is deployed in this strategy. In that way, the senior engineers will have the opportunity to receive one-by-one guidance for knowledge reuse within the workflow by the more experienced P/SEs. Assigning mentoring junior staff leadership roles to the senior engineers may be used as a recognition of good performance of the senior engineers during the coaching. Job rotation may additionally be used to increase employees' eagerness to learn. Furthermore, quarterly lectures are used, given by the senior knowledge manager, aiming to inform employees for the KR initiatives and give them the opportunity to pose questions and give feedback. Inclusion of knowledge reuse training in the induction program for the newcomers is also employed in this concept. The three elements of formalization attribute are also deployed in this concept as they are considered initiatives with only few drawbacks, but with many advantages.

Regarding recognition elements, except informal personal praise and assigning mentoring roles to senior engineers, informal public praise with KR trophy is deployed in this concept aiming to boost intra-project motivation for reuse knowledge. On the other hand inter-project motivation to reuse knowledge would be increased through a KR project team award that is also connected to the HMC reputation strategic objective. Moreover, rewarding of the senior and junior engineers by an increase of their personal budget for courses and training is deployed in this concept. The rewarding would be approved by the EM after the recommendation of the PE. Finally, the PEs knowledge practitioners would be certified by external certifying organizations, aiming to attach them the special status of expert.

6.7 Evaluating design concept alternatives and concept selection

Three design concepts have been developed in the previous section. In this section, these concepts are evaluated to decide which design concept fits best the client requirements. The "Pugh concept selection" method is employed to evaluate the concepts and arrive at the result (Dieter & Schmidt, 2009). The main reason for choosing this method is that it is a relative comparison technique. This implies that with the help of this method, all three design concepts get equal priority in the selection process. The method enables the designer to select the best concept in successive rounds of examination and deliberation, thereby giving a better chance of selecting the best concept.

In the evaluation of the design concept alternatives it was decided to involve an HMC representative, given the fact that HMC is the client of the strategy to be designed. In that interactive discussion, the representative of HMC had to fulfill two requirements. The first requirement is that he/she had to be knowledgeable of the current knowledge management initiatives in the organization. This requirement limits down our target group to the KMU project workgroup. Nevertheless, the KMU leader was decided to be excluded from the evaluation process, due to her involvement in the development of the guiding principles for the KMU project that are used also to guide our strategy development (table 12). The second requirement was that he/she should be knowledgeable of the people management practices in the organization, in order for him/her to be able to judge the fit of the selected attribute's elements to the existing people management practices in the organization. This requirement limits down our target group to the KMU project workgroup members that hold a managerial position within the Technology department.

Based on the requirements for the selection of the appropriate HMC representative for the evaluation of the design concept alternatives, Victor Pegels, the Deputy Engineering Manager of the FIX/FLO Technology product group was selected to participate in the interactive discussion. In fact, he is the only person that fulfilled both requirements of being knowledgeable of both the knowledge management initiatives in the company and the people management practices.

The preparation and execution of the interactive discussion for the evaluation of the alternative concepts followed the steps of the Pugh method. In this section a summary of the preparation and execution phases of the evaluative discussion is presented, while the detailed description is presented in appendix F.

The preparation of the evaluative discussion includes the first three "Pugh method" steps, i.e. the development of the selection criteria, the formulation of the decision matrix and the choice of an alternative concept as the datum (Dieter & Schmidt, 2009). As selection criteria, the appropriateness design guiding principles (G1-G10) from table 12 are chosen. By using these guiding principles, in fact we compare the three concepts on their appropriateness to achieve the design objective, which is, by definition, the aim of this evaluation discussion.

As already mentioned, the second and third steps of the "Pugh method" are the formulation of the decision matrix and the choice of an alternative concept as the datum. The decision matrix can be found

in appendix F. Concept A is selected as the datum concept, aiming to have a reference point for the comparison. More details behind the reasoning of this selection can be found in appendix F.

After the discussion preparation was ready, the interactive discussion with the Deputy Engineering Manager was scheduled and took place on the 9th of July 2012 in the manager's office, and lasted approximately two hours. The discussion was structured around the final three "Pugh method" steps, i.e. running the decision matrix, evaluating the ratings, and finally examining the selected concept for improvement opportunities. The interactive discussion is presented in detail in appendix F.

The evaluative discussion resulted in the selection of an improved hybrid concept, which combines mainly the concepts "Project based interaction strategy" and "Educational strategy", while it uses also three elements of the "Communities of Practice based interaction strategy". Overall, 20 elements are selected to be used in the KR initiatives. These final selected elements are shown as colored cells in the morphological chart that is presented below in table 14.

Attribute	Communication	Training	Formalization	Recognition	Rewards
Element / mean	KR leadership checklist	Microtraining	Knowledge planning	Use of informal personal praise during workflow	Monetary or tangible rewards
	Success stories verbally on the work	Job rotation	Non reuse of knowledge in risk sessions	Informal public praise with KR trophy	All paid participation to conference
	Success stories in company's journal	One to one coaching	Knowledge input-output template	Assign mentoring junior staff reuse leadership role	Increase of the individual's budget for courses and training programs
	Success stories in CoP sites	Mentoring		Assign leading of CoP leadership role	
	KR benefits tree in CoP sites	Lectures		Article in company's journal	
	KR benefits tree in posters	Computer based training		Include KR in the annual performance review	
	KR benefits tree in emails	Serious games		Placement of "recognition plaque" in CoP homepages	
	KR logo in CoP sites	Induction program		"KR Project Team of the year" award	

	KR logo in promotional material			Connect awards with strategic objectives	
	KR Booklet			External certificates to knowledge practitioners	
	KM Blog				

Table 14 – Selected design concept shown by the colored cells in the morphological chart

Reflecting on the concept selection process, overall it can be said that the manager's experience on people management practices and the current knowledge management initiatives in Technology proved to be quite useful in successfully evaluating the alternative concepts. Besides that, involvement of the Deputy Engineering Manager in the design process is in line with the process management approach that is adopted in this research, by making the design to seem more as the result of a negotiation process. Moreover, by involving a manager in the open decision making process, management commitment to the improvement is sustained.

Conclusion

In this section the overview of the strategy to foster the intention to reuse explicit knowledge was initially presented. Following, the first important steps of the design process were presented; the generation of the design alternative concepts and their evaluation. For the first step, a morphological chart was used to organize the ideas that originate from the literature, the internet, the survey, and the designer. Using this chart, three design alternative concepts were developed. Each concept is based on a principle idea and the combination of elements for the accomplishment of this idea was made based on the advantages and disadvantages of the elements, on the findings in the survey among the Technology employees and heuristics of grouping related elements. The three concepts are the "Project based interaction strategy", the "Communities of Practice based interaction strategy" and the "Educational strategy".

Next, the evaluation step followed, which aimed to the selection of the preferred design concept. For this step the "Pugh' concept selection method was employed, and as selection criteria the appropriateness guiding principles (G1-G10) were used. The evaluation of the design alternatives was done in an interactive semi-structured discussion with the Deputy Engineering Manager of the FIX/FLO Technology Product Group. The result of the evaluative discussion is the selection of an improved hybrid concept, which uses mainly elements from the concepts "Project based interaction strategy" and "Educational strategy" and also three elements of the "Communities of Practice based interaction strategy". This final concept was presented at the end of the chapter using colored cells in the morphological chart. In the next chapter, these elements are used to construct the detailed design, which will consist of specific KR initiatives.



7.1 Overview of the preliminary strategy
7.2 Governance of the KR initiatives
7.3 KR initiatives

Chapter 7: Preliminary design of the strategy to foster intention to reuse explicit knowledge

Introduction

Based on the final concept selection during the concept evaluative discussion that was presented in chapter 6, in this chapter the preliminary strategy to foster intention to reuse explicit knowledge is presented. Using the selected elements of the strategy levers from the final concept, 8 Knowledge Reuse (KR) initiatives are constructed in total, which constitute the enablers of the strategy. These initiatives are supported by the governance mechanisms. In the next sections, the KR initiatives (enablers), the used elements from the people management practices (levers) and the supporting governance mechanisms (foundations) are presented as an integrated strategy that aims to foster employees' intention to reuse explicit knowledge in HMC Technology.

7.1 Overview of the preliminary strategy

Before embarking on the explanation of the strategy and more specifically on the development of the KR initiatives, it is important to state once again the use of those initiatives. As explained in sub-chapter 5.8, the strategy to foster intention to reuse explicit knowledge in HMC focuses on improvements that can be realized in a short span of time and with relatively little effort. In other words, the strategy focuses on quick-win initiatives, which can be perceived as the first step of the improvement intervention cycle. In the future, the monitoring governance mechanisms will provide feedback on the implementation of the proposed initiatives, and according to that feedback the initiatives should be adjusted, initiating then the second run of the intervention cycle. In few words, the KR initiatives of the strategy should be perceived as the first run of an intervention cycle towards the direction of improving the intention to reuse of explicit knowledge, rather than as an one-shot solution.

Recalling the pyramid overview of the strategy in figure 18, it should be stressed once again that it is only with the support of the governance mechanisms and the use of the levers' elements that the KR initiatives can be materialized and lead to the direction of achieving the design objective. Aiming to provide the reader with an overview of the strategy and a summary of the strategy propositions, a top view of the foundation strategy pyramid layer is shown in figure 19, and a top view of the enablers and levers strategy pyramid layers is shown in figure 20 .

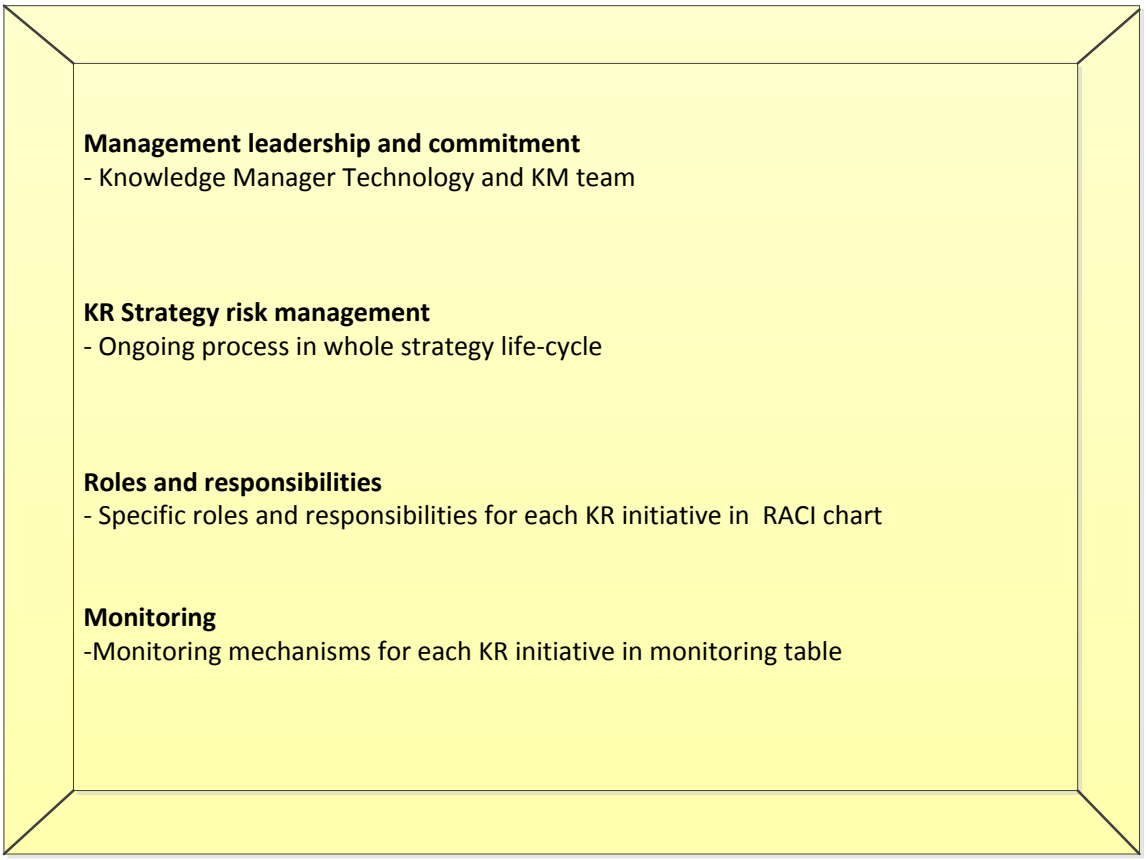

Figure 19 - Top view of foundation strategy pyramid layer



Figure 20 - Top view of enablers and levers strategy pyramid layers

The governance mechanisms "Management leadership and commitment" and "KR strategy risk management" are presented in sub-chapter 7.2. The responsibilities and monitoring governance mechanisms are discussed together with the KR initiatives in sub-chapter 8.3, and are summarized in appendix G, using a RACI (Responsible – Accountable – Consult – Informed) chart and a monitoring table. In the KR initiatives description, it is also clearly described which strategy levers' elements are used for their construction. Finally, for each initiative, references to the design requirements and guiding principles are made using the reference codes of table 12, aiming to explain explicitly how each KR initiative enables Technology employees' intention to reuse explicit knowledge.

It is crucial to mention at this point that for the development of the initiatives using the levers' elements, the preference of the Technology employees over the different levers is taken into account. In figure 15, it is shown that employees seem to believe that communication, training and recognition are more appropriate than formalizing (enforcing) or rewarding knowledge reuse. Aiming to combine all levers in the strategy but also take into account employees' preference, communication elements are used in 3 initiatives, training in 3 initiatives, recognition in 3 initiatives, formalization in 1 initiative and rewarding to 1.

Wrapping up the overview section, the strategy to foster intention to reuse explicit knowledge in its entirety, is a contribution to the scientific knowledge base, since such an integrated strategy isn't available yet in literature. The strategy is based on the theory of KM governance and the theories of people management practices. The contribution is the combination of these theories and the selection of the specific people management practices elements to construct the KR initiatives.

7.2 Governance of the KR initiatives

Management commitment and leadership

Commitment of Technology's management is considered as a crucial governance mechanism of the strategy to foster intention to reuse explicit knowledge. Moreover, it is quite important that this commitment is explicitly shown to the employees (R2). Therefore, it is proposed to appoint a Technology Knowledge Manager that reports directly to the Technology Manager. By creating such a high position in the departmental hierarchy, it is explicitly shown that knowledge management practices are among the top priority of the management. This idea is in line with Dalkir (2011), who proposes that the empowerment of a highly ranked knowledge officer is important for successful development and implementation of a KM strategy.

Main responsibilities of the Technology Knowledge Manager are to set clear corporate expectations about what should be done regarding knowledge management, to manage and monitor all knowledge management initiatives, and to enthuse and encourage Technology employees on knowledge management through inspired leadership. Also he/she is responsible for the alignment of KM initiatives with the strategic business goals of the department.

The creation of a Knowledge Management Core Team is also proposed, for supporting the Technology Knowledge Manager. It is proposed to create the team on the same model that the KMU project is created; a steering team and a workgroup. Having in mind the guiding principle for minimum resources

(G2) and aiming for maximum integration of the KM Core Team in the Technology department, it is proposed to staff the team with existing Technology employees, who will continue working on the HMC projects and will devote some working time per month on assisting the Technology Knowledge Manager to implement the KR initiatives. To be more specific, the steering team should be staffed by the Engineering Managers (Technology Product Managers) and the Technology Advisors (Advisors toward HMC management within and outside specialisms) and will provide the KM Team with the required authority, resources and organizational experience. Creating a steering team is in line with the process management approach for the improvement of the knowledge reuse practices, according to which ensuring that the process is heavily staffed, is an important success factor (De Bruijn et al., 2010). On the other hand the workgroup should be staffed by the Project/Specialist Engineers who will be the key persons for the implementation of initiatives on the project work floor and will also provide the KM Core Team with feedback. Involvement of the P/SEs in the KM Core team, stimulates early participation in the improvement of knowledge reuse practices, which is crucial for giving a sense of improvement process progress (De Bruijn et al., 2010).

Risk management

Governance of the strategy to foster intention to reuse explicit knowledge, involves also identifying the risks associated with the cultural issues, structural obstacles and other relevant concerns as they arise during planning, development, implementation and ongoing operation and management of the KR strategy. Therefore, risk management should be an iterative process throughout all phases of the strategy, aiming for successful and sustainable improvement of Technology employees' intention to reuse.

The risk management process that is proposed for the KR strategy is presented in figure 21, and is based on Joustra's (2010) propositions for risk management in projects. The basic principle is to have a risk session before each major phase of the improvement life-cycle. This is a practice that is also used currently in HMC for all projects. Output of the risk sessions is the risk register, where all potential risks are described together with the potential causes, consequences, mitigative measures and recommendations. Input of the risk sessions should be firstly the risk registers of the previous phase risk session, reviews of the KR strategy progress, and thirdly feedback meetings that should take place before the risk session. The purpose of reviews and feedback meetings except that providing input to risk sessions, is to monitor the progress of the strategy and to provide feedback from the project work floor accordingly. The risk sessions, reviews and feedback meetings should be chaired by the Technology Knowledge Manager, while it is proposed that the steering team participates in the risk sessions and the workgroup in the reviews and feedback meetings.

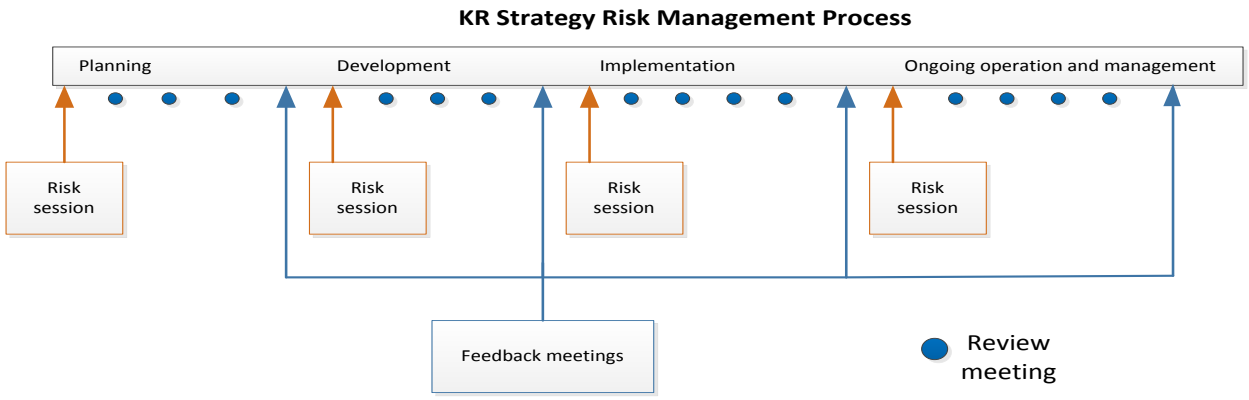

Figure 21 – Risk management process for the KR strategy (Joustra (2010)

7.3 KR initiatives

KR initiative 1: Lead reuse of knowledge in project teams

The first initiative of the strategy is based on elements of communication, training and recognition strategy levers. Its objective is to lead reuse of explicit knowledge within the project teams. As noted by Mayfield & Mayfield (2002), leader communication is found to be a critical factor for superior worker motivation and performance.

Appropriate persons for becoming knowledge reuse leaders in the project teams are the Project Engineers and the Specialist Engineers (P/SEs). As explained in chapter 2 and shown in figure 4, the Project Engineer is the one who coordinates the team that performs all the technical work in project-based teams. The Specialist Engineer is representative of his specialism within the project.

For achieving the leader communication within the project teams three elements are used; a KR Leadership Checklist, which aims to help P/SEs keep track of their own performance regarding leading knowledge reuse in the project teams; Microtraining sessions, which aims to train PEs on being leaders of knowledge reuse in their team; External "Knowledge Management Practitioner" certification for the P/SEs, which aims to give them a special status on KM specialty within their team by training in KM best practices. The three elements are discussed below.

Knowledge Reuse Leadership Checklist

The development of the knowledge reuse leadership checklist is based on the Motivating Language Model (Mayfield & Mayfield, 2002). Based on this model, the authors created a best practices checklist. This checklist is adapted by making the existing questions specific for knowledge reuse. The knowledge reuse checklist is divided to three categories, namely "Direction Giving", "Meaning Making" and "Support". Each category includes a number of questions, which can be used by the P/SEs during all phases of the FED of projects, aiming to increase the communication of KR benefits and values to the employees.

The KR leadership checklist can be used also to reinforce other elements that foster intention to reuse like telling success stories on the work or personal verbal recognition. Therefore two new questions are

added. The checklist can also be extended in the future and include other or adapt the current questions according to the future needs. presented in figure 22 below.

Knowledge Reuse Leadership Checklist	
	Do I give direction…?
	Do I provide my team members with positive feedback when they reuse knowledge?
	Do I provide my team members with feedback on how to improve their performance when they are not reusing knowledge sufficiently?
	Do I tailor my performance feedback communication to maximize each team member's understanding?
	Do I clearly explain to my team members what is expected from them regarding knowledge reuse?
	Do I provide my team members with the relevant organizational information that they need in order to reuse knowledge?
	Do I show to my team members by my actions that I also reuse knowledge?
	Do I explain the meaning…?
	Do I explain to my team members the benefits of knowledge reuse for them as individuals?
	Do I explain to my team members the benefits of knowledge reuse for the project?
	Do I explain to my team members the benefits of knowledge reuse for the organization?
	Do I tell to my team members success stories about reuse of knowledge in the organization?
	Am I supportive…?
	Do I let my team members know when I have had relevant experiences similar to their own when reusing knowledge?
	Do I show my team members that I am willing to listen to their concerns about reusing knowledge?
	Do I give feedback to my team members in ways that validate their own feelings about knowledge reuse?
	Do I use the most appropriate media for expressing my ideas and feelings about reusing knowledge?
	Do I praise personally on the job the knowledge re-users of my team?

Figure 22 - Knowledge Reuse Leadership Checklist (adapted from Mayfield & Mayfield, (2002))

Microtraining sessions

The disadvantage of the knowledge reuse leadership checklist is that it depends on the leadership traits and experience of the leader. Therefore, Microtraining sessions can be organized for the P/SEs, in order for them to be trained on being knowledge reuse leaders, and develop in a sustainable way (H. K. Lukosch et al., 2010) the desired leadership traits. As Microtrainer can be used the senior Technology Advisor of HMC, who is highly experienced person. In each session, 2 P/SEs should participate, aiming to create pairs for exercising the sessions content. Based on the KR Leadership Checklist categories, a series of 3 Microtraining sessions should be created, one for each category: "Direction Giving" session, "Meaning Making" session and "Being Supportive" session.

Each Microtraining session should last 15-20 minutes and consist of 4 phases (De Vries & Brall, 2008). In the first phase the Technology Advisor actively starts the session by shortly presenting the session content and showing to the participants the way to externalize leadership traits. Then the P/SEs practice on each other. Based on that practice, the Technology Advisor gives feedback so the PEs can be improved. The session is finalized by a discussion between the PEs and the Technology Advisor on how they should continue in leading the project teams. The proposed Microtraining structure is shown in figure 23.

Microtraining session structure	
3 min	Active start by Technology Advisor
7 min	PEs practice on each other
4 min	Technology Advisor gives feedback
3 min	Discussion on how to continue in leading the project teams

Figure 23 - Microtraining session structure for training on leading reuse of knowledge

Knowledge Management Practitioner Certificate

Aiming to strengthen the leadership position of P/SEs in the project team it is recommended to certify them as knowledge practitioners by external certifying institutions. A knowledge management certificate will give P/SEs a status of expertise among the project team members, by increasing their awareness on the importance of knowledge management, by showing them their role within the KM team and by teaching them real-world KM exercises. The status of KM expertise will facilitate significantly the acceptance of the leaders by the project team members. The KM certificates, is recommended to be obtained through online workshops by certifying institutions, aiming to hinder minimally the PEs work flexibility.

Reflecting on the first initiative, it includes measures that aim to foster intention to reuse explicit knowledge by creating leaders that communicate knowledge reuse benefits and importance within the project teams (R3). The leaders will make clear to the employees the added value of knowledge reuse (R10). Communicating the benefits is expected to balance the effort-gains ratio for reuse (R8) on engineers' perception. Moreover, communicating the benefits regularly in the project workflow will help employees to routinize reuse of knowledge (R11). Finally through leadership of KR within the project teams, performance gaps (R9) and client's pressure for learning (R6) are expected to be highlighted by KR leaders.

The first initiative can be monitored by looking on the average number of microtraining sessions per P/SE per year and on the number of P/SE participants in KM Certification program. The monitoring mechanisms and the roles & responsibilities for the 1st KR initiative are summarized in the relevant tables in appendix G.

KR initiative 2: Explain knowledge reuse benefits

The second initiative of the strategy is based on the communication lever, and its objective is to explain the benefits of KR in an explicit and appealing way. Skyrme (2011) proposed the use of a benefits tree, where multiple layers of benefits and their interconnections can be presented. This idea is used as a basis to create a KR benefits tree that presents the benefits of KR for the individual, the project and the organization. The graphical communicative power of the tree can be used to show explicitly to the employees of all corporate levels that reusing existing knowledge entails benefits for all organizational entities (R10), and that these benefits are interconnected. Furthermore, the benefits tree can easily be adjusted to fit to project specific benefits just by adding additional blocks to the project benefits layer, or to fit to specialty specific benefits just by adding additional blocks to the individual benefits layer.

The KR benefits tree is decided during the concepts evaluation phase to be communicated using two means; firstly in electronic format in the CoP sites, and secondly in printed format in posters in the project offices. Although for the second communication mean, adjustments are difficult once the benefits tree is printed, for the first communication mean are quite easy to be done several times. Overall, communicating the benefits of reuse using the KR benefits graphical tool in the project offices and in the CoP sites, it is expected to contribute to the cultivation of a KR organizational culture (R5). The KR benefits tree is presented in figure 24.

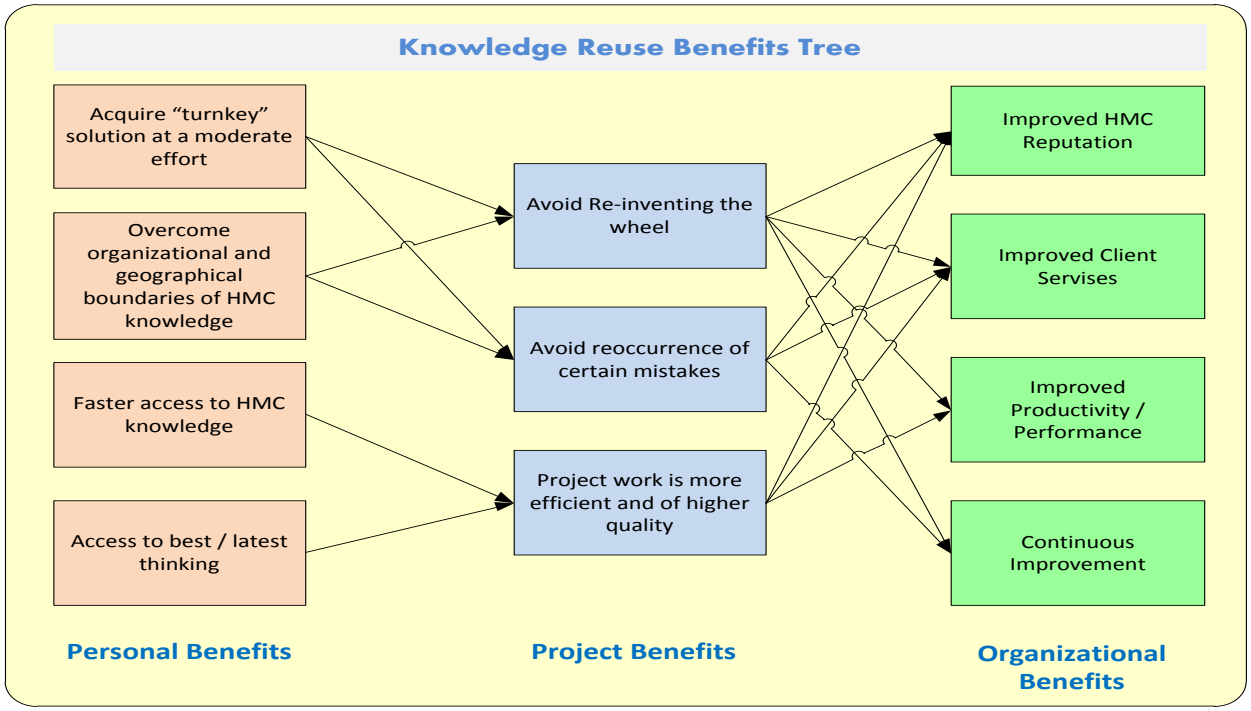

Figure 24 - Knowledge Reuse Benefits Tree (adapted from (Skyrme, 2011)**)**

Concerning the implementation of the second initiatives, Project Managers should be responsible for placing the poster in the project offices, while CoP leaders for adding them in the CoP sites. This initiatives could be monitored by the hits of the relevant link in the CoP sites. The monitoring mechanisms and the roles & responsibilities for the 2nd KR initiative are summarized in the monitoring table and RACI chart accordingly in appendix G.

KR initiative 3: Promote knowledge reuse practice

The third KR strategy initiative is based on elements of the communication lever, and its objective is to promote reuse of knowledge practice. To achieve that objective, this initiative employs telling success stories on the work and also a KM logo. Communication of KR value through storytelling and a KM logo, aims to influence positively the cultivation of a KR organizational culture (R5).

Success stories provide employees with a tangible example of what knowledge assets are capable of, highlighting the value of knowledge reuse in practice (R10). The additional advantage of verbal success stories during the project workflow, is that they are tightly connected to the job that is in progress and thus the tangible example is even better understood by the employees. Also, by success stories of a peer project coworker, the employees are expected to feel social pressure on performing knowledge reuse (R4). The appropriate person to tell that stories is the Project Engineer, who is the coordinator of the technical work in projects, or the Specialist Engineer, who is the specialism representative in projects. To ensure high quality of stories, S. Lukosch et al. (2011) proposed that iterations through collaboration are needed. Therefore, the P/SE should be assisted in the success storytelling by the Engineering Managers (EMs) and the Senior Project/Specialist Engineers who are more experienced persons and can assist the P/SEs with stories examples and format. The later creates an environment of collaborative success storytelling (S. Lukosch et al., 2011), where P/SEs and EMs - senior P/SEs have the roles of producers/ co-producers, and the project team members are the stories recipients.

The second communication element that is used in this initiative is the KM logo. As is explained in chapter 6, the basic communication principle behind the KM logo is the redundancy of message (Klein, 1996). In other words, its objective is to remind the benefits and practice of reuse whenever it is seen by the employees, which contributes to the routinization of knowledge reuse (R11). During the concept evaluation it was decided due to the limited disadvantages, to employ both elements related to the KM logo, i.e. to place it both on the CoP sites and in promotional material. By promotional material it is meant cups, pens, offshore uniforms, jackets, T-shirts etc. At this point it should be mentioned that promotional material is a usual practice for HMC projects. That implies that employees might be sufficiently receptive to a KM logo in promotional material.

For the sake of this initiative, a KM logo is developed and is presented in the figure 25. The references of the KM logo to the HMC logo are clear and are purposefully made. The reason is that a symbol that is familiar to HMC employees might be subconsciously accepted easier by the employees.



Figure 25 - HMC KM logo

The roles & responsibilities for this initiative are summarized in the RACI table in appendix G. This initiative can be monitored in the Risk Management feedback meetings, in which the P/SEs should participate and bring their experience about the influence of success stories and KM logo on the project work floor.

KR initiative 4: Train project teams members on the job

The fourth initiative of the strategy is based on the training lever, and its objective is to educate project team members on performing the practice of explicit knowledge reuse on the job. This can be achieved by employing the training elements "one-to-one coaching", "mentoring" and "job rotation". These training elements will increase the self-efficacy of employees on reusing knowledge (R7) and thus reduce their perception of effort to reuse explicit knowledge (R8).

The idea behind this initiative is to create a multi-layer training structure that will target all project team members. This multi-layer training structure is presented in figure 27 . To depict the training structure, an organizational tree is used, which shows the organizational hierarchy in a project team. The basic principle behind the training structure is that the less experienced is a project team member on a job that needs to be done, the more guidance is required on reuse of explicit knowledge.

Based on this principle, one-to-one coaching is selected for junior staff to be trained by the senior engineers of the project team. This involves the creation of senior-junior engineer pairs, where the experienced senior engineer guides in an organized way the inexperienced junior engineer on knowledge reuse during the project workflow. In other words, the experienced senior engineer should organize quick guidance sessions to show to the junior engineer how and where can he search for explicit knowledge, and to give recommendations to the junior on what kind of knowledge can be reused.

On the job Microtraining sessions (De Vries & Brall, 2008; H. K. Lukosch et al., 2010) are proposed to be organized by the senior engineer for quick guidance of the junior engineer on how and where can he search for explicit knowledge. It is proposed to organize one Microtraining session for each knowledge source or tool that is available in the company. Additionally, on the final Microtraining step,

recommendations to the junior should be given on what kind of knowledge can be reused. The microtraining structure for the senior-junior engineer coaching is presented in figure 26 below.

Microtraining session structure	
3 min	Active start by senior engineer
7 min	Junior engineer practices on the knowledge reuse system
4 min	Senior engineer gives feedback
3 min	Discussion on how to continue and recommendation on what kind of knowledge can be used

Figure 26 - Microtraining session structure for senior-junior coaching

In parallel, the senior engineer should be supported by a mentorship from the Project Engineer. That means that during the project workflow, the senior engineer works close to the experienced PE. This co-existence provides the senior engineer with support on reusing explicit knowledge himself but also with support on how to guide the inexperienced junior engineers. Additionally to one-to-one coaching and mentorship, job rotation is selected for all, engineers and project engineers, aiming to increase their flexibility and eagerness to learn. Therefore the Engineering Managers should take care of rotating their employees among the different Technology Product Groups or departments of HMC.

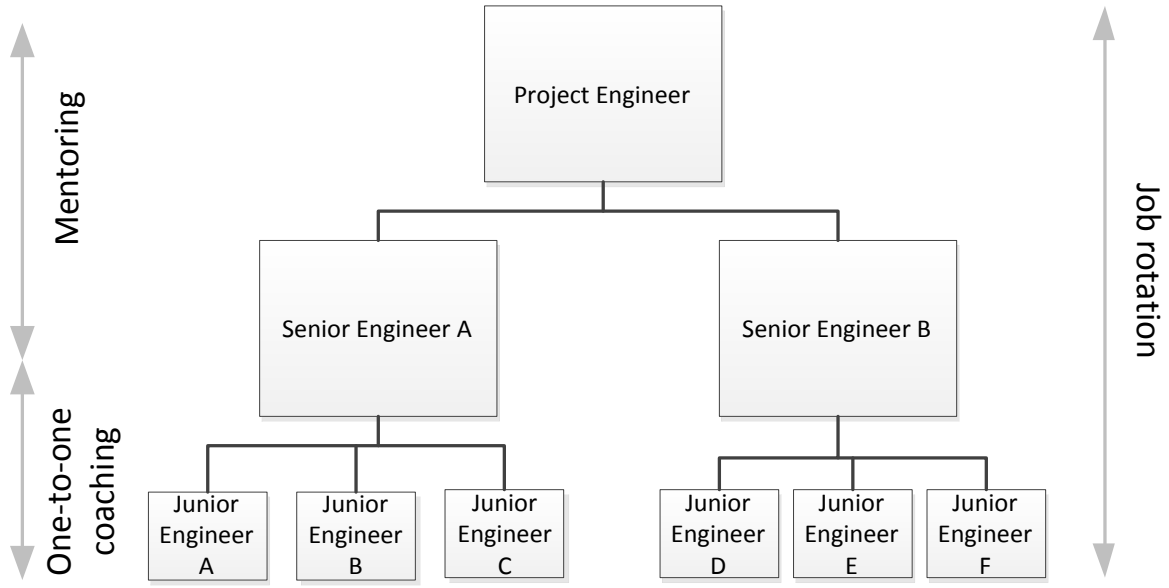

Figure 27 –Multi-layer training structure that targets all project team members

Reflecting on the initiative measures, overall it can be said that training aims to improve the familiarity of the project team members with the sources and tools to find explicit knowledge (R12). Moreover, job coaching and mentoring is expected to increase communication of performance gaps to project team members (R9) and thus increase their intention to reuse.

Monitoring of the multi-layer training initiative effectiveness, should be part of the Risk Management feedback meetings. In these meetings, the P/SEs should participate and bring their experience from the project work floor, reporting and discussing any problems or obstacles that either they or the senior engineers face. Monitoring and responsibilities for this initiative are summarized in appendix G.

KR initiative 5: Empower project team members

In the multi-layer training structure that proposed in the fourth initiative, the responsibility of junior staff training is delegated to the senior engineers of the project team. A characteristic of this structure is that training responsibility is decentralized, rather than being accumulated in the organizationally higher project members.

The delegation of the training responsibility is exploited in the fifth initiative as a mean of recognition for reusing explicit knowledge in projects. Delegation of coaching junior engineers should be based on the senior engineer's recognized performance on knowledge reuse by the Project Engineer. The empowerment of the senior engineers through the leadership role (R3) of coaching junior engineers is expected to influence positively their intention to reuse explicit knowledge, aiming to higher levels of recognition by the PEs.

Additionally, it is also recommended as part of this initiative to further empower Project or Specialist Engineers, by assigning them the role of "Community of Practice leader" (R3). Engineering managers should assign the CoP role to the P/SEs as a mean of recognition for reusing explicit knowledge in the projects that they work. The empowerment of the P/SEs through the CoP leadership role is expected to influence positively their intention to reuse explicit knowledge, aiming to higher levels of recognition by their members of CoP specialty community.

The fifth initiative can be monitored by looking on the average number of coached junior engineers per senior engineer and the number of PEs that participate in leading Communities of Practice. The monitoring mechanisms and responsibilities are summarized in monitoring table and RACI chart in appendix G.

KR initiative 6: Facilitate knowledge flow in projects

During the interactive evaluative discussion of the design alternative concepts, it was mentioned by the Deputy Engineering Manager of the FIX/FLO Technology Product, that in the early beginning of projects, the experienced members of project team discuss about, and then indicate to the inexperienced project team members other previous related projects that they could find useful knowledge. In other words, the manager noted that planning of knowledge takes place unofficially in the early beginning of projects.

Nevertheless, two drawbacks are found in the current practice. The first is that currently the discussion about planning the knowledge that can be used during the project activities is purely based on the experience of the project team members. Secondly, once the unofficial discussion is finished, a check of whether the project team members actually found useful explicit knowledge is not possible.

The sixth initiative of the strategy, aims to describe a formal process that standardizes reuse of knowledge in projects (R1). In that way HMC project teams are helped to overcome the drawbacks that

mentioned above. To create this process, Skyrme's (2011) knowledge input-output template is used as a basis and is adapted by combining it with the element “knowledge planning”. By combining this elements it is created a process that facilitates knowledge flow in projects, and enables tracking of that flow during the whole FED of projects. Therefore, the process is presented in figure 28 in the format of a flowchart.

The blocks in the left side of the flowchart propose that during the planning phase of projects or in the project kick-off meeting, Project Engineer (PE) should find write down in a report the previous projects that can be used by the project team as knowledge sources. One report should be filled in for each of the core activities that are planned for the project. These reports should be used then as a knowledge source reference.

The “Knowledge used” blocks of the chart indicate that after the completion of each core activity, the PEs should add in the reports what knowledge is actually used” in the core activity. The knowledge that is created in each project activity should be also written down in the relevant report, and finally the users or uses of the created knowledge should be reported. In the flowchart these are indicated by the blocks in the bottom and the right.

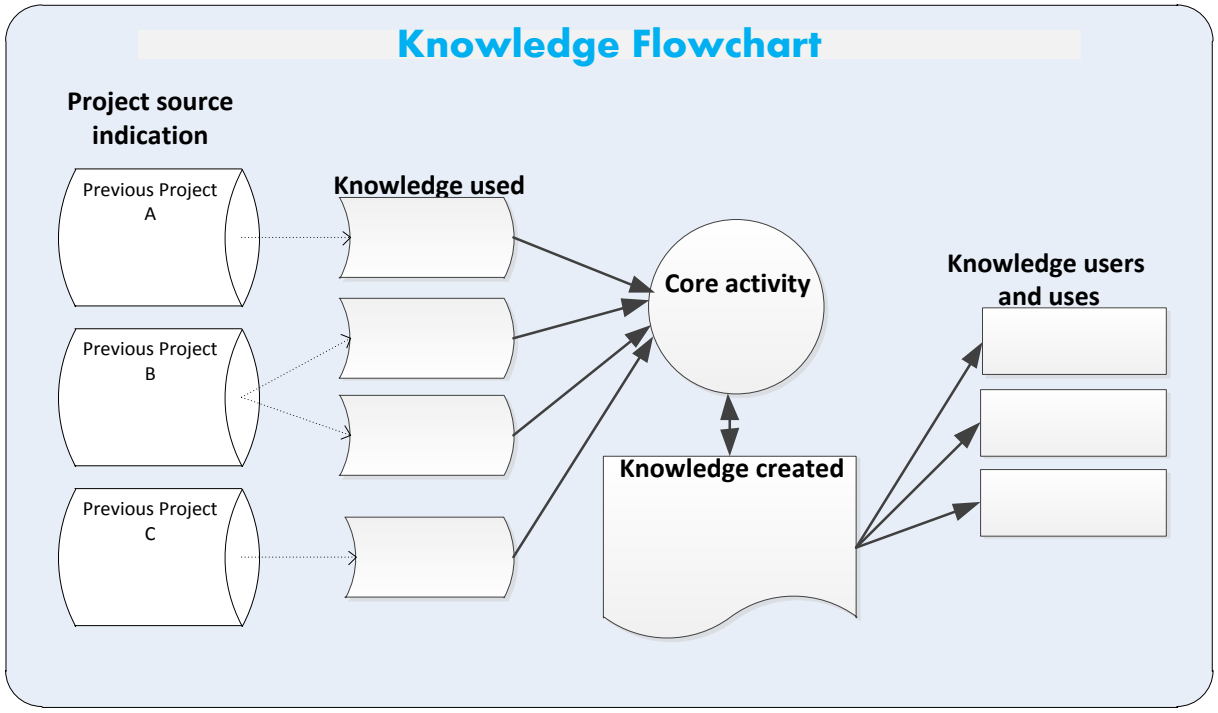

Figure 28 - Knowledge Flowchart (adapted from Skyrme (2011)).

The process that is shown in the Knowledge Flowchart will increase the awareness of project team members about available explicit knowledge by indicating them where to search and thus reducing their perception of effort to reuse (R8). Moreover, the reports of a project can be used in the planning of future projects as an input to fill in the project source indication blocks. In that way, the intra- and inter-project flow of knowledge is facilitated.

To monitor the proposed process, Knowledge Reuse audits by Engineering Managers are proposed. In the audits, they should monitor if the indicated explicit knowledge is indeed used in the project activity. Also, they should monitor if the created knowledge is further used by the indicated users or if it is exploited in the indicated uses. The monitoring mechanism and the responsibilities for the initiative are summarized in appendix G.

KR initiative 7: Praise reuse of knowledge

The seventh initiative for fostering the intention to reuse explicit knowledge is based on elements of the recognition lever of the strategy. Recognition is a powerful workplace motivator (Robbins & Judge, 2009) that makes explicit to employees the fact that reuse of knowledge is valued by the organization. Personal and public praise of knowledge reuse practice and its link to the annual performance review of the employees are employed in the seventh initiative of the strategy.

Personal informal praise of the senior and junior engineers by the Project Engineer during the project workflow is highly recommended for fostering their intention to reuse when they reuse explicit knowledge. To ensure the implementation of personal informal praise in practice by the PEs, the KR Leadership Checklist that is presented in the first initiative is used. The last question in the "Support" category (figure 21) is added aiming to remind to the PEs that they should personally praise the engineers when they reuse explicit knowledge during the project work.

Secondly, it is recommended to include knowledge reuse performance in the annual performance assessment of the engineers by their Engineering Managers. Linking knowledge reuse to personal development is expected to be a strong motivator for the engineers.

To conclude, this initiative aims to trigger intention to reuse through personal praise of employees and linking knowledge reuse to personal development through the annual assessment. The latter makes explicit to the employees the commitment of management to knowledge reuse and its importance for the organization (R2). Finally, recognition of reuse in the annual appraisal contributes to the cultivation of a KR organizational culture (R5).

This initiative can be monitored in the Risk Management feedback meetings, in which the P/SEs should participate and bring their experience from the project work floor, regarding influence of praise. Moreover, annual meetings of Engineering Managers with the Technology Knowledge Manager are proposed for feedback on engineers' knowledge reuse performance. The proposed monitoring mechanisms and the roles and responsibilities for this initiative are summarized in appendix G.

KR initiative 8: Shape starting employees' mindset

The final initiative to foster employees' intention to reuse explicit knowledge is based on the training and rewards strategy levers and targets the starting employees in the company. To be more specific, the eighth initiative recommends the shaping of newcomers' mindset in the company towards reuse, by a training on reuse during their first months in the company and by incentives for further education during their first years in the company. This initiative is especially important for HMC which is a fast growing company.

Currently, the newly hired engineers receive a basic training on the HMC core competences (Technology Department HMC, 2010). This induction training is the first contact of the new employees to the company knowledge and it is recommended to the core competence trainers to stress the importance of knowledge reuse for the company's objectives and to introduce the new engineers to the sources, tools and systems that are available for knowledge reuse (R7).

Furthermore, HMC employees have the opportunity to participate in courses and trainings that are provided by HMC or in cooperation with external institutions on a variety of subjects (technical, language, leadership etc. courses). Participation of employees to these programs is approved by their managers and is paid by the company. As part of the "shaping newcomers mindset" initiative, it is recommended to assign a minimum budget to each employee and raise individual's budget as a reward for reusing explicit knowledge. Therefore, for the first quarters of t an engineer's company life, the engineering managers should adjust the available budget for each engineer according to their knowledge reuse performance. The adjustment may be made after the recommendation of the PEs that supervise the day-to-day work of the engineer. Linking individual's budget for additional courses to their knowledge reuse performance is expected to positively influence the cultivation of a KR organizational culture (R5) in the organization.

To monitor this initiative it proposed to look on the average budget of the engineers for additional courses. The proposed monitoring mechanism and the roles and responsibilities for this initiative are summarized in appendix G.

Conclusion

In the present chapter the preliminary strategy to foster intention to reuse explicit knowledge is presented. Initially the overview of the strategy is presented using top-views of the pyramid layers. Next the governance mechanisms "Management leadership and commitment" and "KR strategy risk management" are presented where it is proposed to assign a Technology Knowledge Manager, who is supported by a KM Team. The KM team will work on a regular basis on managing the strategy risks. The other two governance mechanisms are summarized in the appendix G and are also discussed together with the KR initiatives that constitute the preliminary strategy to foster reuse of explicit knowledge.

In the next chapter, this preliminary strategy is evaluated by an HMC representative for its acceptability. Based on the evaluation comments, the preliminary strategy is refined and the result is the final strategy to foster intention to reuse explicit knowledge in HMC Technology.



8.1 Preliminary design acceptability evaluation
8.2 Final strategy design
8.3 Evaluation of proposed improvement

Chapter 8: Preliminary design evaluation and final strategy design

Introduction

In chapter 7, the selected concept of the strategy to foster intention to reuse explicit knowledge in the HMC Technology department was further elaborated. This elaborated concept forms the preliminary strategy design. An important step before considering the preliminary design as the final one is the evaluation regarding the acceptability of propositions by the management of HMC Technology department. In the present chapter the evaluation of the preliminary design is presented. Moreover, based on this evaluation the preliminary design is refined. The refined design is the final strategy to foster intention to reuse explicit knowledge in Technology department of HMC, which answers **research question 3.1** of this thesis. At last, a final evaluation of the proposed design is attempted, based on a reflection on the design requirements that presented in table 12, sub-chapter 5.7.

8.1 Preliminary design acceptability evaluation

Preparation of the semi-structured discussion for design acceptability evaluation

For the acceptability evaluation of the preliminary design, it was decided to select a representative of Technology management who wasn't at all involved in the design process, aiming to have an objective evaluation of the strategy propositions. Following the same reasoning as with the selection of the alternative design concepts evaluator, the acceptability evaluator had to fulfill the same two requirements; knowledgeable of the current knowledge management initiatives and knowledgeable of the people management practices in the organization.

Based on those requirements, Guido Ammerlaan, the Engineering Manager of the PDR Technology Product, was selected as the acceptability evaluator. The PDR Engineering Manager is deeply knowledgeable of the people management practices in the Technology department due to his managerial position, and is also member of the KMU steering team. The latter implies not only that he is knowledgeable about the current KM initiatives but also that he has an increased sense of responsibility for their success. Involvement of the PDR Engineering Manager in the evaluation process sustains

management's commitment to the improvement of knowledge reuse practices. Moreover, the sense that the final design is influenced by a negotiation process with Technology Engineering Management is strengthened. The latter is a core element in a process management approach (De Bruijn et al., 2010).

For the acceptability evaluation, the method of semi-structured discussion is selected. The discussion was made based on the acceptability design guiding principles (G11-G13) that are presented in table 12 of chapter 5.7. To be more specific, the semi-structured evaluative discussion involved a presentation of the strategy overview and KR initiatives, and in-between discussion for each proposition based on the sufficiency of guidance to understand and execute the strategy (G11), on the thoroughness of the strategy (G12), and finally on the extent of user adoption of knowledge reuse practices and their organizational embedding (G13). The discussion took place in the HMC premises on the 17th of July and lasted approximately 1 hour.

Evaluation recommendations

Overall, it is concluded that the evaluative discussion added significant value to the design of the strategy through the comments made over the propositions in the light of the acceptability guiding principles (G11-G13). More specifically, the evaluative discussion included exclusively positive comments regarding the guidance to understand and execute the strategy (G11), mainly positive comments about its thoroughness (G12) but also recommendations for alterations on some propositions, and finally recommendations and comments about significant room for improvement on the extent of organizational embedding in the Technology department and the resulted user adoption from the Technology employees (G13). Below, the comments made during the evaluation discussion are presented and in the next subchapter they are integrated to the design.

Alterations for increasing strategy initiatives thoroughness

Regarding the thoroughness of the strategy, it was positively commented the fact that RACI chart was used for the description of the roles & responsibilities. This was commented to give a clear overview of who should do what. Most of the proposed responsibilities were accepted with only minor recommendations for change. Based on the recommendations the RACI chart is updated accordingly.

Nevertheless, alterations to KR initiatives were proposed. Rewarding of employees through an increase in engineers' available budget for additional courses from the "Shape starting engineers' mindset" initiative, was recommended to be excluded from the strategy. Approval of employees' participation to courses in the proposed way, was found to be too inflexible, and it was commented "This measure might create barriers on engineers' development. It might be more flexible to let approval of additional courses participation, to managers' judgment of engineers' motivation and ambition for learning". Based on the low preference of employees for rewarding of reuse (figure 15) and manager's recommendation, it was decided to exclude the rewarding element from the strategy.

After excluding the previously mentioned initiative measure, it was decided to incorporate the induction training of initiative "Shape starting engineers' mindset" to initiative "Train project team members on the job", aiming to strengthen the training initiative. Moreover, it was decided to integrate KR initiatives "Explain benefits of knowledge reuse" and "Promote the practice of knowledge reuse", due to the fact that both use exclusively communication elements and aiming to reduce the number of initiatives and

thus make the strategy more manageable. For the same reason it was decided to integrate KR initiatives "Empower project team members" and "Praise reuse of knowledge", which both use recognition elements. The total number of initiatives after the integrations is 5. They are presented in the next sub-chapter together with the incorporation of the recommendations for increasing the organizational embedding of the initiatives.

Alterations were recommended also on the content of KR initiatives "Train project team members on the job" and "Facilitate knowledge flow in projects". In the first case, it was positively commented the fact that a multi-layer training structure is used, which employs different training methods. Nevertheless, a warning was raised regarding the possible creation of boundaries for information flow due to the multiple layers. Moreover, it was commented that it really depends on the project size whether such a multi-layer structure would make sense, since such a structure in small projects with few project team members in total would be inconvenient. Therefore, it was recommended to make the structure more flexible, by keeping the one-to-one coaching "senior-junior engineer" pairs, but extending the mentoring of (Senior) Project Engineers to all engineers.

In the "Facilitate knowledge flow in projects" KR initiative, the creation of a process that facilitates flow of knowledge was positively commented and recommendations for improvement on the process parts were made. Firstly, it was recommended that a link of the process to project deliverables would make more sense for HMC projects than a link to project core activities. Second, it was recommended to create criteria for the indication of the previous project sources, aiming to increase the possibility of finding similarities with previous projects.

Recommendations for improvement on user adoption and organizational embedding of propositions

During the discussion with the PDR Engineering Manager, it was concluded that in this area exists significant room for improvement of the detailed design. The manager, using his experience on the current people management practices in the company, gave to the researcher three directional lines for optimal integration of the KR initiatives to the Technology department, aiming for maximum user adoption (G13) of the proposed knowledge reuse practices.

The first directional line was about the initiatives that involve training of the employees. For optimal integration, the manager recommended to link these initiatives to the current educational plan for the employees. The second directional line was about the initiatives that involve actions from the employees. For these initiatives the manager recommended to specifically state what needs to be done by the employee in the description of their job. Finally, the manager recommended to link the process that is described in the knowledge flowchart with the use of an existing tool. The tool that was recommended was the *Cost Time Resources sheet*, which is used for reporting details for the required cost, time and resources for the development of a project deliverable.

8.2 Final strategy design

Exploiting the valuable recommendations that were made during the acceptability evaluation discussion, the preliminary design that presented in chapter 7 is refined. This refined design is the final

strategy to foster intention to reuse explicit knowledge in HMC Technology department and is discussed in the present sub-chapter. Overall, the main improvements that are made compared to the detailed design are the integration of propositions to 5 KR initiatives in total, and the use of current people management processes and systems in Technology to embed these 5 initiatives. It is important to mention that in this sub-chapter only the improvements after the acceptability evaluation are presented, and thus many references to chapter 7 are included. Some additional references to the design requirements are included in this chapter, using the requirements codes from table X . This final design of the strategy to foster intention to reuse explicit knowledge answers **research question 3.1** of this thesis.

Before embarking on the description of the improved final design, it is important to explain three people management tools that are used currently in Technology, and will be used as the "vehicles" for the organizational embedding and user adoption of the initiatives. These tools are the TAR, the Hephaistos intranet site, and the Performance Management System (PMS), which are explained below.

TAR

Currently in HMC, it is used a documented description of Tasks, Authorities and Responsibilities (TAR) per working function, aiming to specifically state the role that an employee has in a specific function. The TAR aims firstly to guide the employees on succeeding in their roles within the organization and secondly to help the managers assess their subordinates' performance. Aiming for increased adoption (G13) of the initiatives measures and their standardization (R1), it is proposed to add them in employees TARs. The additions in the employees TARs are described in the relevant initiatives.

Hephaistos: Technology Competence monitoring

In order to monitor the competences of each employee and the Technology organization in general, a database exists in Technology, which allows a real time overview of the competences and experience of each employee. The system with the code name Hephaistos, monitors each employee's competences on the following subjects: 1) General, 2)Languages, 3) Experience, 4) Competence Level, 5) Management Skills, 6) Engineering Experience. It is proposed to add as seventh, the subject "Knowledge Management", aiming to monitor all KM related competences of employees. A screenshot of the Hephaistos site with the added "Knowledge Management Skills" tab can be found in appendix H. During the discussion of the KR initiatives, knowledge reuse related contents are proposed to be included in the "Knowledge Management" section of Hephaistos. Of course further skills that are related to knowledge creation activities can be added in the proposed tab in the future.

Performance Management System (PMS)

The third people management tool is the Performance Management System (PMS). PMS is an intranet-based application for the whole company, and its objective is to facilitate both the expectation and target setting process, and the year-end appraisal of employees. The performance appraisal of employees is based on the following 7 Heerema values: 1) Act Safe, 2)Act responsible, 3)Work Together, 4)Show Pride, 5)Be Respectful, 6)Be Daring and 7)Create Impact. Each value has specific factors based on which employees' performance is assessed by their managers. Adjustments on the "Work Together" and "Create Impact" factors are proposed. The proposed adjustments on the "Work Together" value

refer to factors “Communicate” and “Influencing”, and the adjustment on the “Create Impact” refer to addition of a factor. The adjustments are further discussed together with the relevant KR Initiatives. The reasoning behind the adjustments on the current Heerema values appraisal system, is to link knowledge reuse initiatives’ elements to employees’ annual appraisal and in that way strengthen the organizational recognition of knowledge reuse practice. In that way it is expected that user adoption will be increased (G13).

Governance of the final strategy

The governance mechanisms “Management commitment and leadership” and “Strategy Risk Management” were accepted without alterations by the Technology management and thus are not repeated in this section. For more information the reader is referred to sub-chapter 7.2 of this thesis. The other two governance mechanisms “Roles and responsibilities” and “Monitoring” are updated based on the evaluation comments. The updates are discussed together with the KR initiatives and are summarized in a RACI chart and a Monitoring table accordingly in appendix I.

KR initiatives of the final strategy

After three integrations, the total number of strategy initiatives is 5. Using once again the pyramid top-view of the strategy, the levers and enablers layers of the strategy are presented in figure 29 . It is important to note that “Rewards” has been removed from the strategy levers layer, since no rewarding element is used in the initiatives. Also, in figure 29, an overview of the initiatives elements is presented that are discussed in the sections below.



Figure 29 – Top-view of the final strategy levers and enablers layers

KR initiative 1: Lead reuse of knowledge in project teams

The first initiative of the strategy propose the creation of knowledge reuse leaders within the project teams. As explained in the preliminary design chapter this can be achieved with the use of the KR Leadership Checklist (figure 22), by the Project and Specialist engineers during the project workflow. This initiative is almost unchanged after the acceptability evaluation. Nevertheless, aiming for increased adoption of the measure by the P/SEs, it is proposed to add in the responsibilities section of their TAR the sentence "Lead reuse of knowledge in project teams". Moreover it is proposed to add it in the "Work Together" section of the PMS, as a criterion for excellent performance assessment on the "Communicate" factor. An additional monitoring mechanism for the use of KR Leadership Checklists is proposed in the evaluation discussion. The mechanism is related to the traditional common practice in HMC for monitoring project progress. For that, certain KPIs are used that are monitored, and their progress is reported in a monthly basis in the Project Status Summary meetings. This gives the idea of adding the use of KR Leadership Checklists as a KPI in projects and thus monitor the practice.

In the preliminary design, microtraining sessions for the P/SEs on leading knowledge reuse through KR Leadership Checklist were proposed. The content and structure of these sessions are presented in sub-chapter 7.3 in the relevant initiative. In the evaluation, this idea was positively commented. However, it is recommended to use the highest level of project engineers (Senior Project Engineers A) in the company as the trainers instead of the senior Technology Advisor. The basic idea behind this recommendation is to create a team of trainers, aiming to have more people available to conduct the

trainings. The recommendation was accepted and the relevant responsibility cell in the RACI table is changed. As mentioned earlier, the RACI table for the final strategy is shown in appendix I. Aiming for increased adoption of the measure by the Senior P/SEs, it is proposed to add in the responsibilities section of their TAR the sentence "Train P/SEs on leading reuse of knowledge", and also add it in the "Work Together" section of the PMS, as a criterion for excellent performance assessment on the "Influencing" factor.

During the evaluation it was commented that P/SEs should participate in the microtraining sessions in a regular yearly basis. Participation in the microtraining sessions is regarded as a knowledge management competence for the P/SEs and therefore it should be added in the Knowledge Management section of Hephaistos. In that way the initiative is also monitored.

The final element of this initiative is the certification of P/SEs as knowledge practitioners by external certifying institutions. Aiming for increased adoption of the measure by the P/SEs, it is proposed to add it in the Knowledge Management section of the Hephaistos site, aiming to motivate P/SEs obtain such a certification for building up their knowledge management competences. A screenshot of the proposed Knowledge Management tab in Hephaistos can be found in the appendix H.

After the adjustments on the responsibilities and monitoring mechanisms, the RACI chart and the Monitoring table of the final strategy is updated and presented in appendix I.

KR initiative 2: Promote knowledge reuse practice and benefits

The second initiative integrates the "Explain benefits of knowledge reuse" and "Promote the practice of knowledge reuse" initiatives of the detailed design. In general, the ideas that are included in the improved initiative are almost unchanged after the evaluation, and they aim to promote knowledge reuse benefits through the KR Benefits Tree that is shown in figure 24 , and to promote knowledge reuse practice through success stories that are told verbally on the work. Moreover a KR logo is proposed that aims to remind the benefits and practice of reuse whenever it is seen by the employees. In appendix H, it is presented for illustrative purposes a screenshot of how a CoP site will look like after the proposed inclusion of the KM logo and the KR Benefits tree. The KM logo that is presented in figure 25 , during the evaluation was commented as an important tool to ensure continuation of KR practices that it can also be used to explicitly show to HMC clients that knowledge management practices are taking place within the company.

Regarding the knowledge reuse success stories, it is proposed in the preliminary design that the storytellers should be the Project and Specialist Engineers (P/SEs), and that they should be assisted by the Engineering Managers (EMs) and the Senior Project and Specialist Engineers, aiming for increased quality of the storytelling (S. Lukosch et al., 2011). Following the evaluation recommendations for increased user adoption of the measure, it is proposed to add it in the responsibilities section of the PE, SE, EM TARs and in Hephaistos site. Moreover, it is proposed to add storytelling and support for storytelling in the "Work Together" section of the PMS, as criteria for excellent performance assessment on the "Communicate" and "Influencing" factors accordingly. Finally, it was recommended and accepted to include success stories in the departmental meetings, due to the fact that in departmental meetings it

is easy to reach a big audience of story recipients. The recommendation was accepted and added in the initiative (R4).

The final comment that is made in the evaluation regarding this initiative, is to add two monitoring mechanisms. The first mechanism is to add knowledge reuse success storytelling as a KPI in projects and thus monitor this practice. Additionally, a codification of those stories would be a significant advantage of this monitoring mechanism. The second monitoring mechanism is a survey among the Technology employees one year after the implementation of the promotion initiative asking employees the extent that they recognize the initiative elements. Both monitoring mechanisms are added in the Monitoring table in appendix I.

KR initiative 3: Educate project team members

The third initiative integrates the elements of the "Train project team members on the job" initiative and the remaining induction training element from the "Shape starting engineers' mindset" initiative of the preliminary design. The recommendation that was made during the acceptability evaluation, was to make the multi-layer structure more flexible, aiming to fit in various project scales and to avoid creating boundaries of information flow. Therefore it is decided to extend mentoring from the top of the project hierarchy to the bottom. In the new structure the (Senior) Project or Specialist Engineers are responsible of mentoring all lower level engineers in their team. This structure allows a wider spread of the mentoring benefits. Therefore, in combination with KR initiative "Lead reuse of knowledge in project teams", this structure allows the KM experience and competences of higher level project employees, to flow to the project organizational bottom.

Following the evaluation recommendation for optimal embedding of the initiatives to the current Technology organizational structure and aiming to make the structure even more flexible, it is decided to link one-to-one microtraining coaching on knowledge reuse with Technology's "Buddy system". Currently, "every employee that starts in the Technology department gets a buddy assigned. The buddy must have sufficient experience within HMC to be able to guide the newcomer. It is the task of the buddy to assist the new employee with all work related matters and serve as a contact person for questions" (Technology HMC, 2011). Having the buddy system in mind it is proposed to also assign to the "Buddy" the task of coaching newcomers on knowledge reuse. In that way the one-to-one coaching system is much more flexible as it targets not only to junior engineers but also to newcomers on a higher organizational level, and also the coach can be any experienced HMC employee. Discussion of "Buddy Coaching" and mentoring in weekly project meetings is proposed as a monitoring mechanism of the two initiative elements. Following the recommendations for increased user adoption , it is proposed to add "Buddy coaching" and "knowledge reuse mentoring" in the "Work Together" section of the PMS, as criteria for excellent performance assessment on the "Communicate" and "Influencing" factors accordingly.

Job rotation is already a practice implemented in the company, and is expected to increase employees' eagerness to learn. Job rotation is already inserted in the competences monitoring system Hephaistos; the same is proposed for the Buddy coaching that can be added in the new proposed knowledge

management tab. A screenshot of the proposed Hephaistos Knowledge Management tab contents can be found in the appendix G.

Induction training of the newcomers on knowledge reuse systems and sources is added in this initiative and can be considered as an important element on training newcomers on knowledge reuse practices. Knowledge reuse training can be added in the list of trainings for technology employees and should be compulsory for every newcomer. Responsible for that training should be Team Leaders of the HMC engineering core competences. In the evaluation it is proposed to have also similar training sessions on knowledge reuse systems and sources, for the rest employees of the Technology department aiming to increase their familiarity with the existing systems and sources (R12).

Finally, the RACI and Monitoring tables in appendix I are updated accordingly. The flexible multi training structure is shown in figure 30, in which Microtraining on KR leadership and external KM certification are also added aiming to have an overview of the proposed training methods.

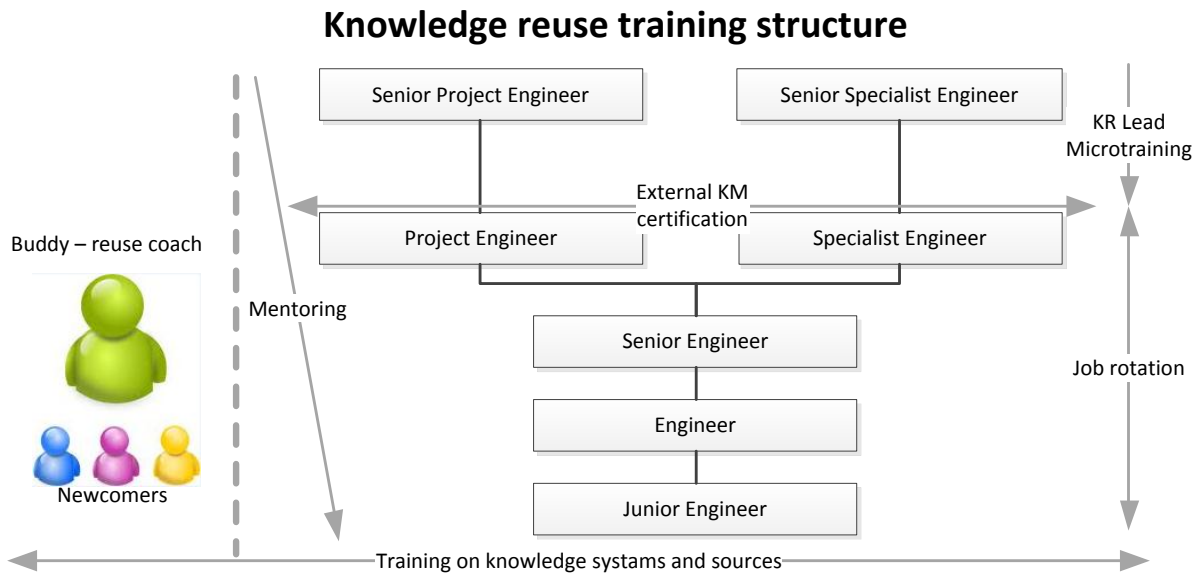

Figure 30 – Knowledge reuse training structure

KR initiative 4: Recognize reuse of knowledge

The fourth initiative integrates the elements of the "Empower project team members" initiative and the remaining elements of the "Praise reuse of knowledge" initiative of the detailed design. In general the ideas that are included in the improved initiative are almost unchanged after the evaluation, and they aim to recognize knowledge reuse practice. This is achieved through the means of personal informal praise, link of knowledge reuse to personal development, and employees empowerment as a mean of knowledge reuse recognition. Following the evaluation recommendation for optimal embedding in Technology, this section elaborates on how this embedding can be achieved.

Informal praise of engineers when they reuse knowledge was proposed in the preliminary design as a responsibility of Project and Specialist Engineers. Therefore it is proposed to add this recognition mean

in the responsibilities section of their TARs and also include it in the "Work Together" section of the PMS, as a criterion for excellent performance assessment on the "Communicate" factor.

Linking of knowledge reuse to personal development by including it in engineer's annual performance assessment is the second idea of this initiative. Aiming for optimal embedding of this idea to Technology it is proposed to create the new factor "Actively seize opportunities for reusing HMC's experience", in the "Create Impact" section of the PMS. In that way, Technology employees will be assessed on their performance on reusing knowledge. Moreover, it should be added in the TARs of all engineering functions under the "Tasks" section.

Finally, this initiative incorporates the ideas for empowering employees as a mean of recognition for their knowledge reuse performance. It is proposed to add in the "Work Together" section of the PMS, as a criterion for excellent performance assessment on the "Influencing" factor, empowerment of employees by assigning the "Buddy coach" and CoP leader" roles (R3). Also being a CoP leader should be included in the knowledge management tab of the Hephaistos, as a recognized competence. A screenshot of the proposed Hephaistos Knowledge Management tab contents can be found in the appendix H. At last, it is proposed to add at the Engineering Managers' and senior Project/Specialist Engineers' TAR task sections, the recognition of Technology employees' knowledge reuse performance, by assigning the "Buddy" and "CoP leader" role.

KR initiative 5: Facilitate knowledge flow in projects

The final initiative incorporates the improvements that were recommended during the acceptability evaluation on the "Facilitate knowledge flow in projects" initiative of the preliminary design. The proposed process is completely redesigned after the evaluation, but the basic principles remain the same. The redesigned knowledge flowchart is discussed in this section.

The main recommendations for improvement were three, namely, linking the process to project deliverables and the redesign of the knowledge flowchart process including filtering criteria for indicating explicit knowledge for reuse. Moreover, linking the process to the use of Cost Time Resource (CTR) was proposed as a measure to increase organizational embedding of the process. The recommendations were accepted and the redesigned Knowledge Flowchart that describes the process for facilitating knowledge flow and knowledge reuse tracking in projects is shown in figure 31. Next, the redesigned process is described.

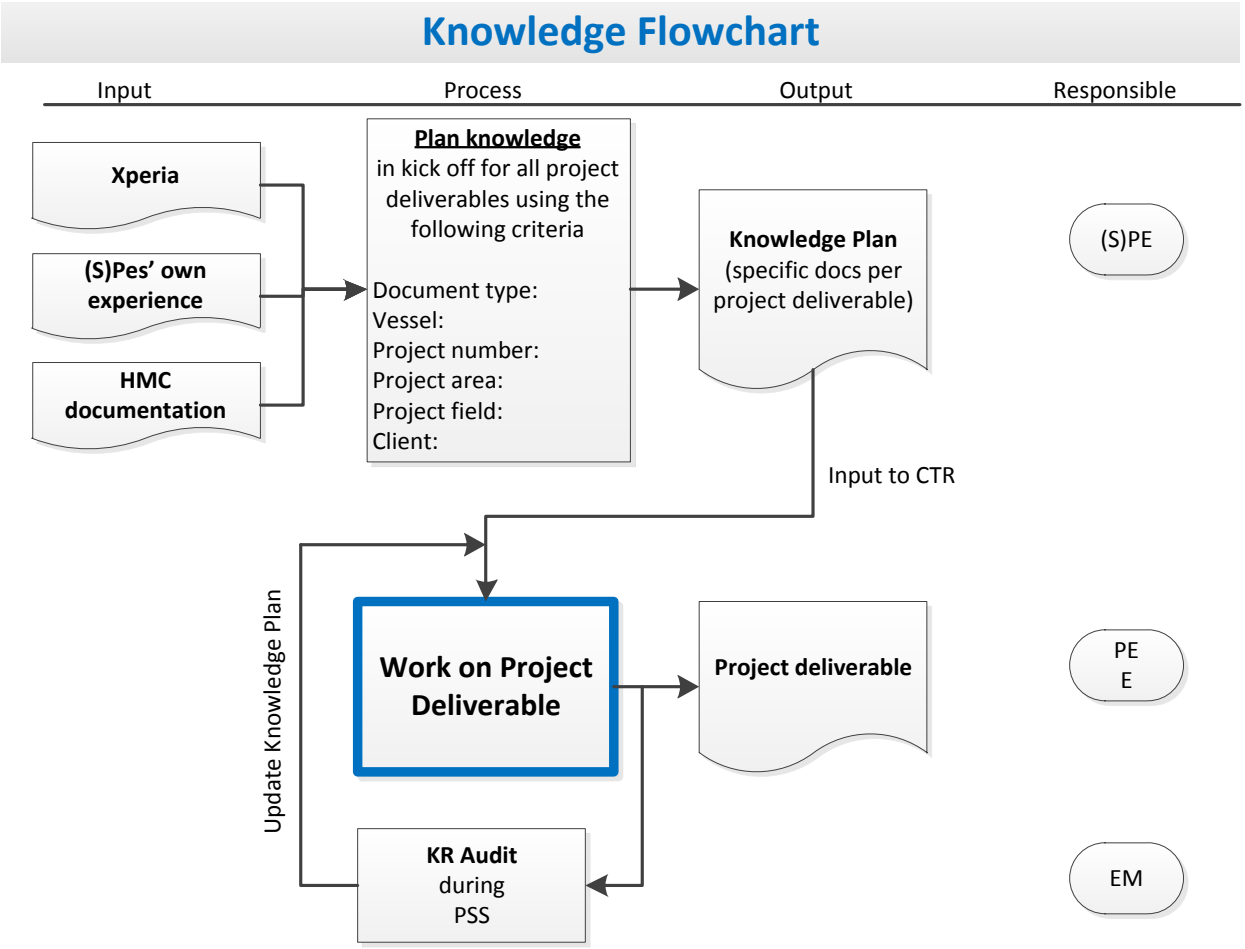

Figure 31 - Knowledge Flowchart

The redesigned flowchart consist of four columns, namely the input, the process, the output and the responsible person(s) for the process. Following the recommendation for linking the process with project deliverables, central block in the flowchart is the "Work on Project Deliverable" process, which is highlighted using a blue frame in the flowchart.

The proposed process starts using the inputs Xperia, (Senior) Project Engineers' own experience and HMC documentation. To be more specific, with the use of Xperia and (S)PEs' own experience, the previous projects are indicated that should be used as knowledge sources. HMC documentation will provide the actual explicit knowledge that is indicated for reuse. These three inputs are used in the "Plan knowledge" process, where the (S)PE indicates during the project kick-off meeting the knowledge that should be used in all project deliverables based on the following criteria: 1)Document type, 2)Vessel, 3)Project number, 4)Project area, 5) Project field and 6)Client. The output of this process is the "Knowledge Plan", which is a report that specifies the documents that should be used in the work for each project deliverable.

Regarding the link of the knowledge flowcharts' use with an existing tool, Cost Time Resources (CTR) sheet was recommended. The CTR sheet is used for reporting details for the required cost, time and resources for the development of a project deliverable. In the CTR among other things are stated the inputs that are required for creating the relevant project deliverable. It is proposed to use "Knowledge Plan" as an input to CTR sheets. In appendix H can be found a CTR template, in which it is shown the inclusion of the "Knowledge Plan" in the CTR input field.

The indicated knowledge in the "Knowledge Plan" and the CTR are used then in the "Work on Project Deliverable" HMC process. KR Auditing is proposed to be inserted in the agenda of the monthly Project Status Summary meetings, where the Engineering Managers monitor (among the rest KPIs) whether indicated knowledge is actually reused in the project deliverable work. This is shown in figure 31 as a feedback loop for updates on the Knowledge Plan based on the actual reuse and also based on any change in project scope of work.

The roles and responsibilities for the new redesigned process are summarized in the RACI chart in appendix I, and the Monitoring table is updated accordingly.

8.3 Evaluation of proposed improvement

In section 8.1, the preliminary design was evaluated for its acceptability by the Engineering Manager of the HMC Technology PDR Product, based on the guiding principles (G11-G13). Based on the evaluation recommendations, the preliminary design was refined and the result is the final detailed design for fostering Technology employees' "intention to reuse", which was presented in sub-chapter 8.2. In an ideal situation this final detailed design would be evaluated on whether a higher quality of knowledge reuse throughout projects is achieved, after the implementation of the strategy in Technology. Nevertheless, this is not the case yet, and therefore a reflection on the strategy design requirements (R1-R12 in table 12) is attempted aiming to evaluate the proposed improvement. The reflection on the strategy design requirements is presented in table 26 below.

	Design Requirement	Reference code	Achievement with the design
	…standardizing explicit KR by an official company process	R1	A process described by the "Knowledge flowchart" is created, linked to an existing tool (CTR), aiming to standardize knowledge reuse in HMC projects. Inclusion of the required knowledge reuse actions in the TARs of each employee function is an additional measure that standardizes reuse of knowledge practice.
	…making clear management's commitment on KR to employees	R2	Commitment of the management is visible now to the employees due to the creation of the "Technology Knowledge Manager" position and the KM core team, the inclusion of knowledge management tab in Hephaistos and the link of knowledge reuse to their annual assessment.
	…spreading leadership of KR in all project teams	R3	Leadership is spread within the project teams through the creation of P/SEs knowledge reuse leaders, and the assignment of the "Buddy coach" and "CoP leader" roles.

	…systematizing employees peer pressure to reuse	R4	Social pressure to reuse is achieved by spreading success stories in the workflow and in departmental meetings. The stories will be told collaboratively by the P/SEs assisted by the EMs- SP/SEs, aiming to increase storytelling quality.
	…cultivating a KR organizational culture	R5	Communication of KR value through storytelling, KR Benefits Tree and a KM logo, aims to influence positively the cultivation of a KR organizational culture. Additionally, recognition of reuse in the annual appraisal contributes to the cultivation of a KR organizational culture. Rewarding was finally excluded as mean to cultivate KR organizational culture.
	…communicating client's pressure for learning to employees	R6	No direct measure is taken to communicate client's pressure for knowledge reuse. Nevertheless, it is expected that knowledge reuse leaders will transfer possible client's pressure to the project team.
	…systematizing training on reuse importance of KR, and on systems/sources for KR	R7	A multi training structure on knowledge reuse is provided to HMC, including mentoring, "Buddy" coaching through microtraining, job rotation, external training for KM certification, and short training sessions to the newcomers and also the rest employees on knowledge reuse systems and sources. Microtraining on leading knowledge reuse is achieved also in this design.
	… balancing employee's perception between KR effort and gains	R8	Communicating the benefits is expected to balance the effort-gains ratio for reuse. Moreover, Technology employees' perception of reuse effort is decreased by this design through the multi training structure that increases their self-efficacy on reuse. Indication of what knowledge should be reused by the "Knowledge Flowchart" also decreases their perception of effort.
	…increasing communication of performance gaps to employees	R9	Realization of potential performance gaps is achieved through the discussions of employees with their "Buddy coaches" and mentors, and through the leading actions of P/SEs using the KR Leadership Checklist.
	...communicating to employees the value of KR	R10	Communication of knowledge reuse is achieved by this design through the KR Benefits Tree , the KR leadership within the project teams and the KR success storytelling. Also, the KM logo ensures the continuation of communication.
	…making KR a routine for employees	R11	The ability of the employees to routinize reuse of explicit knowledge is increased through the use of a KM logo, which reminds continuously the knowledge reuse practice. Moreover, communication of the KR benefits regularly in the project workflow by the leaders, helps employees routinize reuse of knowledge.
	…increasing employees' familiarity with explicit knowledge sources and systems	R12	An increase of familiarity with the knowledge management systems is achieved in this design through the training sessions , mentoring and "buddy" coaching.

Table 15 – Evaluation of the proposed improvement through reflection on the design requirements

Conclusion

In the present chapter the evaluation of the detailed design was presented. For the evaluation, the acceptability guiding principles (G11-G13 in table 12) were used in a semi-structured interactive discussion with the Engineering Manager of the PRD Technology product group. Overall, the evaluation added significant value to design through the critical comments of the manager. The valuable comments were integrated to the design and the result is the final strategy to foster intention to reuse explicit knowledge in HMC Technology department, which is the answer on **research question 3.1** of this thesis. The final strategy consists of the 5 following quick-win enabling initiatives:

6. Lead reuse of knowledge in project teams
7. Promote knowledge reuse practice and benefits
8. Educate project team members
9. Recognize reuse of knowledge
10. Facilitate knowledge flow in projects

Finally, an evaluation was attempted, of whether a higher quality of knowledge reuse throughout projects is achieved, by reflecting on the design requirements (R1-R12 in table 12).



9.1 Recommendations for implementation in the short-, medium-, long- term
9.2 Strategy implementation roadmap

Chapter 9: Roadmap for implementing the strategy in HMC Technology

Introduction

In chapters 7 and 8, the strategy to foster intention to reuse explicit knowledge in the Technology department of HMC was initially developed, and then evaluated and refined. In the strategy, a set of initiatives are recommended to be taken by Technology for fostering intention to reuse. This chapter aims to specifically explain how the implementation of this strategy should take place. This strategy implementation roadmap answers **research question 3.2** of this thesis.

9.1 Recommendations for implementation in the short, medium and long term

In chapter 6, after the identification of the improvement gap in Technology regarding the reuse of explicit knowledge, the improvement strategy is scoped and the design objective is defined. In that chapter, it is explained that the strategy will focus on improvements that can be realized in a short span of time and with relatively little effort. Nevertheless, some elements of the KR initiatives that presented in chapters 7 and 8 are easier and quicker to be implemented than others. The present section categorizes the changes that should be made for the implementation of the proposed strategy in three phases. In the first short-term phase belong all those changes that focus on creating or adapting tools, and can be implemented almost immediately. In the second mid-term phase belong all those changes that focus on creating or adapting processes in the organization, and thus require additional effort and time for their implementation. The mid-term changes require a span of time from 3 to 6 months. Finally, in the long term phase belong the changes that are the results of culture development of people due to changes in the short or medium term, or require feedback from the monitoring mechanisms first, which is something that requires additional time. The long-term changes require a minimum time span of 6 months. Categorizing the changes in the proposed way, gives also a sense of progress, which stimulates the involved parties to stay on the improvement process (De Bruijn et al., 2010).

Before embarking on the discussion about the implementation phases, an important note should be made. Recalling the risk management governance mechanism of the KR strategy that presented in figure 21, it should be mentioned that all four phases of the risk management process should take place, for changes in the short, medium, and long term. In other words, planning, development, implementation and ongoing operation and the proposed sessions and meetings constitute a risk management process that should be followed for the changes on tools, on processes and on people. It is important not to short-circuit the risk management process for any phase of change as that might lead to a failure of the strategy.

In the sections below, the discussion about the implementation of the initiatives on the short, medium and long term is presented.

Short term (0-3 months)

As explained above, the development or adjustment of tools that are to be employed by the strategy to foster intention to reuse, require a short span of time. However, even before the development of tools the proposed Technology Knowledge Manager should be assigned and the KM team should be formed. This is of very high importance, because it is the manager's responsibility to take care of the smooth implementation of all initiatives. This can be realized in the RACI charts where is shown that in the majority of the initiative elements the Technology Knowledge Manager has a role. Furthermore, the KM team is of high importance due to its role in steering and assisting the initiatives and also in providing feedback from project work floor.

After assigning the Knowledge Manager and forming the KM team in the Technology department, the tools can be developed and implemented. Initially the KR Leadership Checklist should be reviewed for possible refinements and then it should be distributed to the Project and Specialist Engineers. In parallel the Technology Knowledge Manager should work together with the KM team to refine the Microtraining sessions that proposed. Then the Microtraining sessions should be introduced to the trainers, i.e. to the Senior Project Engineers A and the "buddy coaches" respectively. Moreover, the Knowledge Manager should review all possible alternative external institutions that offer KM certificates, select the most appropriate for the HMC case, and establish a cooperation program.

In the short term, the KR Benefits tree should also be reviewed for possible refinements and then it should be printed in a poster format and placed to the project offices and also in an electronic form in the Communities of Practices homepages. In these homepages should be placed also the KM logo after possible refinements. Additionally, promotional material with the KM logo should be ordered.

Finally, the TAR of the employee functions in the Technology department should be adjusted, according to the recommendations made in chapter 8. The recommended changes in the Hephaistos competence monitoring site, and the Performance Management System (PMS) site should also be implemented in the short term. Last but not least the Knowledge flowchart process should be refined, added in the MSD and the relevant reference should be added in the CTR template.

Medium term (3-6 months)

Changes or creation of organizational process require additional time and effort compared to the development of tools. Moreover, for the operation of some processes, the development of relevant tools is a prerequisite. One of those processes is Microtraining of the P/SEs on leading reuse of knowledge in project teams. After the refinement of the Microtraining sessions and their introduction to the Senior Project / Specialist Engineers and "Buddy coaches", the actual trainings of the P/SEs should start on the medium term. The fact that the KR Leadership Checklist will have already been distributed to the P/SEs, facilitates the training process, as they will have been familiarized with their use. Moreover, within the time span of 6 months after the initiation of the strategy, the training session on knowledge reuse systems and sources should be in place.

Additional time and effort is required for changing the process of filling in a CTR for project deliverables using the Knowledge Plan as input. For correct implementation of the Knowledge Flowchart process, it is recommended to start implementing it on a recently started project, aiming to use it for all project deliverables of a project, in order for auditing to be able for the whole flow from the start till the end of the project. In a new project is also recommended to start implementing the success storytelling and KR Leadership KPIs in the projects progress status.

Finally, it is required additional time for the P/Es to start expressing their interest for KM certification and thus start to participate in those trainings. In the medium term, the employees should start building up their "Knowledge Management" profiles in Hephaistos.

Long term (6 months-∞)

As explained in the beginning of this chapter, there are some initiative elements that require cultural development of the employees within the Technology department for their implementation or they require feedback from the elements that are implemented in the short or medium term which is something that requires additional time.

After the development and distribution of the KR Leadership Checklist to P/SEs and their training on using it by the Senior P/SEs, it is expected that in the long term the P/SEs will have started leading knowledge reuse in project teams. Nevertheless, as commented during the acceptability evaluation the Microtraining sessions should continue, aiming to keep the knowledge reuse leadership performance of the P/SEs at the desired levels. Furthermore, it is only in the long term that job rotation initiative element can be implemented, due to its feature and taking into account that projects usually last for several years.

Although the changes in the tools and processes can be realized in the short and medium term, it is only in the long term that employees will start performing according to their prescribed role on knowledge reuse. To be more specific, it is only in the long term that P/SEs will start tell stories on the job and will start praising the members of their project teams for reusing knowledge. Time is needed for including success stories in the departmental meetings. Moreover, it is required much time for the "Buddy coaches" and the mentors to actually start performing according to their roles, since it entails a cultural change, which requires both effort and time.

Finally, some elements require the implementation of other initiatives firstly, before they are ready for implementation. In this category falls the empowerment of employees from the Engineering Managers by assigning “Buddy” and “CoP leader” roles. In the “Recognize reuse of knowledge” initiative, it is proposed to the Engineering Managers to take into account the employees’ kR performance, before assigning the “Buddy” and “CoP leader” roles. However, this can only be in the long term and after the employees have been given time to reuse knowledge in projects. In the same category falls the annual performance assessment of the employees based on their knowledge reuse performance, and the KR Audits in project deliverables.

9.2 Strategy implementation roadmap

While the analysis and development of the strategy to foster explicit knowledge reuse in Technology department are major undertakings, the implementation of the proposed improvements is of equal importance. Therefore, a roadmap for the implementation of the strategy to foster explicit knowledge reuse is presented in this section. The roadmap is created based on the discussion that presented above regarding the short-, medium- and long term changes in the Technology department, and it displays the proposed changes along the axes time and difficulty. The implementation roadmap is presented in the figure 32, and answers **research question 3.2** of this thesis.

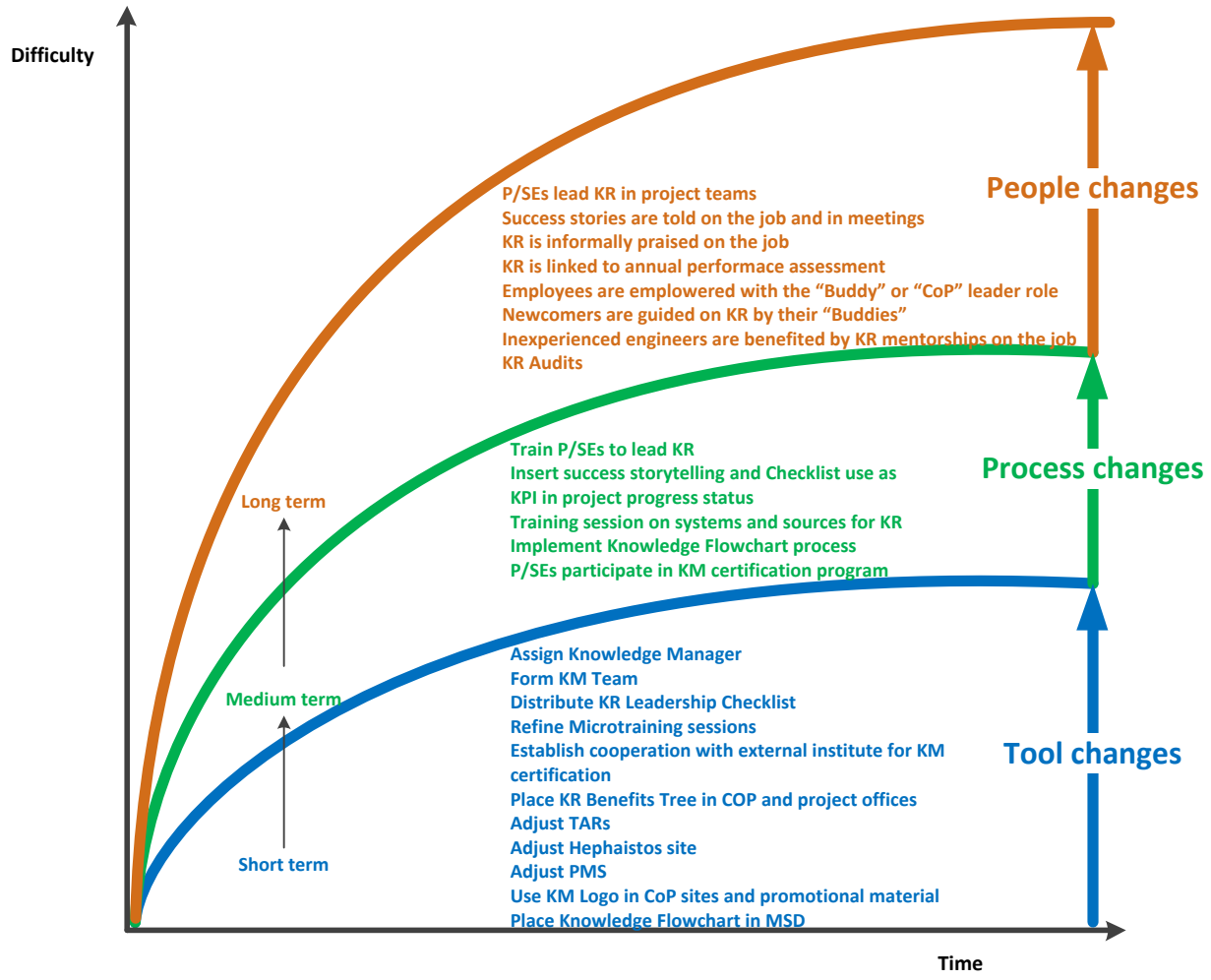

Figure 32 - Strategy implementation roadmap

Conclusion

In this chapter it was presented the roadmap that is proposed to be followed by the HMC Technology for the implementation of the strategy. The roadmap was presented in a time-difficulty axes chart, and categorizes the changes in short-, medium-, and long term ones. In the short-term belong all those changes that focus on creating or adapting tools, while in the mid-term phase belong all those changes that focus on creating or adapting processes in the organization. Finally, in the long term phase belong the changes that are the results of culture development of people due to changes in the short or medium term, or require feedback from the monitoring mechanisms. The implementation roadmap answers **research question 3.2** of this thesis.



10.1 Improvement approach
10.2 Current situation analysis
10.3 Design approach
10.4 General implications

Chapter 10: Implications of research based on the HMC-Technology case

Introduction

In chapters 6-8, the design artifact for fostering reuse of explicit knowledge in Technology department of HMC was presented. The design artifact entails a significant contribution to the organization under study; HMC Technology has been provided with a practical strategy to improve employees' intention to reuse explicit knowledge. For the design of this artifact, Hevner et al. (2004) design science research framework is used. According to Hevner et al. (2004), research contribution to the knowledge base is an important guideline for effective design science research. In our case, by research contribution, it is meant the value of this research for the rest project based organizations in the engineering domain. The design artifact itself cannot be considered as a contribution to the knowledge base, since it is specifically developed for the HMC case and thus has little value for the rest organizations. Nevertheless, important "design construction knowledge" (Hevner et al., 2004) can be derived from this research for the rest project based organizations in the engineering domain. In other words, the strategy development foundation approach, might be of value for the rest project based organizations in the engineering domain that strive for improving reuse of explicit knowledge. In this chapter, the contribution of this research to the knowledge base is presented and answers **research question 4** of this thesis, by describing the lessons learned from the foundation approach for the improvement of explicit knowledge reuse. The strategy development foundation approach consists of the improvement approach, the current situation analysis and the strategy design approach, which are presented in the following sections. An important clarification to make is that the scientific implications of the research are not part of this chapter, and are presented in the reflection section in chapter 11.

10.1 Improvement approach

The approach that is selected in this research for improving reuse of explicit knowledge, is the identification and categorization of the factors that support or hinder reuse of explicit knowledge and their respective exploitation. For the categorization of the factors, a map is developed. The map is a

matrix that categorizes the rows based on the knowledge reuse aspects (Barney, 2011; Jashapara, 2004; Van der Brink, 2003) and elements (Markus, 2001; Szulanski, 2003), and the columns based on the parts of the knowledge reuse process (Markus, 2001; So & Bolloju, 2005). Categorizing the factors using the proposed map, is a basic element of the improvement approach that entails the following two major advantages: Firstly, it provides a clear overview of the various factors that support or hinder explicit knowledge reuse, and secondly, it reveals the interrelationships of the factors with the different parts of the knowledge reuse process. The proposed map can be used as a tool for the improvement explicit knowledge reuse by any PBO, and thus it is a contribution to the knowledge base. The map is displayed in figure 33.

		Knowledge reuse process				
		Intention to reuse	Definition of search question	Search process	Assess and select search findings	Application of knowledge
Knowledge reuse aspects and elements	Technological - content intermediary					
	Social - Recipient					
	Organizational - Context					

Figure 33 - Map to categorize knowledge reuse factors

Before closing the implications section of the improvement approach, a limitation should be highlighted. “Technology push” approaches to knowledge management (Fan et al., 2005) are not taken into account in the selected improvement approach. The reasoning behind the conscious exclusion of these approaches from the improvement approach is Wiig's (1997) proposition that the future of knowledge management seem to rely more on “demand pull” approaches than “technology push” approaches.

10.2 Current situation analysis

For the identification of the strengths and weaknesses regarding explicit knowledge in the current situation, a triangulation of research methods is important to be used. The use of multiple methods provides the opportunity to cross examine the findings and thus delineate the current situation more objectively. In the present research two methods are used; desk research in the company's documents and a survey among the employees.

Analyzing the organizational doctrine of a company by a research on the management documentation reveals the areas for improvement in the current situation that might not be observed by employees in their work routines. In other words, a desk research lets issues emerge that are tied to the work common practice of the employees, who might not be aware of them.

On the other hand a questionnaire based survey among the employees sheds light on the areas of improvement in the current situation that cannot be found in the documentation, by letting employees express their perceptions. As a research method, it is in line with the process management indication to protect core values of the involved parties by providing the respondents with the opportunity of opinion confidentiality through anonymity. Moreover, participation of the employees to the survey increases their sense of urgency for the improvement needed. Finally, a survey among the employees creates a sense of openness in the decision making process, by letting employees influence the improvement process.

However, it is important the questionnaire to be objective and avoid leading questions. To achieve that, pre-evaluation of the questionnaire before distributing to the respondents is done in this research and the same is strongly recommended also to the rest PBOs while assessing their current situation. The pre-evaluation should be done regarding the wording as well as the content of the questionnaire. In the wording pre-evaluation, few randomly selected persons that belong in the survey target group of respondents should be involved. In the content pre-evaluation, a related expert should be involved. To ensure high rate of responses in the questionnaires, two things are required: 1) attractive survey invitation and introduction and 2) explicit top management support to the survey.

As clearer as possible delineation of the current situation through multiple analysis means is an important pillar of the improvement foundation. However, not all problems should be addressed in the improvement strategy. A careful selection of the root causes among all analysis findings is an important step before designing the improvement intervention.

10.3 Design approach

During the assessment of the current situation the areas of improvement are identified in the light of the factors that hinder or support reuse of explicit knowledge. The exploitation of these factors will lead to desired improvement according to the improvement approach that is followed. By exploitation of the factors, it is meant changes of the management system to the desired direction. However, according to Milton (2010), "if any change to a new management system is to deliver value in the organization in the long term, then there needs to be a way of changing the culture, of making sure that the behaviors stay changed, the processes are carried out and the people do what they are supposed to do". Therefore for

a sustainable strategy of change within an organization, an integrated design approach should be adopted.

The design approach that is selected in this research, integrates three layers, all of which are required for the realization of the improvement. The first layer consists of governance mechanisms that "ensure the delivery of anticipated improvement benefits in an authorized and regulated manner"(S Zyngier et al., 2006). In other words, this layer serves as the foundation that supports the whole improvement structure. The second layer consists of the design attributes of the improvement strategy. The attributes are the levers that are supported by the governance mechanisms and that provide the strategy with the structural elements to construct the base for the development of certain KM initiatives. The final layer includes the constructed initiatives that will enable the realization of the desired improvement. These initiatives are constructed using the structural elements from the strategy levers and are supported by the foundation governance mechanisms, for resulting the anticipated improvement benefits.

The three-layer integrated approach to design the improvement is a contribution to the PBOs that desire to devise a strategy of improving knowledge management practices, since such an integrated KM strategy design approach isn't available yet in literature. The three-layer integrated approach to design the improvement is presented in figure 34.

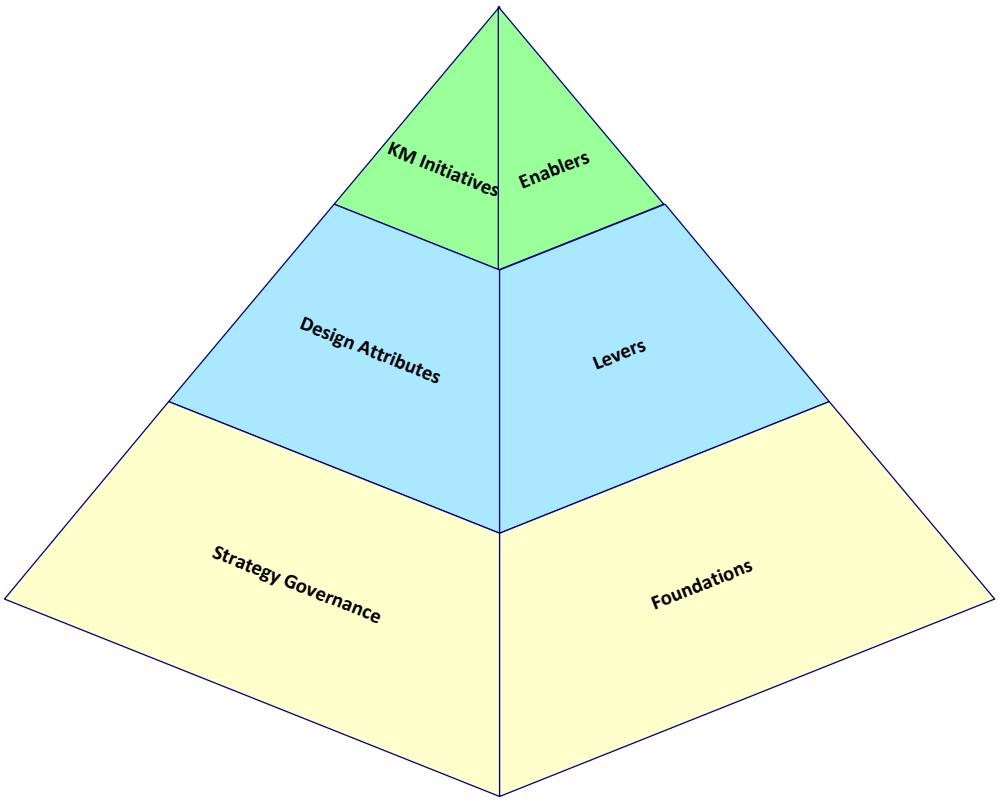

Figure 34 –Integrated design approach for KM practices improvement

10.4 General implications

In the previous sections, improvement related implications for the project based organizations are presented based on the HMC-Technology case study. In this section some general lessons learned from the improvement process. Moreover, an implication regarding rewarding as a motivating factor on knowledge management, as well as an important practical thesis limitation are presented.

One important lesson learned is related to the management of the improvement process. It is important to sustain commitment of the involved parties, by creating an open decision making, where all parties feel that improvement is the result of a negotiation process. Creating also sense of urgency for improvement is also important for sustaining commitment of the involved parties.

Nevertheless, creating an open process might intimidate the involved parties that their core values will be affected. Therefore, a safe improvement process should be created, by preserving the confidentiality of opinions and corporate information.

The third lesson learned is about creating a sense of improvement progress. Therefore, quick wins are proposed that will show quick results to the involved parties, which will tempt them stay on the improvement process.

An implication regarding rewarding as a motivating factor on knowledge management should also be mentioned. In the selection of the design attributes, extrinsic rewarding was selected together with other people management practices due to the fact that it was found to have some motivating power (McDermott & O'Dell, 2001; Robbins & Judge, 2009). Nevertheless, there were also theoretical indications that rewards and bonuses are not identified as motivating factor in knowledge management (Bock & Kim, 2002), but on the opposite, the more people are rewarded for performing a behavior (reuse) the more their intrinsic motivation declines (Fleming, 2011). The rejection of rewarding element from the strategy during the acceptability evaluation, the low ranking of rewarding in the survey among the strategies for improving explicit knowledge reuse (figure 15), and comments in the survey such as "rewarding may result to application of incorrect solutions" might be a practical confirmation of the theoretical negative propositions about rewarding as a motivating factor in knowledge management.

Finally, an important note on a general practical limitation of this thesis should be made. The strategy for fostering the explicit knowledge reuse in this thesis, is influenced by the dynamics that take place currently in HMC, regarding the update of knowledge management in the company. This contributes to sustain commitment on improvement, which might mean that in the HMC case less effort is needed to convince the involved parties in the organization for the improvement needed, and the value of reusing knowledge. For instance, positive attitude on reuse that was found to be a fact in the HMC case, it might be a very tricky objective to achieve in other PBOs. This example implies that ability for generalization from the improvement strategy on HMC is limited, and thus the improvement process should be regarded more as an improvement perspective rather that as an improvement guideline.

Conclusion

In this chapter was presented an overview of the research implications for the project based organizations in the engineering domain. The value of this research for the rest PBOs is limited to the "design construction knowledge" (Hevner, 2004), since the design artifact itself is specifically developed for the HMC case and thus has little value for the rest organizations. This value answers **research question 4** of this thesis.

The strategy development foundation approach that is employed in this research, consists of the three sequential and of equal importance approaches. The first approach is the generic approach for improving reuse of explicit knowledge, which entails the identification and categorization of the factors that support or hinder reuse of explicit knowledge and their respective exploitation. For the categorization of the factors, a map is developed. The second approach is related to the analysis of the areas of improvement in the current situation and entails the use of desk research in the company's documents and a survey among the employees, aiming to cross examine the findings and thus delineate the current situation more objectively. Thirdly, a three-layer design approach is employed, aiming to achieve the desired improvement. The three layers are the foundation (strategy governance), the levers (design attribute) and the enablers (KM initiatives) of the strategy for KM practices improvement. Finally a number of general implications were presented that could be of value for the project based engineering organizations. Once again, it should be mentioned that the scientific implications of the research are not part of this chapter, and are presented in the reflection section in the next chapter.



11.1 Conclusions
11.2 Reflections

Chapter 11: Thesis conclusions and reflections

This final chapter aims to present an overview of the conclusions of the thesis that focused on providing project based engineering organizations with insight on fostering reuse of explicit knowledge in the FED of projects, based on the research that was conducted in the HMC case. Initially, an overview of the research definition is given. The rest conclusions are summarized based on the research sub-questions, and at last the answer to the main research question of this thesis is presented.

This chapter concludes with the research reflections. Initially, it is presented the reflection on the research approach that is adopted in this thesis. Then, a reflection on the research results follows, and finally a personal reflection of the researcher is presented.

11.1 Conclusions

As mentioned in the chapter introductory text, in this section an overview is given of the thesis conclusions. Initially, the research relevance is discussed and then the strategy to answer the main question of this research is summarized. Next, the thesis results that underpin the answer to the research question are summarized. This section concludes with the answer to the main research question. The discussion regarding the validity of this answer is presented in section 11.2.

Definition of the research

Project based engineering organizations focus on an increase of value in their projects, aiming for competitive advantage to survive in harsh competition. Knowledge Management is a practice the adds value in the Front End Development of projects (Bosch-Rekveldt, 2011), and a knowledge management strategy to achieve learning across projects, is codification; converting tacit knowledge to explicit. Nevertheless, both academics (Disterer, 2002; Newell, 2005; Williams, 2008) and practitioners (KPMG, 2003) identified barriers in the explicit knowledge reuse process, and thus characterized those processes in PBOs as problematic.

From a practical point of view, project based engineering organizations striving to increase the value of their projects, focus on ways to improve reuse of explicit knowledge in the FED of their projects. From a

scientific point of view, clear scientific mapping of the factors that support or hinder explicit knowledge reuse in the FED of projects, and what such a mapping entails for a strategy to foster reuse of explicit knowledge in PBOs in the engineering domain is not present yet. Having both views in mind, the main research question of this thesis is:

What factors support or hinder explicit knowledge reuse in the front end development of projects, and how can project based organizations in the engineering domain exploit them aiming to improve value in projects during their front end development?

The approach in this research for improvement of the explicit knowledge reuse in PBOs, is to identify and categorize the factors that support or hinder reuse of explicit knowledge, and then to exploit them respectively. For the categorization of the factors, the theories regarding knowledge reuse aspects and elements, and the knowledge reuse process are reviewed. The integrated perspective of these theories that was adopted to create a categorization map for the knowledge reuse factors, is the first scientific contribution of this research. Furthermore, for the exploitation of the "intention to reuse" social and organizational factors, a strategic approach is created. For this approach, KM governance and people management theories are reviewed. Refining and extending the current literature by providing a combinatorial perspective on the use of the KM governance and people management theories, is the second scientific contribution of this research. These two perspectives entailed also a practical contribution for the project based engineering organizations, i.e. an indicative perspective for improving reuse of explicit knowledge in FED of projects.

Research strategy

The research approach of identifying, categorizing and exploiting the knowledge reuse factors, is guided by the design science research framework that proposed by Hevner et al. (2004). This research methodology prescribes firstly an exploration of the knowledge base to construct the theoretical basis of knowledge reuse factors, and then an exploration to the organization that serves as the research's case study. For that purpose, the Technology department of HMC is selected. Exploration in the HMC Technology entailed the assessment of the current situation regarding knowledge reuse. After the exploration, the research methodology prescribes the development and evaluation of an artifact: a strategy to foster reuse of explicit knowledge by exploiting the knowledge reuse factors. The final step of Hevner's et al. (2004) methodology is to contribute to the knowledge base. As contribution of this research to the knowledge base can be perceived the lessons that are learned from this research process regarding the development of a strategy to foster reuse explicit knowledge that is relevant potentially for relevant improvement approaches to other project based engineering organizations.

To manage the research process, the principles of process management were adopted (De Bruijn et al., 2010), which propose the creation of an open and safe decision making process for the involved parties. To achieve that, a mixed set of methods was used. Initially, a literature review was conducted to identify the factors that support or hinder reuse of knowledge. The exploitation of these factors according to literature, formde the theoretical requirements for an unproblematic explicit knowledge reuse process.

These theoretical requirements constituted the base for the analysis of the HMC Technology environment. For the analysis of the current situation, aiming to counterbalance the dynamics that the internal project for upgrading knowledge management practices (KMU) was creating to the research, it was decided to conduct desk research on the KMU project documents. Moreover, the HMC organizational documents were reviewed, aiming to analyze the organizational doctrine of the PBO under study. Additionally, a survey among the Technology employees was included in the analysis of the current situation, aiming to create both a sense of urgency in the company and also an open process where the organizationally lower employees participate in the knowledge reuse improvement decision making process. Aiming to sustain management commitment to the improvement process, management's opinion on the improvement needed was taken as a final step of the current situation analysis.

The multiple analysis methods of the current situation, resulted to a number of improvement gaps. Based on these gaps the design requirements and guiding principles for the strategy to foster intention to reuse explicit knowledge were derived. For that design, the engineering design principles were used (Dieter & Schmidt, 2009; Dym & Little, 2009); the solution space was generated, and guiding principles were used to converge that solution space and come up with the preliminary design. Evaluation based on the guiding principles of the preliminary design resulted to the final design. The evaluation of the final design based on reflection on the design requirements is the last step of the design process. Aiming to create an open decision making environment throughout the research process and also sustain management's commitment to improvement, members of the Technology Engineering Management team were used both for the evaluation of the design concepts and the preliminary design.

In the following sections, the answers to the research sub-questions are presented and then they are aggregated to form the answer of the main research question of this thesis.

1) PBOs: Theories on explicit knowledge reuse and influencing factors

Three elements are contained in the first research sub-question, i.e. mapping framework of knowledge reuse factors, identification of knowledge reuse supportive or hindering factors, and requirements of an unproblematic explicit knowledge reuse process.

To create the map for knowledge reuse factors categorization, firstly the theories of the knowledge reuse process were reviewed, aiming to construct the first axis of the map. Markus (2001) in her paper described the knowledge reuse process, which consists of 4 sub-processes; the definition of the search question, the process of searching for expertise, the process of assessment and selection of the appropriate expertise from the search results and finally the application of knowledge. So & Bolloju (2005) went one step back from the definition of search question and added the intention of the (potential) knowledge re-user to reuse knowledge. To create the second axis of the map, the theories of knowledge reuse elements by Szulanski (2003), and the interdisciplinary approach to knowledge management are reviewed (Barney, 2011; Jashapara, 2004; Orlikowski, 1992; Van der Brink, 2003). Aiming to link these theoretical concepts, when looking knowledge reuse from the technological aspect then the elements knowledge content, and intermediary are the dominant ones for a successful knowledge reuse. When studying knowledge reuse from the social perspective, then the knowledge

recipient is the dominant element. Finally, context is the key element when knowledge reuse is studied in light of the organizational aspect. The aspects and elements of knowledge reuse, construct the second axis of the map. The 2-dimension map was presented in figure 10, and serves as the tool to categorize the knowledge reuse factors.

After having created the map, we moved to the second element of this research sub-question; identification of the factors that support or hinder reuse of knowledge. For that step, scientific journal articles and papers were reviewed, and in total 20 distinct factors were found. Then, the developed map was used to categorize those factors, based on the three knowledge management aspects (technological-organizational-social), and the knowledge reuse process that they affect. To summarize, three technological, eight organizational and nine social factors were found that were spread in all knowledge reuse sub-processes. The developed map together with the factors from literature, construct the theoretical factorial knowledge reuse model which was presented in table 4, and provides the researcher with a clear overview of the identified knowledge reuse supportive or hindering factors.

The theoretical factorial knowledge reuse model was used then as an input for the third element of this sub-question; the development of the requirements of an unproblematic explicit knowledge reuse process. Recalling that the factors in the model explain the creation or overcoming of the barriers that create problems to reuse of explicit knowledge, it was realized that exploitation of these factors are also the requirements for an unproblematic explicit knowledge reuse process. Therefore, the technological, organizational and social requirements for an unproblematic explicit knowledge reuse process were developed. These requirements were shown in table 5. From a technological point of view, accessing of knowledge should be easy, the repositories should contain sufficient explicit knowledge, which also should be of high quality. From an organizational point of view, knowledge reuse should be standardized and management should be committed to the practice. Important is to have responsibility, leadership and training on knowledge reuse, while an organizational culture should be cultivated through communication, recognition and reward of reuse. Finally, from a social perspective, people should have positive attitude, low perception of effort, high trust and high perception of knowledge reuse added value. Additionally, people should have absorptive and retentive capacity of knowledge reuse practice, they should be familiar with knowledge reuse systems and tools, and finally should be motivated to reuse by performance gaps.

These requirements had a crucial role in the rest research steps. They were used as a basis for the analysis of the current situation in HMC Technology, and also as a basis for the development of the design requirements for the proposed improvement strategy.

2) Technology HMC: Assessment of the current explicit knowledge reuse

In the second research question, regarding the assessment of the current explicit knowledge reuse, three elements are contained. The first is the identification of improvement areas, the second is the importance of the factors that influence the reuse of explicit knowledge and the third is the development of the design requirements and guiding principles for the strategy to foster reuse of explicit knowledge in the Technology department of HMC.

Regarding the areas that a need for improvement is identified in the current situation, looking from technological, organizational and social perspectives, in all areas it was identified room for improvement. Looking from the perspective of the KR sub-processes, the major room for improvement was found on the "intention to reuse" KR sub-process. Additionally, it was encouraging that at that moment initiatives were found to be developed in Technology department, aiming to improve the technological aspect of "intention to reuse". Based on the analysis results and the improvement initiatives in Technology, it was indicated that the improvement strategy in HMC should focus on the social and organizational aspects of employee's intention to reuse explicit knowledge. Nevertheless, following the process management principle for making the design process to be the result of negotiation among the involved parties, the opinion of management was taken. Overall, it can be said that Technology management also identified room for improvement in the "intention to reuse" process. Moreover, it was encouraging to find out that there is no big difference between analysis findings and managements opinion regarding the improvement needed. Same was the case in the importance rating of factors that influence the reuse of explicit knowledge, where none of them was rated as unimportant either by the employees or the management.

Based on the results of the current situation assessment, the design requirements and guiding principles for the strategy to foster reuse of explicit knowledge in the Technology department of HMC were developed. To summarize, all requirements of intention to reuse was decided to serve as design requirements for the improvement strategy, except "Individual's values and norms" and "trust on knowledge". The first was excluded since it was indicated both by analysis and management that no improvement was needed in this area, and the second, because during the discussion with the Technology management it was found that there was already an initiative in place to increase employees' trust on knowledge. Furthermore, the principles that guide KMU project of HMC was decided to be taken as guiding principles for the design of the strategy, aiming to design a strategy that fits to Technology. The design requirements and guiding principles were summarized in table 12.

3) Technology HMC: Design of the strategy to foster intention to reuse

With the developed requirements and guiding principles to guide the design, the strategy to foster employees intention to reuse in HMC Technology was devised and evaluated, and is summarized in this section. Moreover, an implementation roadmap was developed for the strategy elements and is included also in the present conclusion.

The designed strategy to foster "intention to reuse" in HMC Technology, consists of three layers, namely the strategy foundations, the strategy layers and the strategy enablers. Considering the fundamental role of governance for the success of any KM strategy, it was decided to take the KM governance mechanisms as the foundations upon which the strategy was built. The governance mechanisms are management's commitment and leadership, allocation of roles and responsibilities, monitoring and strategy risk management. As levers of the strategy to foster employees intention to reuse were taken the people management practices communication, training formalization and recognition of knowledge reuse. Using elements from these levers, 5 KR initiatives were constructed, which are supported by specific governance mechanisms. The design was presented purposefully in the format of a pyramid, aiming to stress exactly the fact that the KR initiatives will successfully enable people's intention to

reuse explicit knowledge, only if they use people management levers' elements, and if they are supported by the KM governance foundations.

The KR initiatives and their elements are summarized in the pyramid top-view in figure X below, and next are briefly discussed.



Figure 35 - Top-view of the final strategy levers and enablers layers

The first KR enabling initiative aimed at the creation of knowledge reuse leaders within the project teams. This was achieved with the use of the KR Leadership Checklist. The checklist includes three categories of questions, namely "Direction Giving", "Meaning Making" and "Support" that aim to help Project and Specialist Engineers (P/SEs) keep track of their own knowledge reuse leading performance during the project workflow. Additionally, Microtraining sessions for the P/SEs on leading knowledge reuse through KR Leadership Checklist were proposed, aiming to help them develop in a sustainable way the desired leadership traits. Based on the KR Leadership Checklist categories, a series of 3 Microtraining sessions were proposed. Aiming to strengthen the leadership position of P/SEs in the project team it was recommended finally to certify them as knowledge practitioners by external certifying institutions.

The second KR enabling initiative aimed at the promotion of knowledge reuse practice and benefits. The latter was achieved with the KR Benefits Tree, which presents the benefits of KR for the individual, the project and the organization. In the Tree, the interconnections of the three layer benefits are also presented. Promotion of the knowledge reuse practice was achieved through KR success stories, which

provide employees with a tangible example of what knowledge assets are capable of, highlighting the value of knowledge reuse in practice. Finally, a KM logo was developed for HMC, aiming to remind the KR benefits and practice whenever it is seen by the employees.

The third KR enabling initiative aimed at the education of the project team members on knowledge reuse. For that reason, a flexible multi-layer training structure was constructed. This structure involves firstly the (Senior) Project or Specialist Engineers, who are responsible of mentoring all lower level engineers in their team. Additionally, the creation of "Buddy KR coaching" was proposed, aiming to create pairs where the experienced buddy is coaching the inexperienced employee, by organizing microtraining sessions for KR systems and sources in the company. Short training sessions on knowledge reuse sources and systems both for the newcomers in the company and the older employees was also proposed, aiming to increase their familiarity with the existing systems and sources. Finally, job rotation of employees was proposed, aiming to increase employees' eagerness to learn.

The fourth KR enabling initiative aimed at the recognition of knowledge reuse practice. This was achieved firstly through personal on the job informal praise of knowledge reuse. Secondly, it was proposed to link knowledge reuse to annual performance assessment of the employees, aiming to trigger their intention to reuse. Finally, it was proposed to empower employees, by assigning them the "Buddy coach" and "CoP leader" roles, aiming to recognize employees' performance on knowledge reuse.

Finally, the fifth KR enabling initiative aimed at facilitating the flow of knowledge in projects. For that reason a flowchart was created, which describes a process that should be followed, aiming to increase project team awareness of what knowledge is available for reuse and also to track knowledge flow in projects. Key element in this process is the "Knowledge Plan", which includes the indicated knowledge that should be reused per project deliverable. KR Audits were proposed to ensure that this knowledge is actually used while working on the project deliverables.

Overall, specific monitoring mechanisms and responsibilities were proposed for the governance of the above mentioned initiatives. The foundation of the design was strengthened by the proposition of a KM core team, which would ensure commitment and leadership on reuse and would manage the risks in the implementation of the strategy.

The final element that contributes to the answer of the third research question, is the implementation roadmap. It serves as a guideline for the Technology department on the implementation path of the strategy propositions. The roadmap was presented in a time-difficulty axes chart in figure 32, and categorizes the proposed changes in the strategy, in short-, medium-, and long term ones. In the short-term belong the changes that focus on creating or adapting tools and can be implemented almost immediately. In the mid-term belong the changes that focus on creating or adapting processes in the organization, and can be done in a time span of 3 to 6 months. Finally, in the long term phase belong the changes that are the results of culture development of people due to changes in the short or medium term, or require feedback from the monitoring mechanisms, and can be done in a minimum time span of 6 months.

4) PBOs: Practical implications based on the Technology HMC-case

In this last section, the value that can be extracted for the rest project based engineering organizations is summarized. The value of this research for the rest PBOs is limited to the "design construction knowledge" (Hevner, 2004), since the design artifact itself is specifically developed for the HMC case and thus has little value for the rest organizations. Moreover, some lessons learned from the improvement process that was followed in the HMC case can be derived.

The design construction knowledge that can be derived from this research, consists of three sequential approaches. The first is the generic explicit knowledge reuse improvement approach, which entails the identification and categorization of the factors that support or hinder reuse of explicit knowledge and their respective exploitation. The second approach is related to the analysis of the improvement areas in the current situation, and entails the use of desk research in the company's documents and a survey among the employees, aiming to cross examine the findings and thus obtain a clearer overview of the current situation. Thirdly, a three-layer design approach is employed for the desired improvement. The tree layers are the foundation (strategy governance), the levers (design attribute) and the enablers (KM initiatives) of the strategy for KM practices improvement.

Reflecting on the management on the improvement process, three lessons learned were presented. The first lesson is to sustain commitment of the involved parties, by creating an open decision making process. The second lesson is to preserve the core values of the involved parties, while the third is to create a sense of improvement progress, by focusing on quick wins improvements. Finally, a reflection on practical limitations for generalizing findings from HMC case were presented.

Main research question

The main research question of this thesis was: *What factors support or hinder explicit knowledge reuse in the front end development of projects, and how can project based organizations in the engineering domain exploit them aiming to improve value in projects during their front end development?* Based on the answers on the research sub-questions that presented in the previous sections, an answer can be formulated for the main research question and is presented below.

The identification and categorization of the factors that support or hinder reuse of explicit knowledge in the FED of projects should be done from an interdisciplinary point of view (technological, organizational, social) and per knowledge reuse sub-process. A successful exploitation strategy for these factors that will improve value in the FED of projects should be taken from an integrated point of view; the enablers of the knowledge reuse improvements should use elements from the strategy levers, and should be based on the strategy foundations. More specifically, the strategy to foster intention to reuse explicit knowledge in the FED of projects should include specific KR initiatives, namely "Lead reuse of knowledge in project teams", "Promote knowledge reuse practice and benefits", "Educate project team members", "Recognize reuse of knowledge", "Facilitate knowledge flow in projects". These initiatives should use elements from four people management practices, namely "Communication", "Training", Formalization" and "Recognition" of reuse. Finally, the strategy initiatives should be supported by the KM governance mechanisms Management commitment and leadership", "Allocated roles and responsibilities", "Management of strategy risks" and "Monitoring".

The improvement of explicit knowledge reuse should be an iterative process, rather than an implementation of an one shot solution. Finally, the design process of the explicit knowledge reuse improvement should be managed, aiming to cope with internal and/or external dynamics . Management of the process includes the creation of openness on the process and the results, and protection of involved parties' core values.

In the next section, a discussion follows regarding the validity of this answer, including reflections on the scientific and practical aim of this research.

11.2 Reflections

In sub-chapter 11.1, the answers on the research sub-questions were presented, based on which the answer to the main research question was derived. This section focus on the reflections of the thesis, and includes reflection on the adopted research approach and reflection on the research results. This section concludes with a personal reflection of the researcher.

Reflection on research approach

A general reflection on the practical implications of the adopted approach to design a knowledge reuse improvement strategy based on the HMC Technology case, was presented in chapter 10. This chapter focuses more on the reflection on the quality of the adopted research approach, and on how this could have been improved.

Reflecting on the complexity of the research topic, overall it can be said that much more research is conducted on the knowledge management processes of capturing, verifying and storing the captured knowledge, than on the processes of sharing and applying knowledge. In other words, the knowledge base for knowledge reuse theories was found to be lacking, and that complicated the process because there were less theories to underpin the research. The improvement approach of identifying and categorizing the supportive or hindering factors, and their relevant exploitation, contributed to lower complexity in the field.

Reflecting on the scope of the research, overall it is concluded that it was very ambitious. Even after the initial decision to focus only on the FED of projects rather than the whole project process, the scope was too broad to be addressed. Therefore, it was decided to focus only on the first KR sub-process; the "intention to reuse". Reflecting on the scoping decisions, the research could have been scoped differently, by focusing purely on the root causes of the explicit knowledge reuse problems and the possible causal relationships of the identified factors. Another way to scope down the research would be to focus on the rest KR sub-process, assess the initiatives that are taken by HMC and propose improvements on those initiatives. On the one hand this could improve the quality of the existing initiatives, but would have contributed less to the delineation of the overall improvement strategy in HMC. Finally, two thesis limitations should be mentioned. The first is the decision to exclude from the scope the "technology push" approaches to knowledge management. Including these approaches might have increased the scope of the research, but it would have contributed to a more integrated view on the knowledge reuse approaches. A second limitation of this thesis is the fact that project dynamics regarding reuse were not taken into account. Although, the KR Audits that proposed in the "Facilitate

knowledge flow in projects" initiative constitute a feedback loop to update the planned knowledge taking into account new information or demands from client, it is concluded that a lot more measures could have been taken to cope with the dynamics in the project process.

Regarding the choice and implementation of methods and techniques, a number of reflecting comments can be made. Focusing on the method to categorize the factors that support or hinder explicit knowledge reuse, it can be said that the knowledge reuse elements of Szulanski (2003), could be a third distinct categorization axis, rather than liking them with the knowledge management aspects. The result would be a 3-dimension map that would give a clearer overview of the factors. Regarding the identification of the factors, the literature research could have been extended, increasing in that way the possibilities to find additional factors. When reflecting on the methods that used in the assessment of the current situation, overall it can be said that the survey successfully protected the core values of the respondents and also gave the sense of urgency for the improvement needed. The desk research also seem to let issues emerge that were tied to the common practices of the employees and thus were difficult to arise. Nevertheless, more methods could have been used to strengthen the assessment results. The comments in the free text boxes of the survey, showed to the researcher that HMC employees are critical persons with creative ideas for improvement. The latter implies that some interviews additionally to the desk research and the survey could have been done, aiming for a clearer picture of the current situation and more insights on the improvement initiatives. Regarding the design methods, the engineering design techniques proposed by (Dieter & Schmidt, 2009; Dym & Little, 2009) were used. Reflecting on these techniques, they provided the researcher with a structured design approach. Nevertheless, the use of the House of Quality technique could have been used additionally to link the design requirements with the engineering characteristics, aiming for a clearer design process from the requirements till the concept selection. Finally, regarding the evaluation methods, overall it can be said that the decision to involve members of the Technology Engineering Management team was a good choice that gave to the management the sense that the improvement propositions are a result of negotiation. The latter increased the possibilities of design acceptance. Nevertheless, the number of semi-structured evaluation meetings is a limitation of this thesis. Involving more people in the improvement decision making process might have extended the research period, but it would have certainly improved the quality of the propositions.

At last, regarding the choice and implementation of scientific theories, overall it is concluded that Hevner's et al. (2004) design science research framework provided the researcher with a structured approach for the improvement, that resulted in a relevant and rigor research approach. Reflecting on the use of design science research framework, it can be said that more design-evaluation iterations could have been done aiming to increase the quality of the design. Furthermore, the use of process management principles to manage the research process, is concluded to be a useful theory for coping with research dynamics. It helped the researcher sustain involved parties' commitment to the improvement process, and to convince them stay on the improvement decision making table. Reflecting on the use of process management principles, more evaluative discussions of the design would have increased the sense that improvement propositions are the result of negotiation, resulting to broader acceptance of the design.

Reflection on research results

In this section a reflection on the research results is attempted. To be more specific, a reflection on the validity of the main research question answer on section 11.1 is attempted, and also a reflection on the practical and scientific goals that defined in sub-chapter 1.2 is presented.

The answer in the main research question was given in section 11.1, and in brief is the perspective of an improvement approach of the explicit knowledge reuse process. Following Hevner's et al. (2004) design science research framework, the research approach was rigorous, meaning that the research was based on solid theoretical basis using theories from the knowledge base. The relevance of the research is achieved by assessing the current situation in the environment under study based on a triangulation of methods. The improvement process within the environment was actively managed using process management principles. The design consists of propositions for improving the employees' intention to reuse in the HMC Technology environment. Reflecting on these propositions, their link to the current knowledge management upgrade program in the company could have been more explicit. Overall, the suggestions were evaluated and accepted by the Technology Engineering Management and was said to be a step forward in the organization and thus the practical aim is considered as achieved. Recalling the scientific aim of this thesis for a scientific categorization of knowledge reuse factors, an integrated point of view was proposed based on different theories. Additionally, an integrated perspective on the successful exploitation of these factors was proposed aiming to improve value in projects during their front end development.

Regarding the validity of the answer to the main research question, a rigorous research process it was followed in order to come up with the integrated perspective for identification, categorization and respective exploitation of knowledge reuse factors. Nevertheless, an important remark should be made at this point. The propositions are based on the single case of HMC. This fact limits the ability for generalization of findings. This remark aims to highlight once again the fact that the improvement process should be regarded more as a perspective rather than as a guideline for improvement. In order to be considered as a guideline for improvement, it should be considered for use in other project based engineering, aiming to verify its generalizability to other cases.

In addition to the future research for improving the scientific validity of the answer, some recommendations for future research are presented as a conclusion of this section. 1) Firstly, research is needed on exploiting the factors of the rest KR sub-processes based on the requirements that are developed in sub-chapter 5.7. 2) Second, research on fostering reuse of explicit knowledge through "technology push" knowledge management approaches is needed; these approaches were excluded from this thesis. 3) Finally, how reuse of knowledge will be sustained in the highly dynamic environment of project, is something that was not addressed sufficiently in this thesis and should be further researched.

Personal reflection

The reflection section is concluded with a personal reflection of the researcher. This research project was the second research initiative of the researcher, after the master thesis in the field of electrical engineering that was conducted in 2009. This minor research experience, made the research think in the early phases of the research project that it would be slightly easier to cope with the research dynamics. Nevertheless, this belief proved to be wrong, since a research in a company regarding people's attitudes and practices, is a totally different context than research in the laboratory regarding engineering improvements. Managing interactions with the research stakeholders, proved to be a much trickier task than expected.

Reflecting on the research topic, knowledge management is a broad topic, which was a relatively new to the researcher. That resulted to a significantly quick increase of the researcher's knowledge capacity on this scientific field. Overall, it turned out to be a very interesting research topic that taught the research to identify people's experiences as valuable knowledge assets that should continuously flow, aiming for societal development.

Finally, reflecting on the contribution of the acquired knowledge in the "Management of Technology" courses to the thesis, it can be said that they provided the researcher with the required resources to successfully execute the research project. A set of methods and theories that taught in the two years master program, turned out to be valuable solutions that assisted the researcher in the completion of the research project.

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***Note:** The appendixes can be found on the CD provided with the report.*