MASTER

Tailoring knowledge sharing using task characteristics
a case study in the maritime industry

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Tailoring knowledge sharing using task characteristics: a case study in the maritime industry

by

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Abstract

This research project focuses on testing eight design propositions and improving the knowledge sharing performance at several departments in the company. The design propositions focus on the link between task characteristics and two knowledge sharing strategies. The data provided evidence for six of the eight design propositions of which one was partially supported, two where fully supported, and three were not supported. The academic contribution of this research is the insights in the link between task characteristics and knowledge sharing strategies. The corporate contribution of this research is the advice how to improve their performance regarding knowledge management and knowledge sharing.
Management summary

Knowledge management is a management topic that has been emerging for the last few decennia. This topic focuses on a systematic process of managing two types of knowledge: explicit and tacit. Explicit knowledge exists outside the human mind and contains information that is generally accepted like theories, procedures, and manuals. Since it can be codified or recorded, it is easily shared and stored. Tacit knowledge exists within the human mind and contains experience, skills and attitude (Nonaka, 2000; Weggeman, 2006) which are shared through personal interaction.

Knowledge sharing is one activity in the umbrella term of knowledge management. This activity is focused on the sharing of both types of knowledge. Since there are two types of knowledge, there are also two knowledge sharing strategies: codification and personalization. Codification focuses on the sharing of explicit knowledge, extracting it from a knowledge carrier and making it available for other persons. Personalization focuses on the sharing of tacit knowledge through face-to-face situations like conversations, master-apprentice relationships, and workshops. Since it is unlikely that these strategies occur in isolation of each other (Hansen et al, 1999), there is likely to be a certain balance between them in every situation.

This research project focuses on the link between three task characteristics (frequency, heterogeneity, and causal ambiguity) of Zollo & Winter (2002) and the two knowledge sharing strategies. There are multiple situational factors affecting the preference for a certain knowledge sharing strategy like organizational culture (Janz & Prasamphanich, 2003; Lee & Choi, 2010), costs and benefits (Kankanhalli et al., 2005), and product maturity (Hass & Hansen, 2005). Zollo & Winter (2002) provided three hypotheses requiring testing on both knowledge sharing strategies. Since Hansen et al. (1999) provided a different view on task frequency, eight design propositions have been created as shown in table 1.

The next research question and research objective have been created in this project:

**Research question:**
How can knowledge sharing be tailored to task characteristics?

**Research objective:**
Provide the company with advice how to close the gap between the current situation of knowledge sharing (“ist”) and its requirements (“soll”).

The data for this research project has been gathered through questionnaires, interviews, and brainstorming sessions. Fifteen knowledge management scans have been collected providing information on the current (“ist”) situation of knowledge sharing in three departments of COMPANY X. Ten interviews have been conducted to gather evidence and test the eight design propositions. Three brainstorming sessions have been held to determine the required (“soll”) situation of knowledge sharing at the departments.

The test results of the design propositions are shown in table 1. Since there was only a small usage of the codification strategy, the corresponding design propositions were not supported, or only partially supported. Since knowledge was shared to reuse it, there was no evidence on the design propositions with regard to learning lessons. The two supported design
propositions show the use of personalization when a task looks similar in every occurrence or when the causal relationship between subtasks is clear.

<table>
<thead>
<tr>
<th>#</th>
<th>Design proposition (DP)</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>DP1</td>
<td>For high frequent tasks from which knowledge needs to be reused, a codification strategy is required in order to improve knowledge sharing.</td>
<td>Partially supported</td>
</tr>
<tr>
<td>DP2</td>
<td>For high frequent tasks from which lessons need to be learned, a personalization strategy is required in order to improve knowledge sharing.</td>
<td>No evidence</td>
</tr>
<tr>
<td>DP3</td>
<td>For low frequent tasks from which knowledge needs to be reused, a personalization strategy is required in order to improve knowledge sharing.</td>
<td>Not supported</td>
</tr>
<tr>
<td>DP4</td>
<td>For low frequent tasks from which lessons need to be learned, a codification strategy is required in order to improve knowledge sharing.</td>
<td>No evidence</td>
</tr>
<tr>
<td>DP5</td>
<td>For tasks with a high level of heterogeneity, a codification strategy is required in order to improve knowledge sharing.</td>
<td>Not supported</td>
</tr>
<tr>
<td>DP6</td>
<td>For tasks with a low level of heterogeneity, a personalization strategy is required in order to improve knowledge sharing.</td>
<td>Supported</td>
</tr>
<tr>
<td>DP7</td>
<td>For tasks with high causal ambiguity, a codification strategy is required in order to improve knowledge sharing.</td>
<td>Not supported</td>
</tr>
<tr>
<td>DP8</td>
<td>For tasks with low causal ambiguity, a personalization strategy is required in order to improve knowledge sharing.</td>
<td>Supported</td>
</tr>
</tbody>
</table>

The information from the questionnaires and brainstorm resulted in seven improvement points to close the gap between the current and required situation of knowledge sharing:

1. Promotion of knowledge management throughout the company
2. Clear corporate KM strategy
3. One knowledge sharing system for explicit knowledge
4. Employees rotation across departments to share implicit knowledge
5. Overview of required knowledge
6. Visible tacit and explicit knowledge
7. Errors and mistakes prevention

The first improvement point is pre-conditional in order to have a solid base for the other points. This pre-conditional improvement focuses on promotion, motivation, and stimulation of knowledge management by the top managers of COMPANY X.

Improvement points 2 to 4 are focused on corporate improvements. First, there needs to be a clear knowledge management strategy that is linked to corporate strategy of COMPANY X. Second, there needs to be one knowledge sharing system for explicit knowledge crossing all departmental boundaries. Third, there needs to be rotation of employees across departmental boundaries in order to improve the unity of the company and the sharing of tacit knowledge.

Improvement points 5 to 7 are focused on departmental improvements. First, there needs to be an overview of the required knowledge in the department. Combined with an overview of the available knowledge, the department is able to determine what knowledge is absent and needs to be developed or acquired. Second, tacit and explicit knowledge needs to be made visible. For the explicit knowledge, the corporate knowledge sharing system can be used. For the tacit knowledge, an extended yellow pages system needs to be developed and filled with information. Finally, there needs to be a solid system for the registration and prevention of mistakes and errors of which the solutions need to be available throughout the company.
Preface

This report is the result of a master thesis project, which was conducted as a partial fulfilment for the degree of Master of Science in Innovation Management at Eindhoven University of Technology. This project was executed in cooperation with COMPANY X, located in Location Y. In this preface, I would like to thank a couple of people who have made it possible for me to reach this point in my life.

First, I would like to thank my family. Without the love and material and immaterial support of my parents, grandparents and brother, it would have been hard, if not impossible, to reach this educational level.

From COMPANY X, I would like to thank Ralf van Beek, my company supervisor. He has been a great help during my project and provided well-founded criticism and feedback to improve my research and report. Second, I would like to thank Henk van Muijen, director of the department RESEARCH CENTER, for providing me with the opportunity to conduct my graduation project. His department offered me a challenging environment with many young and intelligent colleagues. Finally, I also would like to thank everybody of the RESEARCH CENTER department for the nice environment and the cosiness during coffee and lunch breaks.

From the university, I would like to thank Hans Berends, my primary supervisor, for his knowledge, and support during my project. After a slow start, we have had several meetings and discussions, which were very helpful for the progression of my project. Next to Hans, I also would like to thank Mathieu Weggeman, my second supervisor, for his time and feedback during my project. Additionally, I would like to thank him for all his published work, which created a solid base for this project.

Last but definitely not least, I would like to thank my dearest friends and especially Laura. She has supported me in the last few years, even though my time and devotion were focused heavily to my master study.

Finally, I would like to end this preface with a quote from Marcus Aurelius, emperor of Rome from 161 to 180 AC, whose name was occasionally given to me by my grandfather Guus Janssens. For me, this quote shows the required critical view for every researcher.

“Everything we hear is an opinion, not a fact. Everything we see is a perspective, not the truth.”

(Marcus Aurelius, 121-180)
List of abbreviations

BoD   Board of Directors
BU    Business Unit
CAD   Computer Aided Design
CB    PMC Custom
CB-D1 PMC Custom Department 1
CB-D2 PMC Custom Department 2
CBS   Centraal Bureau voor de Statistiek (Dutch central bureau for statistics)
COP   Community of Practice
D/BU Man. Department or Business Unit Management
DP    Design Proposition
Error com. Error committee
EVA   Ervaring (experience), Vaardigheid (skill) & Attitude
HR    Human Resources
HRM   Human Resource Management
IMS   Innovation Management Support
IT    Information Technology
IT spec. Information Technology specialist
KM    Knowledge Management
KM-scan Knowledge Management Scan
KPI   Key Performance Indicator
KS    Knowledge Sharing
PDM   Product Data Management
PG    Project Group
PMC   Product Markt Combinatie (product market combination)
SC    PMC Standard
SC-D1 PMC Standard Department 1
SC-D2 PMC Standard Department 2
SECI  Socialization Externalization Combination and Internalization
1 INTRODUCTION

In the post-industrial society, the common production factors labour, capital, and resources are shaded by a new, important production factor: knowledge (Weggeman, 2001). Knowledge, knowledge management, and knowledge sharing are topics that are recently gaining importance. This increase is not only due to the maturing of these research areas, but also because managers are signalling the importance of knowledge in the organization. Multiple researchers (Holsapple & Jones, 2004; Prusak, 1996; Ndofor & Levitas, 2004; Alavi & Leinder, 2001; Davenport & Prusak, 1998; Grover & Davenport, 2001) have indicated that knowledge is a critical resource for a company in order to become or stay competitive. Knowledge has even been characterized as more powerful than natural resources, big factories, or fat bankrolls (Stewart (1997) in Holsapple & Jones, 2004).

In order to make good use of the knowledge inside the organization, it is important to share it and make it accessible to the people in the organization who need it. Since knowledge can be split into two different types (explicit and tacit), there are also two different strategies to share knowledge (Hansen et al., 1999): codification and personalization. The codification strategy focuses on the sharing of explicit knowledge like theories, formula, procedures, manuals, drawings, etc (Weggeman, 2001). A personalization strategy focuses on the sharing of tacit knowledge like experiences, skills, and attitudes.

Besides the type of knowledge being shared, the choice for a certain knowledge sharing strategy is dependent on multiple situational factors. Some situations are more favourable for using a codification strategy where other situations require a personalization strategy. Putting it the other way around, a certain knowledge sharing strategy may require alignment of the situation in order to fit. Multiple researchers have provided general success factors on knowledge sharing (Hansen et al., 1999; Haas & Hansen, 2007; Kankanhatli et al, 2005; Cress & Kimmerle, 2008; Janz & Prasarnphanich, 2003; Reagans et al., 2005). Other researchers have focused on factors characterising the knowledge sharing strategies (Hansen et al., 1999; Haas & Hansen, 2005; Zollo & Winter, 2002; Lindkvist, 2005). This latter group of factors is important for management in order to determine the right knowledge sharing strategy for a given situation or vice versa.

In this thesis, the focus is on the customization or tailoring of knowledge sharing by using the next task characteristics from Zollo & Winter (2002): task frequency, task heterogeneity, and causal ambiguity. The academic interest for this project concerns the practical testing of proposed design propositions and elaborating on some inconsistencies in the academic literature. The design propositions are created by Zollo & Winter (2002) requiring empirical testing to support them. The inconsistencies focus on the knowledge sharing strategies for different task frequencies according to Zollo & Winter (2002) and Hansen et al. (1999). With the practical testing, an attempt is made to clarify these different views.

The practical environment for this project is COMPANY X, the leading company in the production of dredging and offshore ships. For this company, knowledge management is still at its infancy. However, knowledge management and knowledge sharing are gaining interest due to trends in the industry. Additionally, the company required to focus on knowledge management in order to complete their strategy goals. The results of this project provide the company with advice how to improve their knowledge sharing strategy and performance.

This master thesis is structured using the work of Aken et al. (2012). The methodology is focused on design-orientation, theory-information, and problem solving. Through design-orientation, the solution to the problem is found through design instead of ad hoc investigation. The scientific literature used for this project makes it theory-informed. By testing the design propositions and designing advice for improvement, the project also incorporates problem solving.
The knowledge-generating research process (Aken et al., 2012) used in this thesis is the reflective redesign (figure 1). This process is based on the problem-solving cycle (Appendix A) and reflective cycle (Appendix B). In figure 1, the red fields correspond to the parts of the reflective cycle and the blue fields correspond to the regulative cycle.

![Figure 1: Reflective redesign](image)

This master thesis is structured according to the research process of figure 1. The thesis starts with a review of the available academic literature on knowledge, knowledge sharing strategies and the task characteristics. The results from this review provide a base of known and unknown issues regarding knowledge sharing. In chapter 3, the business context at COMPANY X is explained. In this company, there is a struggle to determine and structure the implementation of knowledge management. Chapter 4 describes the research project including the problem definition and the research group. Additionally, the analysis and solution design process are introduced. Chapters 5 and 6 focus on collecting data from the practical environment and performing analyses. This information is used to analyse the current situation in the company and to test the theoretical design propositions. Chapter 7 focuses on the solution design through which advice is created to improve the current performance of knowledge sharing in the company. This design makes use of the results from chapter 5 and 6 and other information from the academic literature. Chapter 8 is the discussion section in which a broad look is taken at the findings and the project in total. This section provides the general conclusion of the project extended with an academic reflection, the limitations of the project and recommendations for future research.
2 THEORETICAL BACKGROUND

This chapter focuses on the first part of the reflective redesign. Academic literature is used to explain knowledge, knowledge management, knowledge sharing strategies, and the task characteristics link to these strategies. In the end a set of design propositions is stated, that are going to be tested and elaborated.

2.1 Knowledge and knowledge management

The definition of knowledge has been a topic of many debates since the classical Greek era (Alavi & Leidner, 1999). In the relevant literature, the following definitions of knowledge have been selected to provide some clarity.

“Knowledge is a justified personal belief that increases an individual’s capacity to take effective action” (Nonaka, 1994).

“Knowledge is the ability of a person to complete a task. This ability is dependent on information, experience, skills, and attitude” (Weggeman, 2001).

Knowledge can be split into two types: explicit knowledge and tacit knowledge (Nonaka et al, 2000; Weggeman, 2006). Explicit knowledge contains theories, formulae, procedures, schematics, drawings, manuals, data, and specifications that are available outside the human mind. All this knowledge can be processed, transmitted, shared, and stored rather easily. Weggeman (2006) calls this type of knowledge the I-part, referring to the information part of his knowledge definition. In contrast, implicit knowledge is dependent on the knowledge worker and contains experiences, skills, attitudes, insights, and intuitions (Nonaka, 2000). In the “knowledge function” of Weggeman (2006), this type is also called the EVA-part. EVA is the abbreviation of Ervaring (experience), Vaardigheid (skills), and Attitude.

Knowledge Management (KM) is a management topic regarding the management of knowledge. It is an old topic but emerging in the last 60 years. Because of its emerging characteristic, the definition of KM is not unilateral. In the academic literature, the definitions are diverse.

“Knowledge management is a systemic and organizationally specified process for acquiring, organizing, and communicating both tacit and explicit knowledge of employees so that other employees may make use of it to be more effective and productive in their work” (Alavi & Leidner, 1999).

“Knowledge management is an umbrella term which refers to any deliberate efforts to manage the knowledge of an organization’s workforce, which can be achieved via a wide range of methods” (Hislop, 2009).

Knowledge management concerns the ‘shaping and managing the processes of the Knowledge Value Chain in such a way that the efficiency and fun of knowledge is increased’ (Weggeman, 2006).

According to multiple articles, KM is (becoming) of major importance for companies. KM can be used as ‘a basis for competitiveness’ (Holsapple & Jones, 2004), offering ‘a competitive edge to an organization’ (Prusak, 1996), and ‘increase the intellectual capital of the organization’ (Alavi & Leidner, 2001; Davenport & Prusak, 1998; Grover & Davenport, 2001).
2.2 Knowledge sharing and KS strategies

Knowledge management is an umbrella term for different activities focused on the management of intellectual capital and knowledge (Hislop, 2009). Holsapple & Joshi (2002) reported on a Knowledge Chain Model containing five primary KM activities: acquisition, selection, generation, assimilation, and emission. Weggeman (2006) presents the Knowledge Value Chain as a schematic representation of the minimum set of activities that an organization needs to undertake in order to implement KM. The chain contains six consecutive processes: determining required knowledge, inventory available knowledge, knowledge development, knowledge sharing, knowledge application, and knowledge evaluation (figure 2). The activities from both models partially overlap although they use different definitions.

In organizations where tasks are being executed, knowledge is being developed or used. This can be called knowledge application according to Weggeman (2006). By executing this task, experience is gained and capabilities are likely to improve. This activity is called knowledge development (Weggeman, 2006). There is however one activity dividing the development of knowledge and the actual application of knowledge: knowledge sharing.

Knowledge sharing is, like KM, defined in different ways. Hansen (1999) has defined knowledge sharing as ‘the provision or receipt of task information, know how, and feedback on a product or a procedure’. According to Foss et al. (2010), knowledge sharing is designed ‘to transfer individual knowledge into organizational knowledge’. Multiple researchers have argued that knowledge sharing may lead to increased competitiveness through improved innovation capacity and absorptive capacity (Grant, 1996; Kogut & Zander, 1992). All the mentioned definitions and descriptions about knowledge sharing are closely related to the primary KM class ‘knowledge assimilation’ of the knowledge chain model of Holsapple & Singh (2000).

Knowledge sharing takes place in two ways, called codification and personalisation (Haas & Hansen, 2007). The SECI model of Nonaka et al. (2000) (figure 3) even provides four different activities to share knowledge. One is aimed at the sharing of tacit knowledge, which Nonaka et al. (2000) call socialisation. The other three activities (externalisation, connecting, and embodying) are aimed at sharing of explicit knowledge.
2.2.1 System-oriented knowledge sharing
If knowledge is stored, this implies it is extracted from a knowledge carrier (employee, person, and group) and made explicit. In this way, the stored knowledge is made available for other persons to use it. Through this indirect way of sharing knowledge, the receiver does not need to contact the provider of the knowledge but can use the codified knowledge as a stand-alone resource (Haas & Hansen, 2007). Hansen et al. (1999) call this the ‘person-to-document’ approach. In this approach, knowledge is extracted from the person who developed it. By making it independent of that person, it becomes possible to reuse the knowledge in different situations.

The knowledge sharing strategy that corresponds to this system-oriented (Choi & Lee, 2003) way of sharing knowledge, is also called codification (Hansen et al., 1999) or exploitation (March, 1991). For this project, the label of Hansen et al. will be used. When codifying knowledge, it should be noted that not all the attributes from knowledge, as defined by Weggeman (2001), are suitable to be shared in their explicit form. It is most likely that information and best practice guidelines (experience) are suitable for codification.

2.2.2 Human-oriented knowledge sharing
If knowledge is distributed between people directly, this so-called tacit knowledge is shared from one knowledge carrier to the other without codification. Hansen et al. (1999) call this the ‘person-to-person’ approach. The dialogue between individuals offers the possibility to share knowledge that is not (able to be) codified. Brainstorming sessions, workshops, and conversations are examples of face-to-face situations where tacit knowledge is being shared.

The knowledge sharing strategy that corresponds to this human-oriented (Choi & Lee, 2003) way of sharing knowledge, is also called personalization (Hansen et al., 1999) or exploration (March, 1991). For this project, again the label of Hansen et al. will be used. From the dimensions of Weggeman (2001), skills, attitude, and personal experiences can be shared through personalization because of their tacit form.

2.2.3 The balance between KM strategies
Both knowledge sharing approaches and their strategies have their advantages and disadvantages and are unlikely to take place in isolation of each other (Hansen et al., 1999). For instance, codification takes time and effort but makes the knowledge suitable for generalization and application in other areas. On the other hand, personalization is a quicker method as people can talk directly to each other making sure the knowledge is shared and understood correctly. However, ambiguity is difficult to be solved using personalization where codification can resolve this issue (Zollo & Winter, 2002).

Haas & Hansen (2007) stated that companies with a personalization strategy use electronic document systems to support people by providing background information and putting them in contact with each other. It is however also possible to transfer tacit knowledge using technologies like telephone calls, e-mails, and videoconferences. In this way there seems to be a certain balance between the two
strategies. According to Hansen et al. (1999), this balance should be 80-20 in which 80% of the knowledge sharing takes place by one strategy and the remaining 20% by the other knowledge sharing strategy. This indicates the secondary strategy is used to support the primary strategy. Choi & Lee (2003) try to seek the right balance and do not presume a fixed ratio between them.

2.3 Situational factors
The choice for a certain knowledge sharing strategy is not straightforward for every situation. It is important for management to know which strategy is beneficial for a certain organizational, environmental, production, and social situation. This importance is twofold. First, if the organization has chosen a primary knowledge sharing strategy, the organization needs to know which situational factors make the strategy work. Second, if for any reason the organization has not made an explicit choice for a strategy, the situational factors could be used to determine which strategy fits best with the situational factors at hand.

By studying the literature about knowledge sharing, there are multiple factors that are important for knowledge sharing in general. Janz & Prasarnphanich (2003) and Lee & Choi (2010) found that organizational culture is a factor that positively affects knowledge sharing in an organization. Kankanhalli et al. (2005) provided two other factors affecting knowledge sharing which are costs and benefits. When knowledge is being shared, whether codified or personalized, this process takes time and effort, which cannot be used for alternative activities (incurred costs). However, a reward system motivates employees, under some conditions, to share knowledge and return for benefits. The management of knowledge workers (Lee & Choi, 2010) is also an important factor for knowledge sharing in general since this encompasses human resource management to gather the right employees and provide favourable working conditions. Other factors that are (theoretically) related to knowledge-sharing strategies are product type (Hansen, Nohria, & Tierney, 1999), product maturity (Haas & Hansen, 2005), task frequency (Zollo & Winter, 2002), and group cohesion (Lindkvist, 2005).

2.4 Task characteristics
This thesis focuses on three task characteristics of Zollo & Winter (2002). They investigated the role of tacit and explicit knowledge sharing mechanisms through which organizations develop dynamic capabilities. Prencipe & Tell (2001) focused on the inter-project learning according to the learning processes of Zollo & Winter (2002) and provided three different learning landscapes. This leaves the hypotheses from Zollo & Winter (2002) on the next three task features untested: frequency, heterogeneity, and causal ambiguity. The hypotheses state a relationship between the three task characteristics and knowledge sharing strategies. These task characteristics are explained in the next sections.

2.4.1 Task frequency
Task frequency is a factor, which is likely to be different for every task that is being performed. For instance, the sharing of knowledge from high frequent tasks is likely to be linked to one knowledge sharing strategy. For low frequent tasks, knowledge is then shared according to the other strategy.

The articles by Hansen et al. (1999) and Zollo & Winter (2002) both elaborate on this factor. Because knowledge management is a relatively young practice, there are no clear guidelines for executives how to manage knowledge. Hansen, Nohria, and Tierney (1999) try to fill this gap by studying knowledge management practices of several industries. Most of the information has been found in practices from consultancy firms because they heavily rely on knowledge management. Zollo & Winter (2002) also performed a non-empirical study but on a different use of knowledge management. They looked at mechanisms through which organizations develop dynamic capabilities and how the task characteristics frequency, heterogeneity, and causal ambiguity are affecting this development. Their view on task frequency is to learn from the transferred knowledge. It can be hypothesized that in this situation the preferred strategy for sharing knowledge is different compared to the situation of reusing knowledge. From their work, Zollo & Winter (2002) provided a couple of testable hypotheses for future work.
Both articles focus on frequency levels of tasks. However, they differ in the reason why a certain strategy needs to be used for a given frequency level. The main difference is found in the static or dynamic behaviour of the knowledge being shared. When knowledge is being shared in order to reuse it, the knowledge itself in this situation is being regarded as static. The receiver gets this knowledge for the first time and will reuse it without altering it. On the other hand, when knowledge is being shared in order to learn from it, the receiver will combine this knowledge with already known knowledge, making the behaviour dynamic. In this way, it becomes possible to change present knowledge or created new knowledge. In order to explain the differences in the work of Zollo & Winter (2002) and Hansen et al (1999), both frequency levels will be addressed separately to provide some clarity in these two-sided views on task frequency.

**High Task frequency**
According to Hansen et al. (1999), the knowledge from high frequent tasks needs to be codified. High frequent tasks are likely to be standardized tasks of which most information is present among the employees. In order to make sure that all the employees execute the task similarly and according to best practices, this knowledge needs to be made explicit and available to use. In this way, it becomes possible for new employees to get all the codified knowledge, get familiar with the procedures, and reuse all this knowledge in practice. For the codification of knowledge at high task frequencies, it can be hypothesized that the reason for the sharing is to reuse standard knowledge and make it available for all employees.

However, knowledge of high frequent tasks can also be shared through personalization. Zollo & Winter (2002) state it is impossible to codify all relevant knowledge from high frequent jobs. It takes too much time and effort from the employees resulting in less work being performed. However, the reason to share knowledge, according to Zollo & Winter (2002), is to learn and not to reuse by somebody else who does not possess the knowledge yet. If the personalization strategy is used, employees are able to share the knowledge, do not lose too much time on the sharing process and still learn lessons and improve the overall knowledge and capabilities. For the personalization of knowledge at high task frequencies, it can be hypothesized that the main reason for the sharing is to quickly exchange experiences, learn lessons, and improve capabilities.

From the work of Hansen et al. (1999) and Zollo & Winter (2002), it becomes possible to formulate design propositions. The structure of these design propositions is based on the work of Romme & Endenburg (2006) and Denyer et al. (2008).

**Design proposition 1**
For high frequent tasks from which knowledge needs to be reused, a codification strategy is required in order to improve knowledge sharing.

**Design proposition 2**
For high frequent tasks from which lessons need to be learned, a personalization strategy is required in order to improve knowledge sharing.

**Low task frequency**
According to Zollo & Winter (2002), it is most favourable for the codification strategy to have low task frequencies. The human brain has limited capabilities. These capabilities can be extended by externalizing the knowledge from the contributor and storing it in a knowledge repository. Furthermore, because of the low frequency, there is enough time to codify knowledge for storage but also to learn from them, combining it with other knowledge and keep on evolving the dynamic capabilities (Zollo & Winter, 2002). For the codification of knowledge at low task frequencies, it can be hypothesized that the reason for sharing is to learn lessons and improve skills.
For Hansen et al. (1999) there is a clear reason why knowledge from low frequent tasks not to be codified. Customized products and services are likely to contain low frequent tasks. For this customization, the experts share their knowledge through personalization. This process demands new or creative solutions, which are not likely to be present in codified knowledge. Through personalization, some of the expert knowledge is being shared and combined in order to come up with the solution to the specific problem. For the personalization of knowledge at low task frequency, it can be hypothesized that the reason for sharing is to reuse knowledge of the expert but share it to create customized solutions.

For low frequencies, the design propositions can be formulated as follows:

<table>
<thead>
<tr>
<th>Design proposition 3</th>
<th>For low frequent tasks from which knowledge needs to be reused, a personalization strategy is required in order to improve knowledge sharing.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design proposition 4</td>
<td>For low frequent tasks from which lessons need to be learned, a codification strategy is required in order to improve knowledge sharing.</td>
</tr>
</tbody>
</table>

Since design proposition (DP) 1 to 4 look very similar, the next table is added in order to provide a clearer overview about their differences.

<table>
<thead>
<tr>
<th>Table 2: Overview of design propositions 1 - 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High frequency</strong></td>
</tr>
<tr>
<td>Reusing</td>
</tr>
<tr>
<td>Learning lessons</td>
</tr>
</tbody>
</table>

### 2.4.2 Task heterogeneity

Heterogeneity is the variance in the characteristics of a task as they present themselves in different situations. The level of heterogeneity has an impact on the ability of individuals to judge whether experiences on past situations are applicable for the task (Zollo & Winter, 2002).

When the characteristics of a task are very different compared to previous tasks (heterogeneity is high), it is hard to make inferences about the applicability of the lessons learned from experiences. When heterogeneity increases, it becomes difficult to make inferences, and generalizations become inappropriate. Under task conditions of higher heterogeneity, knowledge sharing should be done through the codification strategy (Zollo & Winter, 2002). By using this strategy, it becomes possible to uncover interdependencies between the dimensions of heterogeneity and the action-performance relationships.

Low heterogeneity means that the characteristics of a task look similar to those in other situations. Since the employee is able to reuse experiences from previous tasks, there is no need to codify the knowledge and experience but share them through personalization (Zollo & Winter, 2002). There are fewer difficulties to make inferences and to generalize knowledge. It is again hard to imagine how personalization can be used for both tasks with low heterogeneity, and customized tasks as stated by Hansen et al (1999). However, if an employee is able to see how experiences and knowledge from another project can be reused in a new customized project, this indicates both low heterogeneity and customization. Customization is unlikely to use very extensive explicit knowledge and low heterogeneity does not need to be codified in order to be understood.

The following two design propositions, based on the work of Zollo & Winter (2002), require testing in a practical environment.
Design proposition 5
For tasks with a high level of heterogeneity, a codification strategy is required in order to improve knowledge sharing.

Design proposition 6
For tasks with a low level of heterogeneity, a personalization strategy is required in order to improve knowledge sharing.

2.4.3 Causal ambiguity
The level of ambiguity in the causal relationship between actions and performance is called causal ambiguity (Zollo & Winter, 2002). The number of subtasks and interdependence among subtasks are important factors influencing the performance. If there are a high number of subtasks and changes are made during the process, it is likely that the implications of this change for the result are unclear. The same also accounts for a complex interdependency. Zollo & Winter (2002) state these two factors are the most important ones for determining the level of complexity, which leads to causal ambiguity. The third factor affecting causal ambiguity is the degree of simultaneity among the subtasks. Tasks that are performed sequentially are easier to manage and the consequences of a change in one subtask are easier to track in subsequent subtasks.

With the codification strategy, the organization is able to share knowledge from tasks with a high level of causal ambiguity (Zollo & Winter, 2002). In this situation, it is hard for employees to find cause-effect relation making it hard to learn and reuse the experience and knowledge. By codifying knowledge and information from tasks with a high level of causal ambiguity, it becomes possible to determine causal relationship better by reusing lessons learned from previous experiences. It can be hypothesized that in this way the veil of ambiguity can be penetrated and adjustments to routines be facilitated. Although the costs for this codification are higher compared to the personalization strategy, in order to learn and reduce ambiguity these costs are justifiable (Zollo & Winter, 2002).

If the cause-effect relation between actions and performance are very clear, there is no need to use codification (Zollo & Winter, 2002). In this situation, where causal ambiguity is low, individuals are able to understand and communicate the effects of certain actions on performance. This clear relationship can be created by a low amount of subtasks, a simple interdependence between the subtasks, and by performing subtasks sequential as much as possible. There is no need to incur high costs for the codification of knowledge since knowledge and information is transferred easily between employees directly.

The following two design propositions, based on the work of Zollo & Winter (2002), require testing in a practical environment.

Design proposition 7
For tasks with high causal ambiguity, a codification strategy is required in order to improve knowledge sharing.

Design proposition 8
For tasks with low causal ambiguity, a personalization strategy is required in order to improve knowledge sharing.

2.5 Testing the design propositions
The testing of the design propositions can provide an interesting addition to the academic literature. The results from this research can be used as an addition to the already known factors influencing the choice for one of the two knowledge sharing strategies.
In order to test the design propositions, information needs to be gathered about task characteristics and knowledge sharing strategies. Some of this information will be directly available and known in the research context. However, some information may be unknown to the research context. For instance, there may be situations in which there is no explicit choice for a knowledge sharing strategy. In these situations, more in-depth information needs to be gathered to find out which underlying mechanisms are being used to share knowledge. These mechanisms can refer to one or both of the knowledge management strategies.

By carefully choosing the research context, the usefulness of the gathered information can be impacted. For instance, if the context is primarily focused on one knowledge sharing strategy, it is likely that not enough information is gathered about the other strategy. Furthermore, if task characteristics are very similar in the research context, it is likely that it is hard to test the proposed links between task characteristics and knowledge sharing strategies. Therefore, the context needs to provide enough diverse information to test the design propositions for both strategies and all the used task characteristics in the previous sections.

After gathering all the information about the task characteristics and knowledge sharing strategies, the analysis will take place. This analysis is aimed at providing an overview of the link between the task characteristics and knowledge sharing strategies in the practical environment. Next, the analysis is extended by taking into consideration the design propositions and determining whether they are in line with the practical evidence.

### 2.6 Using the Integral Organizational Model

For the analysis and solution design of this research, the Integral Organizational Model of Weggeman (1985) will be used (Appendix C). The core of the model is titled ‘organize’ and based on the 7s-model of Athos & Pascale (1981) and Peters & Waterman (1982). This 7s-model contains seven design variables (all starting with an ‘s’) used to determine the performance of an organization. In order to link the organization to the environment, it is extended with a ‘formulate’-part focused on the mission, vision and objectives of the organization. Additionally, the core is also extended with a ‘realize’-part to analyse and (re)design the organization. Subsequently, the three parts are elaborated in more detail.

The ‘formulate’-part of the model contains the mission, vision and objectives of the organization. The mission provides an answer to the question why the existence and survival of the company is important. This provides an overview of what the organization and its employees want to contribute to the environment and each other. The vision is in line with the corporate mission and provides a long-term perspective on what the organization wants to achieve. The objective provides an answer on what needs to be achieved at what moment in time.

The ‘organize’-part of the model provides an answer to the question how the organization needs to be organized given a certain objective. This part is primarily linked to the ‘formulate’-part by the design variable ‘strategy’. The strategy provides the answer how to achieve the formulated objectives. Since this link is dependent on the management style in the organization, this design variable is also placed in the overlap between the two parts of the model. The other design variables in this part of the model are focused on the division and coordination of work and responsibilities (‘structure’), the control and facilitation of daily work (‘systems’), the employees (‘personnel’), and the common values of the organization (‘culture’).

The ‘realize’-part of the model contains the primary and secondary processes of the organization (Weggeman, 2006). This part needs to provide an answer to the question how work activities or processes need to be executed with the preset objectives and organization.
3 PRACTICAL BACKGROUND

This chapter is focused on the practical environment for this research project: COMPANY X. This company provided the possibility to use their environment to practically test the design propositions concerning knowledge management strategies and task characteristics. This section focuses on the second part of the reflective redesign and provides information about the Dutch maritime industry, the company, and its organizational structure including information about their link to knowledge management.

3.1 The Dutch maritime industry

The Dutch maritime sector has been developing strongly in the past 50 years. According to Beunen & Hoekema (2009), who based their work on data from CBS, the interest of the Dutch shipbuilding industry is growing in Europe. About 12% of the European turnover in shipbuilding industry was generated by Dutch companies. The Dutch market share for the production of professional vessels in Europe has increased from 7% in 2000 to 14% in 2008. For specialized vessels for dredging and offshore activities, Dutch companies are the market leaders accounting for 80% of the European market.

Companies in the maritime industry are, like many other companies, dependent on different trends in the world economy, the labour market, and their own sector (Beelen, et al., 2011). Organizations that are not able to effectively handle these trends are likely to lose their role in the global market. At the same time, these trends offer opportunities to organizations that are able to respond effectively. The next sections provide a grasp of the relevant trends and opportunities for the maritime industry in the Netherlands.

3.1.1 Trends

The first trend is focused on the switch from production-focus to project-focus. In the mid of the previous century the focus was primarily on the in-house production of similar ships repeatedly. Due to the worldwide recession in 1987, this focus was shifted. Because of these developments, the industry changed from a primary labour-intensive industry into an industry that is both labour-intensive and knowledge-intensive. For Dutch shipbuilding companies, the knowledge-intensive work is primarily located in The Netherlands where most of the labour-intensive work takes place abroad.

Another trend in the maritime sector is the ageing of employees. This trend can result in the loss of knowledge and therefore also information, experience, and skills. The expectations are that through retirement of 25% of the oldest employees about 50% of the tacit knowledge in the maritime sector is going to be lost. Through knowledge storing and knowledge sharing, this threat could be minimized.

The continuous demand for innovations is also a trend in the maritime sector. This results in innovative vessels and technologies that can be used under tougher circumstances. Also environmental and safety regulations push industries to keep on developing and innovating. Through the development of new knowledge and effectively using this knowledge, the shift in regulations and demands can be addressed.

Active participation on the international level is also a common trend in the maritime sector. Due to emerging economies and developing countries, some labour-intensive activities have been lost to companies abroad. The internationalisation also brought opportunities to the sector. Major players in the sector have partnerships through which all the advantages of foreign countries are combined with their own innovative power. With regard to knowledge, the focus is on effective (knowledge) management and preventing the loss of knowledge.

Other relevant trends for the maritime sector are the competition for talented personnel, low availability of technically educated personnel, and the development of IT and internet (Beelen, et al., 2011).
3.1.2 Opportunities
For companies involved in the production of tangible products, it seems to be very hard to learn from things that went wrong. The detection of errors can only occur after the completion and sometimes the use of the product. By tracking errors or faults in all parts of the product, these parts can be improved in the future. In addition, successful products and processes are not tracked making it hard to replicate the used procedures. The systematic capturing, using, and evaluation of lessons learned can improve both the processes and products.

Many different IT-systems (like repositories, Wiki’s and forums) can be used to manage explicit knowledge. The choice for a certain system is however dependent on its purpose and how it needs to be used and accepted. When the need for a knowledge management system is detected, top management needs to dictate the required investment and the users need to be offered participation in the creation of the actual system.

Sometimes it is impossible or undesirable to store all relevant knowledge in a knowledge management system. In these situations, it becomes important to know where certain knowledge is residing inside the company. In larger organizations, it can be very hard to find the right person with the answer to a specific question. This issue can be solved by using a system based on transactive memory and yellow pages. A transactive memory system is based on individual knowledge combined with information regarding domains and expertises of colleagues (answering the question: Who knows what?) (Wegnet et al., 1985). The yellow pages system provides information about persons and not the knowledge they poses (answering the question: Who is who?).

3.2 COMPANY X
COMPANY X is a Dutch company with a rich history in dredging and shipbuilding and is the global market leader in the dredging sector. COMPANY X was a partnership, started during the Second World War, between multiple shipyards. After hitting rough weather of the worldwide recession in 1987, many organizational changes occurred. In 2005, COMPANY X and shipyard Y joined forces by forming COMPANY X Y BV which later adopted the name COMPANY X.

Currently COMPANY X is focussed on the continuous development of design and construction activities for the specialist maritime sector. The company has in-house expertise for engineering and manufacturing innovative vessels and advanced equipment, as well as providing life-cycle support. Their customer base is broad including dredging operators, oil and gas corporations, offshore contractors, and government authorities.

3.2.1 Strategies
According to the COMPANY X Annual Report of 2010, there are four strategic priorities within the company; internationalisation, growth, product and process development, and cooperation.

Internationalisation
COMPANY X has based 400 employees outside The Netherlands and is producing several standardized products in low-cost countries. Some of the products are complex and custom-built which requires the resources and knowledge that are situated at the Dutch COMPANY X Shipyards.

Growth
According to COMPANY X, larger companies are better able to cope with difficult financial times. The company wants to grow by offering new products or higher volumes of standard products. This growth is being generated by acquisitions of companies that fit with the corporate profiles and the investment in property, plant, and equipment.
**Product and process development**
The importance of product and process development has increased in 2011. Life-cycle support will continue to be a priority. COMPANY X aims to continually improve its processes, particularly with regard to production, engineering, and supply chain management.

**Cooperation**
Strong relationships are important for COMPANY X (Annual Report 2010). Internal cooperation is a challenge in order to create innovative vessels and advanced equipment. Through this cooperation, COMPANY X is able to grow and use available knowledge to generate market opportunities and technological developments.

3.2.2 **Organizational structure**
COMPANY X is a company that consists of multiple dependent and independent business units. Figure 4 shows an organizational chart of the company. This relatively new organizational structure has been developed in order to put more focus on the products within COMPANY X.

![Figure 4: Organizational chart of COMPANY X](image)

The production of a new ship can be displayed using figure 5. The figure shows the different groups involved in the production of Product B, which is a dredging vessel. The whole process is initiated at the sales department for dredging vessels. After designing, engineering, production and testing, the product is delivered to the customer.

![Figure 5: Development cycle of Product B](image)

3.3 **Knowledge management relevance**

3.3.1 **The strategic importance**
The success of the strategies of COMPANY X is, among other factors, dependent on the focus on knowledge management supporting the corporate strategies. In addition, the vision of being a technology innovator can be supported by a focus on knowledge management. Finally, the key
performance indicators (KPI) need to be in line with the strategies of COMPANY X including supporting activities like knowledge management. The next sections will elaborate on this.

Internationalisation has some constraints that need to be overcome in order to be successful. Besides language constraints, there are also the problems of different time zones over the world and geographical distances between employees. By using new IT developments like wiki-systems and online documenting, these constraints can be overcome and information and knowledge can be codified, stored, and reused across time and space. Computer-mediated communication (Song, Berends, Bij & Weggeman, 2007) is one of the technology developments helping the constraints related to knowledge management.

Growth is, among other factors, dependent on the cost of products and the available knowledge. Darroch (2005) shows that not the external market prices and costs signals but the internal processes and insights influence the growth of a firm. The internal processes are surrounded with uncertainty since decision makers have insufficient information and knowledge available. While knowledge can be regarded as a resource on its own, the management of knowledge can affect the quality of the decisions making process. This also affects the growth of a company.

By using Plessis (2007), cooperation can also be called collaboration for which knowledge management is a vital enabler. Through collaboration, knowledge sharing communities can be formed. These communities can exist within and across organizational boundaries and can work together to achieve shared business objectives. Through strong relationships within the community, a greater amount of tacit knowledge will be shared (Plessis, 2007). The development of explicit knowledge will enable the possibility for this tacit knowledge to be re-used in different contexts. Also for this codification part, knowledge management plays a crucial role.

Knowledge management also contributes heavily to innovation. According to Plessis (2007), there are three drivers why knowledge management can be applied to innovation: (1) to create, build and maintain the competitive advantage, (2) to reduce complexity in the innovation process and (3) to integrate both internal and external knowledge to the organization, making it available and accessible.

COMPANY X is not yet using KPIs to measure the performance with regard to the strategies and vision. In order to increase the focus on knowledge management, future KPIs need to incorporate the outcomes of knowledge management activities.

3.3.2 Structured KM activities at RESEARCH CENTER

RESEARCH CENTER, the knowledge centre of COMPANY X, is one of the few departments where knowledge management is applied. For the rest of COMPANY X, knowledge management is still at its infancy. There are no clearly structured strategies or activities aimed at managing the knowledge inside the company. At RESEARCH CENTER, pilot projects are running focussing on knowledge management. These knowledge management projects are focused on master-apprentice combinations, the use of a knowledge repository, a yellow pages system, and a social network community. The objective of these projects is to retain the existing knowledge and to develop new knowledge. The strategy is to stimulate internal knowledge sharing between employees and to foster the transfer of knowledge between R&D and product development departments.

Another knowledge management project in which RESEARCH CENTER is participating is called integral collaboration (Integraal Samenwerken) in which knowledge management practices are shared and structured together with several companies in the region.
4 PROJECT DESCRIPTION

In this chapter, information is provided on the project that was executed. First of all, the problem is defined using the gap in the academic literature and combining it with the interests of the company. This results in a research question with two sub questions and a research objective with two sub objectives. Afterwards the research group is determined and the methods for data collection and analysis are elaborated. Finally, the focus is shifted to the different parts of the reflective redesign process.

4.1 Problem definition

As shown in the previous two chapters, research was required on knowledge sharing for both the academic literature and COMPANY X. The academic literature showed a gap in the link between task characteristics and strategies for knowledge sharing. Some of these links lacked practical evidence. Other links provided ambiguous theoretical explanations, requiring testing in order to provide clarity. The following research question was formulated to provide answers to the academic literature:

Research question:
How can knowledge sharing be tailored to task characteristics?

In order to answer this question, the next to sub questions were created:

Sub question 1:
What is the current situation of knowledge sharing at COMPANY X?

Sub question 2:
How are task characteristics linked to strategies for knowledge sharing?

The answer to the first sub question needed to provide a starting point for the research project and in particularly for the advice to the company. The answers to the second sub question needed to provide information about the different task characteristics and the used knowledge sharing strategy. In case of an unknown knowledge sharing strategy, the underlying mechanisms needed to be investigated. These mechanisms are related to the knowledge sharing strategies and the task characteristics.

At the company, there was no overview of the status and requirements of knowledge sharing. Most of the units within the company lacked structured strategies and policies on knowledge management and knowledge sharing. The following research objective was formulated in order to help the company to improve their knowledge sharing performance:

Research objective:
Provide the company with advice how to close the gap between the current situation of knowledge sharing ("ist") and its requirements ("soll").

In order to solve this objective, the next to sub objectives have been created:

Sub objective 1:
Determine the requirements of knowledge sharing at the involved departments of COMPANY X.

Sub objective 2:
Design the advice according to the requirements by using results from the problem analysis and other (situational) factors that are linked to knowledge sharing.
The information from this first objective needed to provide an overview of the requirements for knowledge sharing at the departments. By answering sub question 1 and sub objective 1, the status of knowledge sharing (“ist”) and its requirements (“soll”) could be determined. Sub objective 2 focused on the advice that needed to be designed to close the gap. The link between task characteristics and sharing strategies provided one part of the advice. However, there are also other factors that needed to be considered in order to complete the design according to its requirements.

The research question is focused on the problem analyses of the reflective redesign process (blue part in figure 6) where the research objective is focused on the solution design of this research process (green part in figure 6). The results from the problem analyses are reused in the solution design of the project.

![Figure 6: Reflective redesign](image)

### 4.2 Research group

Within COMPANY X, there were multiple PMCs that could be involved in the research. For most of these PMCs, there was no clear overview of their activities in knowledge sharing. However, in order to test the relation between task characteristics and strategies for knowledge sharing, there needed to be clear differences in the research group.

First, the choice was made to use two PMCs by considering the type of product being designed and delivered. Hansen et al. (1999) state standard products use a different knowledge sharing strategy compared to customized products. The standardized Product A series (figure 7) from the PMC Standard (figure 4) was considered to be the most standard product of the company. Product B (figure 8) from the PMC Custom was considered to be the most customized product of the company. With these two products, it was estimated to have large differences in the knowledge sharing strategies.

![Figure 7: Product A](image) ![Figure 8: Product B](image)

By considering these two vessels, the research group was chosen in more detail. For a standardized product, like Product A, it was assumed that the multiple disciplines within this PMC’s were primarily characterized by the use of standardized and explicit knowledge. For a custom-built product, like Product B, it was assumed that most of the disciplines are characterized by tacit knowledge. These assumptions were tested by conducting several interviews with employees from both PMC’s.

For this research project, only two consecutive departments of the PMCs were investigated instead of all the departments in the product development process. This was done due to time constraints and to
narrow down the focus group. In this way, attention was focused on knowledge sharing within and across departments. Departments like sales and production were not considered since they were not controlled by the PMCs. This left Department 1 and Department 2 as the best options for the project. The latter department is, according to the organizational chart (figure 4), a shared resource, and not part of the PMC. However, these two departments were the best pair for this research group and primarily controlled by the PMCs. Additionally, this research provided insight into the knowledge sharing between departments inside and outside the PMC.

Two interviews were conducted to estimate the differences in task characteristics and knowledge-sharing strategies between the PMC Standard and PMC Custom. For the PMC Standard, both departments scored high on task frequency, low on task heterogeneity, average on causal ambiguity and used the two knowledge sharing strategies equally. For the PMC Custom, both department scored low on frequency, high on heterogeneity and causal ambiguity and personalization is the used knowledge sharing strategy. Although the sample size for this estimation is small, the interviews still provided some clear differences inside the research group. When considering the three task characteristics (including the subdivision at task frequency), it is theoretically possible to create 16 different combinations. This research group only accounted for a limited set of combinations, which limited the eventual results of this research.

4.3 Problem analysis

4.3.1 Data collection

The method for the collection of data is dependent in multiple dimensions (Blumberg et al., 2008). Since there was no historical data available to answer the research question for this project, the information needed to be gathered through interrogation and communication like interviews and questionnaires.

It was important to have a good structure during the interviews to make the results comparable. By using a semi-structure interview style, the conversations were guided to get answers to the preset questions. At the same time, this style kept enough freedom for the interviewees to add additional information. These additional results could provide interesting information that was relevant to the project. By making sure the structure of both the scans and interviews stayed the same, it was possible to analyse the results easily.

From every department three employees (management, senior, and medior) were involved in this project. By involving three employees, it was possible to compare the results from the interviews by triangulation. Additionally, in order to make the research project representative for the department, the employees originated from different levels. Appendix D shows the actual research group.

Data collection for sub question 1

In order to answer the first sub question, data was collected by using questions from the KM-scan of Weggeman (2001). Appendix E shows the form containing all the questions regarding knowledge sharing. These questions are supplemented with some general questions on the other activities of the Knowledge Value Chain (Weggeman, 2006) and the Integral Organizational Model (Weggeman, 1985). In total 15 KM-scans have been send and received.

Data collection for sub question 2

In order to answer the second sub question, data was collected by using a semi-structured interview. This structure provided a good base to compare the results and maintained the option for additional interesting information. By using open questions (Appendix F), the interviewee was offered the possibility to provide rich and in-depth information. This made it possible to discover the task characteristics, the underlying mechanisms related to knowledge sharing, and its performance.
In total 10 interviews have been conducted. Due to priority reasons, one department was only able to provide one employee, resulting in 10 instead of 12 interviews. Next to the 10 interviews and KM-scans, five additional employees for one department completed the KM-scan.

4.3.2 Data analysis
Since there are two sub questions that needed to be answered, two analyses were made. One was focused on the providing a score to the results of the KM-scan. The other was focused on extracting information from the interview recording and summary.

Analysis of the KM-scan
The results from the KM-scan were grouped for each department. Additional to the table, also a short report was generated with the most interesting issue from the scan. The issues contained large differences in the scores by different employees and elaborations of the employees as provided at the start of the interview session. All this information generated an overview of the current (“ist”) situation with regard to knowledge sharing.

Analysis of the interviews
For the analyses of the interviews, thematic content analysis was used (Burnand, 1991). This method contains several stages in which the interview transcript is categorized and codified. For this research, some of the stages of Burnand (1991) were grouped together. Other stages have been removed since the interview questions and answers were structured according to the task characteristics.

Stage 1. Read the transcript and making notes about general themes in it. This was done in a software package from QSR International called Nvivo (9).
Stage 2. Use of ‘open coding’ (Burnand, 1991). This means as many headings are added to the transcript to describe all the aspects of the content. This is done in Nvivo. Tags for certain content are named ‘Nodes’.
Stage 3. Create a list of higher-order categories in which a number of sub-headings can be grouped. For this research project, these categories were linked to the questions of the semi-structured interview. This was done in Nvivo after completing the coding of three transcripts. For all the remaining transcripts, these higher-order categories were used to code the content.
Stage 4. Collect the coded section together in their categories. This was done in Nvivo by viewing all the content under a certain Node. By using search queries in the program, the content can be viewed per person, group, or one department.

By using this method, it became possible to categorize the responses from the interviewees according to the different task characteristics and the knowledge sharing mechanisms.

Linking task characteristics to strategies
When all the information from the interviews was extracted, the links between the task characteristics and strategies for knowledge sharing was made. From all the interviews, the level of the task characteristics and the strategy for sharing knowledge was determined.

Testing design propositions
The testing of the design proposition needed to be done by comparing the practical evidence from the interviews to the theoretical links. This comparison could result in three situations:

- Both the practical and theoretical links were inline.
- The practical and theoretical links were contradicting but the current performance was positive.
- The practical and theoretical links were contradicting and the current performance was negative.
In case the practical and theoretical links were in line, the evidence could be used to support the academic literature. If the practical evidence showed contradicting results compared to the theory, the current performance of the knowledge management strategy needed to be considered. If the current performance was good, the practical evidence rejected the theoretical design proposition for this case study. If however both the practical and theoretical link were opposing and the performance was low, it was hard to determine which relationship (practical of theoretical) was rejected or supported. In this case, there was no evidence for the theoretical relationship and the practical relationship between the strategies.

4.4 Solution design

4.4.1 Data collection
For the first sub objective, brainstorm sessions were conducted focused on the requirements of knowledge sharing. The questions from Appendix G were used to gather information on the requirements for knowledge sharing. These questions were again based on the KM-scan of Weggeman (2001) but modified to be more open and to incorporate desired requirements. On all the questions from Appendix G, the departments were asked to think about targets, barriers, solutions, and limitations. Afterwards these were transformed into the functional requirements, user requirements, boundary conditions, and limitations.

For the second sub objective, the literature study from section 2 was extended by additional factors affecting knowledge sharing.

4.4.2 Designing
The design process (figure 9) of Aken et al. (2012) contains several sub-processes for creating a design.

![Diagram of design process](image)

Figure 9: A general model for a design process (Aken et al., 2012)

For the problem analysis in the design process, the information from both the KM-scan and the interviews was used to determine the “ist”-situation. The current strategy was determined using the underlying mechanisms. At this stage, it was possible that both strategies we used. This is not necessarily a problem since multiple researchers have argued for a balance between the two knowledge management strategies (Haas & Hansen, 2007; Hansen et al., 1999; Choi & Lee, 2003).

The requirements for knowledge sharing were determined using the brainstorm sessions. The analysis of this information resulted in a strategy for knowledge sharing that best fits the requirements and the task characteristics of the department at hand. In case the requirements and characteristics required different strategies, a balance of the two strategies was chosen.

The sketching process was focused on determining improvement points indicating the gap between the “ist”- and “soll”-situation. Some of these points were focused on the company and other are focused on the departments.

In the outline design, the advice was created on an abstract level.

In the last part of the process, details were added to the advice by using the design variables of the Integral Organizational Model (Weggeman, 1985). Additionally, evidence from the academic literature was added to support the advice. In addition, the results from section 4.3.2 were used to improve the knowledge sharing strategy at the individual departments.
5 ANALYSIS OF CURRENT ("IST") SITUATION

This chapter provides answers to the first sub question:

What is the current situation of knowledge sharing at COMPANY X?

The current situations were determined by using an adjusted knowledge management scan extended with elaborations from interviews with employees. The results from the scans were discussed in general and afterwards more specific for the individual departments.

The knowledge management scan contains three different parts. The first part focuses on knowledge awareness based on the Integral Organizational Model (Weggeman, 1985; Appendix C). This part shows to what extend the six organizational design variables are supporting knowledge management. The second part of the KM-scan focuses on activities in the Knowledge Value Chain (Weggeman, 2006). As this study focuses on knowledge sharing strategies, only a few questions are used focusing on the Integral Organizational Model and the other activities in the Knowledge Value Chain. The third part focuses completely on knowledge sharing and contains all the questions from the original KM-scan. Appendix I to Appendix L provide an overview of the results.

Additional to the score of the scan, comments from interviews were added to support the answers of the scan. During these interviews, information was also gathered on the knowledge sharing between departments. This information is also elaborated in this chapter.

Since the names of the departments are rather long, the next abbreviations are assigned to the different departments in the different PMC’s:

- SC-D1 = PMC Standard – Department 1
- SC-D2 = PMC Standard – Department 2
- CB-D1 = PMC Custom – Department 1
- CB-D2 = PMC Custom – Department 2

Before proceeding to the results of the scans, two remarks are made. First, the data from the SC-D2 department was based on the contribution of one employee. Additionally, the knowledge management scan was completed after conducting the interview, leaving no room for supporting statements on the answers. Therefore, it was not possible to draw any sound conclusion on the current situation of knowledge sharing at the SC-D2 department. The results from the scan will remain in the complete data set. Second, the scores on knowledge awareness and the activities in the Knowledge Value Chain (except of ‘knowledge sharing’) haven been based on only a few question from the KM-scan. Therefore, the results needed to be considered with caution. Additionally, no specific information was available to explain several scores.

5.1 Overall current situation

Knowledge awareness and the Knowledge Value Chain

Figure 10 shows the results for knowledge awareness and the Knowledge Value Chain for each department in two radar diagrams. Knowledge awareness scored between average (3) and good (4) at each department (figure 10a). Although the departments had similar scores for some of the topics, there were also some notable differences.

On ‘KM strategy’, the D1-departments outperformed the CB-D2 department as they had some implicit targets with regard to planning, controlling, and managing of knowledge. The results for ‘management style’ again showed outperforming D1-departments as they focused on output and core competences of the employees were known. The CB-D2 department regularly managed on throughput and explicit information was missing on the core competences of the employees.
As these two topics are related to the formulation part of the Integral Organizational Model (Appendix C), their low scores were likely caused by absent mission, vision and objectives with regard to knowledge management. This made it difficult for the department to organize knowledge management.

On ‘structure’, all the departments scored just above ‘average’ (3.5). The scores on ‘systems’ showed some differences. The SC-D1 department scored highest as they used IT more explicit for knowledge sharing where other departments lacked the use of IT as a knowledge management tool.

![Figure 10: radar diagrams on (a) knowledge awareness and (b) the Knowledge Value Chain](image)

The scores on the Knowledge Value Chain indicated the CB-D1 department outperformed the other two departments at almost every activity (figure 10b). All the departments seemed to have a ‘good’ (4) overview of the ‘available knowledge’ and scored ‘average’ (3) on ‘knowledge sharing’ and ‘knowledge application’. Next, the scores on the ‘required knowledge’, ‘knowledge development’, and ‘knowledge evaluation’ are elaborated.

There was no clear explanation why the CB-D1 department outperformed the other departments on ‘required knowledge’. However, due to the position of this activity in the Knowledge Value Chain, a possible explanation was found for the differences on ‘knowledge development’ and ‘knowledge evaluation’ of the departments. The Knowledge Value Chain starts with required knowledge for a department. Combined with the available knowledge within a department, this results in an overview of knowledge that needs to be developed (or acquired). If there is no overview of the required knowledge, it is likely to be difficult to determine what knowledge needs to be created or to evaluate what knowledge remains useful or not. Both the SC-D1 and CB-D2 department scored low on the first activity of the chain (required knowledge), which was a probable cause for the lower scores on other activities of the chain (‘knowledge development’ and ‘knowledge evaluation’). The CB-D1 department scored high on the first activity (required knowledge) and the following activities in the chain. This department had an overview of what knowledge was required and available and therefore what knowledge needed to be developed or was still usable or not (evaluation).

**Knowledge sharing**

On average, the scores on knowledge sharing for the complete data set were just above average (3.1, Appendix H). At each department, knowledge was shared spontaneously and informally, as there was no loss of power when sharing knowledge and the process was facilitated through reports, manuals, informal face-to-face interactions, on-the-job-training, and information technology.

Although knowledge sharing seemed to be performing well, there were multiple issues lowering the performance: no rewarding, repeating mistakes, no rotation of employees, no decent archives, and no communication promoting layouts of the buildings.
Knowledge workers were not rewarded for frequently sharing knowledge with colleagues. Employees were paid to perform their work, but not motivated to, explicitly or implicitly, share their knowledge since this was not regarded as part of their day-to-day work activities. Throughout the organization, expensive mistakes were made due to missing knowledge and not enough was learned from each other’s mistakes. This was caused by the lacking distribution of available knowledge and absent case evaluations and decent documentation systems. The present informal interactions were hindered by the absent communication-promoting layouts of buildings and employees rotation across departments. There was more emphasis on locating functional groups together instead of promoting collaboration across functional groups. Employees only knew their direct colleagues and the knowledge they possessed. There was insufficient communication with people outside the department making it difficult to know what knowledge was present at other places in the organization.

**Concluding**

On average, there was an average knowledge awareness and average performing Knowledge Value Chain at the participated departments. In the Knowledge Value Chain, ‘knowledge sharing’ scored lowest, supporting the topic of this study. Although knowledge was shared spontaneously and informally, employees were not motivated in their knowledge sharing activities, as there were no rewarding systems, usable archives, communication-promoting building layouts, and employee rotation across departments.

**5.2 Current situation at SC-D1**

This department scored on average 3.5 on knowledge awareness, 3.0 on the Knowledge Value Chain and 3.2 on knowledge sharing. In Appendix I, the scan results are found for this department. In this section, these results are elaborated.

**Knowledge awareness and the Knowledge Value Chain**

This department scores on average 3.5 on knowledge awareness. There was a good management style focussed on output within the planned time and rules and procedures regarding knowledge management did not hinder work.

‘KM strategy’, ‘culture’, ‘structure’, and ‘personnel’ were the lowest scoring design variables from the Integral Organizational Model (Weggeman, 1985). There were no explicit targets for the planning, controlling, and managing of knowledge. The knowledge management culture scored below average as the not-invented-here syndrome was present; knowledge from other departments or external partners was not (re)used. Although it was easy to connect to colleagues regardless of seniority, gender, department, or function, ‘Structure’ still scored below average as employees were only deployed within the department. ‘Personnel’ seemed to be scoring well as there was good balance (20-80) between thinkers and doers. However, since there was not enough structured training of new employees, the actual score on ‘personnel’ stayed below average.

The Knowledge Value Chain scored a 3.0 at this department. The highest score was given to ‘available knowledge’, which indicated the available knowledge of the department was known. ‘Knowledge sharing’ scored above average, but the other three activities in the chain scored below average. First, ‘required knowledge’ scored 2.3 indicating the department had insufficient overview of which knowledge was required to execute their tasks. This is likely to be caused by insufficient input information from KM objectives into the Knowledge Value Chain. Similar to the explanation in section 5.1, the other low scores on ‘knowledge development’ and ‘knowledge evaluation’ were likely caused by an insufficient overview of the required knowledge in the department.

**Knowledge sharing**

The results from the scan (Appendix I) showed spontaneous and informal sharing of knowledge throughout the department facilitated primarily through informal face-to-face interaction, on-the-job training, documents, and information technology. Additionally, there was no indication of a ‘knowledge = power’ game at the department:
“I’m very glad we don’t have a ‘knowledge = power’ game at our department. Not according to my personal experience. Of course, it is commonly known when you keep knowledge for yourself, you are protecting your position. I’m very allergic to this kind of game and luckily I do not recognize it at our department.”

There were multiple indications of a poor knowledge sharing performance. Expensive mistakes were made because knowledge was not available at the right time in the right place. This was probably caused by poor distribution of available knowledge. Additionally, mistakes from others were repeated. The absence of case evaluations on completed projects was a possible cause for these low scores. If there are no opportunities to evaluate projects on good and bad performance, it is difficult to uncover mistakes. The next statement provided an additional reason why mistakes were repeated:

“I believe we make a lot of similar mistakes (C.8). In some project, you notice that problems need to be solved by Department 2. Reports are made on these issues, but they are not used due to a lack of time on other activities…Everybody is convinced of the importance but due to a lack of time it is omitted.”

Rotation of employees was not happening at this department. Internally, there was no reason for rotation since the group was small. This caused, however, problems when there was no colleague available for help when needed. The next statement provided an additional reason why rotation of employees was not facilitated at the department:

“Sometimes we have projects together with other departments. However, this does not imply somebody is located at another department...In my opinion rotation would be positive for the department although you are limited to a certain capacity in workforce. Rotation will reduce the efficiency of the department. In the long run this could lead to better communication across department and a larger network of colleagues.”

**Knowledge sharing across boundaries**

At the department, knowledge as primarily shared through codification like documents and emails. Occasionally, tacit knowledge was shared through face-to-face contact. Recent developments showed the sharing of knowledge improved when there was more face-to-face contact and interaction. However, during regular execution of the work activities, there was not enough time to implement this development:

“Sometimes the interpretations of the documents fail. A ‘Toyota’ is sold and designed but in the end a ‘Hummer’ is engineered. This mismatching was solved when group leaders from our department and engineering had spare time to have a close collaboration on a project. This makes sure a ‘Toyota’ will remain a ‘Toyota’.”

**Concluding**

On average, this department had an ‘average’ to ‘good’ knowledge awareness and ‘average’ Knowledge Value Chain. There were multiple parts in the Integral Organizational Model, which scored just above ‘average’. The explanation in section 5.1 explains the relatively low scores in ‘KM strategy’ and ‘required knowledge’ as strategy is one of the inputs into the first Knowledge Value Chain activity ‘required knowledge’.

Even though the score on knowledge sharing was above average, many mistakes were repeated since there were no evaluations and knowledge was distributed poorly. Additionally, rotation was not facilitated because of the impact on the efficiency of the departments. Knowledge sharing across the departmental borders was primarily done through codification supported by personalization. However, recent developments showed the advantages of increasing the amount of knowledge shared through personalization.
5.3 Current situation at CB-D1

This department scores on average 3.7 on both ‘knowledge awareness’ and the Knowledge Value Chain and 3.5 on ‘knowledge sharing’. In Appendix K, the scan results are found for this department. In this section, these results are elaborated.

Knowledge awareness and the Knowledge Value Chain

This department had good knowledge awareness. The management style scored four out of five, which indicated a good overview of the available core competencies and a focus of management on output instead of throughput. ‘Culture’, ‘structure’, and ‘personnel’ scored evenly well. There was more respect for the leading specialist instead of the leading manager. However, the score on culture was reduced by the presence of the not-invented-here syndrome. Regarding ‘structure’, it was easy to connect to other employees regardless of gender, seniority, function, or department. However, employees were not deployed where they were most needed, but they stayed at their group or department. Finally, there was a good training of new employees and a good balance between thinkers and doers at the department.

The two parts of the Integral Organizational Model scoring lowest on knowledge awareness were ‘KM strategy’ and ‘systems’. With regard to the latter, documentation systems were only used to store document. Explicit knowledge from libraries was not reused since it tended to be outdated or inconsistent. With regard to ‘KM strategy’, there were no explicit target with regard to planning, controlling, and managing of knowledge. Additionally, these targets were not structured top-down through the department.

The Knowledge Value Chain scored good (3.7) as the department had a good overview of the required knowledge, the available knowledge, which knowledge needed to be developed or acquired, and which knowledge was no longer useful. The lowest scoring activities were ‘knowledge sharing’ and ‘knowledge application’. The later was characterized by a large amount of conservatisms hindering the spontaneous usage of shared knowledge and new technologies. This was caused by insufficient focus on innovation and the continuous input of customers.

Knowledge sharing

Similar to the overall results of the scan, knowledge was shared spontaneously and informally through face-to-face interactions, on-the-job training, and several supporting documents. There was no sign of a ‘knowledge = power’ game at the department and all the employees accepted the ‘give’ and ‘take’ obligation for sharing knowledge.

Although knowledge sharing seemed to be scoring very well, the scores on mistakes, rewarding, employee rotation, and documentation lowered the score. Mistakes were repeated due to missing knowledge and a low priority to preventing mistakes. Additionally, the user-unfriendly IT-systems hindered the logging of mistakes. The next two statements are made with regard to mistakes:

“We are trying to maintain the list of improvements as good as possible. Improvement point meetings have started but in practice, these meetings are progressing slowly since employees have other priorities. Familiar mistakes are still occurring daily.”

“We had a common question for a long time: What would be the effect on profit if we would prevent common mistakes? There has been a committee investigating failure costs. If the labour hours exceeded the budget of 500,000 hours by 10% and hourly rate is 50 Euros, this would result in a loss of 2.5 million Euros. This is not added to the costing price of the product but subtracted from the profit of the company.”

The primary task of an employee was to execute the required work. Since knowledge sharing was not regarded as required work, no time was scheduled leaving it open to individual willingness. Employee
rotation was also not implemented as it increased the workload for other employees. The next statement showed why this knowledge sharing method could be beneficial:

“The rotation of valuable, scarce knowledge carriers is not happening. However, in my opinion it would be good for new employees to learn more quickly. Additionally it would also be good for experts since they tend to get some kind of autocracy in the department with regard to projects.”

**Knowledge sharing across boundaries**

The knowledge sharing across boundaries was characterised by a balance between codification and personalization. Projects were handed over to Department 2 at transfer meeting at which all the documents and elaborations were provided. Additionally, several employees stayed connected to the project at Department 2 to ensure the right interpretations were made. The slight presence of the not-invented-here syndrome hindered knowledge sharing as Department 2 had insufficient involvement in the design phase of the project.

**Concluding**

Most of the parts in the Integral Organizational Model scored well, except of the missing ‘KM strategy’ and ‘systems’ at the department. Although knowledge was shared informally, spontaneously and without weakening one’s position, mistakes were still made and repeated due to missing knowledge. Additionally, documentation systems were user-unfriendly, employees were not rotated, and no time or budget was available to reward knowledge sharing. Across the departmental boundaries, the sharing of explicit knowledge only took place at transfer meeting. The interpretation of the explicit knowledge was assured by keeping several employees connected to the project for two to three months.

5.4 **Current situation at CB-D2**

This department scores on average 3.2 on ‘knowledge awareness’, 3.0 on the Knowledge Value Chain and 2.8 on ‘knowledge sharing’. In Appendix L, the scan results are found for this department. In this section, these results are elaborated.

**Knowledge awareness and the Knowledge Value Chain**

Knowledge awareness scored 3.2 for this department. ‘Structure’ scored ‘good’ as it was easy to connect with other employees, regardless of gender, seniority, function, or department although the deployment of employees remained dependent on the importance of projects. ‘Management style’ and ‘systems’ scored above average although management seemed to be focused slightly more on throughput.

‘KM strategy’, ‘culture’, and ‘personnel’ scored lowest with regard to knowledge awareness. The score on ‘KM strategy’ was caused by the unclear or not determined explicit knowledge management targets and the low knowledge quality. The awareness at ‘culture’ scored low due to the slight presence of the not-invented-here syndrome. Additionally, there seemed to be more respect for the leading manager instead of the leading specialist. On ‘personnel’ there were no special remarks on the scores.

At the Knowledge Value Chain, there was a ‘good’ overview of the available knowledge outperforming the other activities in the value chain. There was no overview of the required knowledge although improvements were initiated. In line with the explanation in section 5.1, the low scores on the other activities in the value chain were likely caused by the missing overview on the required knowledge and a missing knowledge management strategy.

**Knowledge sharing**

At the CB-D2 department, knowledge is shared spontaneously and informally. All the employees had a ‘give’ and ‘take’ obligation with respect to acquiring and distributing knowledge through the
department. The sharing of knowledge was primarily facilitated through information technology, internal lectures, and education and training.

The score on knowledge sharing was considerably lowered in different ways. The primary task of the department was to execute project work, which left no time and motivation for other activities, like knowledge sharing. Mistakes were repeated regularly, as there were no case evaluations of completed projects and no information about mistakes was shared. The poor distribution available data also increased making mistakes. There was no possibility or structure to rotate employees across departments as it was likely to reduce efficiency. The building layouts were characterized by large distances between interrelated departments, hindering the direct, informal communication:

“... In the past, multiple groups, such as design and cost estimation, procurement and the technical manager, were located next to each other. When I heard a colleague had some problems, I was able to help quickly. When I needed more information, I could easily walk to a designer. When there were issues at procurement, a quick visit was enough to solve it. This situation worked like clockwork. Now all the groups are located on different levels in the building, hindering communication. Employees are clustered in functional groups instead of project groups. It is not a huge effort to walk up to somebody and ask for information, but the current situation is hindering communication.”

**Knowledge sharing across boundaries**

The incoming information from the CB-D1 department was initially shared in a transfer meeting. In this meeting, documents were handed over and information was provided on how the project evolved. Although the shared information was clearly structured, loose ends on remaining work stayed unclear. In addition, the philosophy of a customer and the purpose of a ship were not incorporated in the presented documents.

**Concluding**

The structure to organize knowledge management was ‘good’ at this department. The lower scores on ‘KM strategy’ and ‘management style’ originated from the undefined strategy and objectives on knowledge management. Combined with the score on ‘systems’, the realization of any strategy or objective was difficult. The ‘good’ overview on the available knowledge at the department was considerably lowered by the other activities in the value chain. The missing KM strategy and objectives were probably not only affecting the design variable ‘KM strategy’ but also the overview of the ‘required knowledge’ of the value chain. This also reduced several scores in several other activities in the chain.

The absence of the communication-promoting layout of the building and the rotation of the employees was decreasing knowledge sharing. In addition, no time was available as a reward to stimulate sharing of knowledge. The low score on case evaluation are the probable cause of repeating mistakes. The knowledge sharing across boundaries was structured well through both codification and personalization. However, more codified knowledge was required on the philosophy of the costumer and with what request the company was approached.

**5.5 Answering sub question 1**

By using KM-scans, information was gathered in order to answer the first sub question of this study:

*What is the current situation of knowledge sharing at COMPANY X?*

Overall, there was an ‘average’ to ‘good’ knowledge awareness at the involved departments. From the design variables in the Integral Organizational Model (Weggeman, 1985), ‘Management style’ scored the highest and ‘KM strategy’ scored the lowest. This low score on the latter was likely caused by the absence of corporate vision and objectives with regard to knowledge management.
These strategic topics are also a required input into the Knowledge Value Chain. The low score on the first activity of this chain (‘required knowledge’) was likely caused by the missing information on these strategic topics. Additionally, the low score on this activity was affecting some of the following activities in the chain.

Knowledge sharing performed above average and was characterized by informal, spontaneous, and face-to-face interactions. Structured knowledge sharing activities like case evaluations, avoiding mistakes, and using libraries and documentation systems scored considerable lower.

Knowledge sharing across departments primarily occurred when projects were handed over. The project transfer meetings were characterized by the use of codified knowledge such as drawings and cost calculations. Only the departments from the PMC Custom used a balance between codification and personalization to transfer their knowledge between departments. Documents were handed over between the CB-D1 and CB-D2 department supported by explanations and elaborations of some employees. Additionally, several employees from the CB-D1 department stayed involved into the project for a couple of months to ensure the right interpretation of the codified knowledge. However, important knowledge on the initial request of the customer was still missing which also makes it difficult to make the right interpretation of some of the shared documents.

Concluding, the KM-scan showed the personalization strategy was used more at these departments and performed better in comparison to the codification strategy. However, several low scores on the scan were possible caused by missing explicit targets and a low reliance on codification to share knowledge between employees. For each department and the entire company there may be several reasons why to focus on the personalization strategy. In the next chapter, the task characteristics of the departments are used to investigate their link to the knowledge-sharing strategies and to determine whether each department is focusing on the right strategy in their circumstances.
6 ANALYSIS OF DESIGN PROPOSITIONS

This chapter focuses on answering the second sub question:

How are task characteristics linked to strategies for knowledge sharing?

Interviews were used to create case descriptions of the four departments. With these case descriptions, the design propositions from section 2.4 were tested.

The first section provides an overview of the analysis of the interview data. The second section describes each department according to their task characteristics and knowledge sharing strategies. Afterwards these descriptions are compared to the theoretical design propositions. This chapter is concluded with implications of the testing and answering the research questions and the second sub question.

6.1 Overview and classification of interview data

The transcripts from all the interviews have been coded using the software package Nvivo. In addition, this package offered customizable search queries usable for retrieving information on questions, topic, or task characteristic.

To provide a clearer picture of the outcomes on all the different topics of the interview, an overview was created using MS Excel. From each interview, the information was classified and entered into the overview. The classification was done by putting the information into perspective for COMPANY X or by combining answers to the interview questions into one classification. Next, this classification is elaborated.

With regard to task frequency, the scores have been compared to relevant corporate figures. A high frequency referred to a high amount of executions where a low frequency referred to the building of only one ship per year. For task heterogeneity, the typologies of Perrow (1967) and Woodward (1958) were used by considering task variability, task analyzability, and routines of work. Low variance and high analyzability resulted in a low heterogeneity level where high variance and low analyzability resulted in a high level of heterogeneity. Causal ambiguity was determined by several factors of Zollo & Winter (2002). Few subtasks and clear interdependency resulted in a low causal ambiguity where many subtasks and unclear interdependency resulted into a high causal ambiguity. When the information from the interviews pointed to both levels of a task characteristic, a medium classification was assigned.

The classifications were put into the MS Excel overview extended with supporting reasoning for the classification. This overview of the interviews per interviewee was reduced into one overview for each department. In this way, it became possible to make case descriptions for each department and test the design propositions. Both overviews (per interviewee and department) are found in Appendix M.

6.2 Case description SC-D1

Task information

The primary task of this department is to provide the sales department and Department 2 with accurate technical and economical information about the standard cutters. The sales department requires this information in order to respond to inquiries or the selling of vessels. Department 2 requires this information for the actually engineering of vessels.

There are 15 different standard cutters that are being produced in stock. For these vessels, the calculators of the department track all the financial information continuously. When these vessels are being sold without any adjustments, the SC-D1 department has no involvement in the process. When
predetermined options need to be added to the vessel, some technical and economical work needs to be executed.

In total, this department consists of seven employees including the group leader, designers, and a calculator.

**Task frequency**
The repetitive character of the work within this department is considered to be high. The purchase of supplies and the sales of vessels is a continuous process. This requires continuous updating of the sales department on the prices of the vessels. For the more technical engineering work on these vessels, there is a difference between real projects and information requests. For the real projects, some more calculations and drawings are needed in comparison to the information request. There are about 20 real projects per year where the amount of information request is about 3 to 5 times higher. When comparing the repetitive character of the work in this department with that in other departments, this task frequency level is classified as high.

Next to this high level of task frequency, there is also a high level of standardization. This level of standardization is dependent on the requests of a customer. Nevertheless, since there is a high standardization it is possible to reuse information of previous vessels. The standardization level is supported by the next quotation of one of the interviewees:

> “We score an 8 on standardization. Why an 8 and not a 10? It is not standardized in such a way that a sales representative gets a price and specification just by checking some options in a program. We have a standard specification with 10 chapters and an 11th chapter named ‘optionals’. The customer-specific optionals are added in the last chapter and the name is changed into ‘additional equipment’. Furthermore there are also standard price lists.”

The knowledge required to execute the primary task is considered to be static. In order to improve the performance of the vessels, some new knowledge is acquired which is regarded as dynamic knowledge. Overall, most knowledge remains the same, thus static.

**Task heterogeneity**
There is a low amount of variance in this department when comparing the work activities of different projects. The work that needs to be executed is the same for every project and called “standard, basic and static.” This level of variance is also supported by the reuse of assumptions across projects as mentioned in one of the interviews:

> “In general we copy assumptions. When making calculation for a standard cutter we use an excel document with 30 sheets for every optional. The eventual calculation contains the basic sheet of the standard vessel and additional sheets of the included optional. Basically, this is just copying. We do not start from scratch over and over again. This also accounts for the technical description and specification.”

Other information about the vessels is also being reused frequently. For instance, drawings and calculations from previous built vessels are consulted in case of a similar project.

The low amount of exceptions in the work activities is also in line with the amount of variance. In case of any problems or exceptions, there is an analytical approach to finding a solution. The primary step is contacting colleagues or the group leader. In this way, implicit knowledge is being used to find a solution for the problem at hand. Additionally, calculations are being recalculated or alternatives are being sought in the documents of previous projects. Although the amount of exceptions is low and the problem solving process is effective, there is no indication that information from this process is being stored afterwards.
**Causal ambiguity**
The designing and cost estimation of standard cutters is not considered to be a complex task. There is a lot of information from previous vessels that can be reused and the technology is not considered to be “rocket-science.” Some complexity still remains due to the amount of orders and projects that need to be conducted simultaneously. However, when only considering one project at a time, there is enough experience available in order to minimize the complexity level. The low amount of subtasks and the serial order in which they are executed indicate a low level of causal ambiguity. Additionally, the logical interdependency between the subtasks makes it possible to change the execution order of subtask. In this way, it becomes possible to start with more important tasks if required. Since there is a low complexity, clear execution order, and clear interdependency of subtasks, it becomes possible to easily predict the effect of any changes on the eventual outcome of the process. This prediction remains dependent on the experience of an employee where increasing experience make the prediction of outcomes easier and more reliable.

**Knowledge sharing within the department**
The sharing of the knowledge in this department is done through personalization and codification. Both experienced and inexperienced employees of the department share knowledge primarily through personalization. There are master-apprentice relationships, many face-to-face contacts and employees are located close to each other. Additionally, the department is very small and clustered together making it easy to communicate with colleagues.

Furthermore, a lot of information and assumptions are shared through documents of previous, as-built vessels. However, some of the codified knowledge is becoming outdated making implicit knowledge from recent projects more reliable.

Similar to the sharing of knowledge through the department, the problem solving process is characterized by the use of both implicit knowledge of employees and explicit knowledge from previous vessels.

For this department, these two knowledge sharing strategies are working well as long as there is more than one employee involved within a certain discipline. When there is no colleague available to ask for implicit knowledge, there is no knowledge or guidance available, increasing the risk of making mistakes or redoing part of the work. For work executed by only a few employees, the need for codification is high in order to provide guidance and making knowledge more available.

**Concluding**
Based on the collected data, the next conclusion can be drawn for this department.

The task frequency level tends to be high because of the high amount of repetition per year and high level of standardization of the process. The task heterogeneity level tends to be low because of the low amount of variance, high amount of reusing information, and high level of task analyzability. The causal ambiguity also tends to be low since work is not regarded to be complex and the interdependency and execution order of the few subtasks are clear.

Inside the department, knowledge is shared through both personalization and codification. These strategies seem to be working reasonable to good. With regard to personalization, knowledge is shared quickly and there is a good understanding between colleagues. However, in difficult situations or by insufficient support from colleagues, this strategy performs insufficient. With regard to codification, there is a lot of knowledge available and reused indicating a good performance although the codification process takes a lot of time and codified knowledge becomes outdated.
6.3 Case description SC-D2
Before stating anything about the task information and characteristics within this department, it is important to mention that only one interview has been conducted within this department. This will make the collected information regarding this department biased.

Task information
The primary task of this department is to make production drawings, specifications of components, and taking care of client documents concerning the standard cutters. The department consists of approximately 20 employees of different disciplines including three group leaders.

Task frequency
The repetitive character of the work within this department is high. Work on the standard cutters is being executed on a high frequency of 10 to 15 vessels per year. Furthermore, work activities are clearly defined and standardized, and require particularly static knowledge. Most of the knowledge regarding all the projects stays the same. Only the presence of creativity and continuous improvements towards new technologies make the used knowledge slightly dynamic.

Task heterogeneity
When comparing the work that needs to be executed in different projects, there is a low amount of variance in this department. Furthermore, there is also a high reuse of assumptions across different projects. This reuse is however dependent on personal capabilities of the employees. Additionally, there is also a development list on which choices, assumptions and calculations are being logged. Other information from previous projects is being reused frequently by looking at the documented information.

The problem solving process is focused on an analytical approach using primarily implicit knowledge from colleagues supported by documents from previous vessels.

Casual ambiguity
On the level of complexity, there is a split between technical complexity and workload. On a technical level, the primary work of the department is categorized as “no rocket science.” However, on the level of workload and planning the complexity is higher because there are multiple projects running simultaneously with multiple employees involved.

This level of complexity is supported by a low amount of subtasks consisting of the creating of handbooks, ordering of options, providing drawings, and handing everything to the production units. These tasks are being executed in a parallel order but since there is no dependency, it is easy to predict the consequences of any changes in the specification of the vessel. For this department, a change in specification is however exceptional.

Knowledge sharing within the department
The sharing of the knowledge in this department is done primarily through personalization. For both new employees and experienced employees, the main way to share knowledge is through personalization. New employees are being trained using a master-apprentice relationship. In this way, inexperienced employees get to know the work of the department and how it is conducted. Additional techniques are being taught by colleagues resulting in a training based on increasing experience. In addition, the sharing of experience and information between experienced employees takes place through face-to-face communication since this knowledge is hard to put into documents and these documents are open to personal interpretation. There are no books available to be used as guides during the work activities. Furthermore, the next statement is made: ‘persons are no robots’. This indicates the high level of personal interpretation supporting the personalization strategy.

The reuse of information and assumptions is also done through personalization with support from a codified development list and CAD drawings from previous vessels. For the problem solving process, there is also the same balance between personalization and codification. This process is focused on an
analytical approach using primarily personalized knowledge from colleagues supported by codified knowledge from previous vessels.

For this department, the knowledge sharing strategy is working well when reusing assumptions and information, and when predicting the effect of intermediate changes. However, for learning lessons and reusing knowledge of colleagues the performance of this strategy is unknown.

**Concluding**

Based on the collected data, the next conclusion can be drawn for this department.

The task frequency level tends to be high because of the high amount of repetition per year and high level of standardization of the process. The task heterogeneity level tends to be low because of the low amount of variance, high amount of reusing information and high level of task analyzability. The causal ambiguity also tends to be low since work is not regarded to be complex. Although work is executed parallel, the interdependency remains clear.

Inside the department, knowledge is shared through personalization. With regard to learning lessons and knowledge reuse between experienced employees, the performance of this strategy is unknown. With regard to the reuse of assumptions and other information, the personalization strategy is working well. Additionally, codification is used as a supporting strategy.

### 6.4 Case description CB-D1

**Task information**

The primary task of this department is providing technical and economical information for a customer specific and custom built self-propelled suction dredger. This task starts when a customer approaches the company with a request to design a ship. This request often contains specific requirements with respect to the capabilities of the ship.

The technical information contains the design, the specification, and a general plan of the ship. The economical information contains the price of the custom build ship, which needs to be provided to the sales department of this PMC.

In total, this department employs 10 designers, of which five mechanical engineers and five shipbuilding experts, four calculators, one drawer, one programmer and one group leader.

**Task frequency**

The repetitive character of the work within this department is considered to be medium. On average 10 ships are being designed per year. The duration of the design and cost estimation for these ships ranges from one or a few weeks, for small projects, to a couple of years, for big projects. It should be noted that these projects are not executed full time since multiple projects need to be executed at the same time. Additionally, not every design turns into a project.

The level of standardization is classified as being medium. The specification and some of the calculations are standardized. However, there are also pieces of work that are not standardized and for which there is a lot of freedom regarding how to execute them. A possible cause for the lower levels of standardization is the individual retention of knowledge in the previous decades. A lot of knowledge remained personalized for each employee and the employees were reluctant to share this knowledge. Due to this low amount of sharing, it becomes hard to standardize process and practices. This medium standardization level for this department is supported by the next quotation:

> “The level of standardization is sufficient, a 7. It will never become a nine or a 10 because the ships are custom built and every project is different compared to the previous ones. There is a standard base and for every project there is space required for the individual wishes of the customer.”
The knowledge used to execute the primary task of this department is predominantly static. Only a small amount is considered to be dynamic in order to cope with new development. Two important topics are innovation and new regulations. Some work activities are stored into standard calculations and specifications. From previous vessels or versions, this information is easily retrievable. However, other knowledge or information is hard to find due to multiple different and inconsistent systems.

**Task heterogeneity**

When comparing the work that needs to be executed in different projects, there is a low amount of variance for this department. The creation of the design, the specification, the price, and the schedule is similar across different projects and clearly defined. There is some variance when also considering the interplay with the sales department since different customers requires different negotiation approaches.

Since customers are closely related to the development process, there is a medium reuse of assumption across projects. In some cases assumptions can be reused, which is primarily done through face-to-face contact leaving the option open for a personal philosophy and design. In order to help reusing assumptions at the start of a new project, there is a desire to store assumptions more often. The next quotation is an example of how codified knowledge is being reused at this department:

> “How is it possible to guarantee that mistakes at this moment are still recognized after 5 years? In addition, how do you make sure this mistake is not repeated? In the past, we made a checklist, which needed to be used to check the design. In practice, this checklist was not used or used incorrectly. It was overloaded with too many details. Now the checklist only contains main issues and all the other details are stored in the basic specification. This seems to work but it is again dependent on the reuse of this information by the employees individually.”

The reuse of other information from the projects is characterized by individual knowledge retention. Personal skills and best practices are not shared but only reused at the individual level. Other information is extracted from drawings, specifications, and schedules.

The amount of exceptions in the primary task of this department is low. Nevertheless, in case of an exception or problem, the solving process is focused on contacting persons. The advantage of this focus is the speed in which the answer can be found by approaching colleagues, suppliers, or experts from other departments. Documents from previous projects can also be reused. However, a lower reliability of this data makes face-to-face contact with colleagues favourable.

**Causal ambiguity**

The level of complexity of the primary task of this department is high. First of all, the work activities are considered to be broad and very comprehensive. Second, the department plays an important role in the development process. On one side, the design of a new custom-built ship needs to be sold and on the other side the other departments in the development process need to build the ships that has been designed. Because of this position and the involvement of many people in the process, the complexity of this primary task is considered to be high, even though technically the task is not considered to be “rocket-science.”

There is a medium amount of subtasks that is being executed both in a serial and parallel order. Additional there are also iterations in some of the tasks. For instance, estimations are made about the dimensions of the ships, which are recalculated at a later moment in time to confirm the final dimensions. Even with these recalculations, the interdependency between the subtasks remains clear.

The next quotation displays the reason for repeating some subtasks in case of some changes in the specifications.
“In practice we will repeat all the iterations just to comply with the accuracy that is expected. There is enough experience and knowledge to estimate if the price will be 100 million or 120 million Euros according to the request of the customer. In case of any changes, we need to make some iteration to narrow the price down to plus or minus 5%. And eventually the price needs to be calculated within a range of plus or minus 1%.”

For small changes during the design and calculation, the effects are not too hard to predict. For large changes, the whole design and calculation process unfortunately needs to start all over again. This indicates it is difficult to predict effects in case of large changes during the execution of the work.

**Knowledge sharing within the department**
The sharing of the knowledge in this department is done primarily through personalization. Since this strategy has been used for the last decades to retain personal knowledge, it is likely to be a reason for the lower levels of standardization.

For inexperienced and experienced employees, the static knowledge of the department is shared primarily through personalization. For inexperienced employees there, is a structured master-apprentice relationship through which experience and skills are being shared. This process is supported by stored information from previous vessels and seems to be working well. However, there are some remarks concerning the absence of knowing who knows what and where information can be found. The sharing of knowledge between experienced employees is done in multiple ways. When projects are handed over between employees, there is face-to-face communication. Furthermore, work from less experienced employees is checked by more experienced employees and project information is stored in calculation and specifications. Additionally, senior managers and group leaders provide advice if required. This strategy is performing well. However, there seems to be insufficient time to start communication on this personalized knowledge.

This reuse of assumptions is also primarily taking place through personalized knowledge. This strategy is not working well enough since it is unknown which employee is working on which topic, within or across departments. The preferred strategy for this department is to codify these assumptions more often. This makes it easier to reuse the assumptions when starting a new project.

The reuse of other information from the projects is characterized by individual knowledge retention. Personal skills and best practices are not shared but only reused at the individual level. Other information is extracted from codified knowledge in drawings, specifications, and schedules. However, a lower reliability of this data makes personalization favourable.

**Concluding**
Based on the collected data, the next conclusion can be drawn for this department.

The task frequency level tends to be medium. Both high and low, repetitions are present and there is a medium level of standardization of the work process. The task heterogeneity level also tends to be low. There is a low amount of variance and assumptions and other information is often reused. With regard to causal ambiguity, the level tends to be high. Work is considered to be complex. Additionally, there is a medium amount of subtasks, which are executed, both serial and parallel. This makes the interdependencies unclear.

Inside the department, knowledge is shared primarily through personalization. With regard to learning lessons, the knowledge sharing strategy is personalization, which is working well in this department. With regard to knowledge reuse, this strategy is performing low. With regard to sharing assumptions and information, the strategy is also performing not well enough.
6.5 Case description CB-D2

Task information

The primary task of this department is converting a basic design into a detail design. This task is divided into two phases. The first phase is called the basic engineering and concerns primarily the mapping of the ship, fitting all the components at the right places, specifying the components, sending requests to suppliers, and making calculations to determine the right dimensions, capacity, strengths, and stiffness. The second phase is called the detail engineering and concerns adding information in order to produce the ship and its components. In this phase, the production location also needs to be taken into account. In total, this department consists of 90 employees of who half is involved in mechanical engineering or shipbuilding.

Task frequency

The repetitive character of the work within this department is considered to be low. In the last 10 years, about 30 ships have been engineered. In the last few years, there have been eight project teams who have engineered eight ships simultaneously for one year. When comparing this with the other involved departments in this research, the frequency level is considerably lower.

The level of standardization in this department is qualified as ‘medium’ to ‘high’. The process is standardized in such a way that the same consecutive steps are made in order to engineer a ship. However, since Department 2 is focused on custom designed products, there needs to be enough freedom in the process in order to incorporate the request from the customer. With an increasing amount of details added to the process, the level of standardization is lowered. The next quotation shows how the level of standardization is being classified:

“We try to reuse standard components as much as possible. Currently we are considering reusing parts of the construction by, for instance, copying a deckhouse from ship A to ship B. This needs to be done in accordance with the design and cost estimation department and needs to result in a reduction in cost price of the ship. The procedure, the division of work and the order of task execution is standardized. However, there is a tension with the aspect ‘custom built’ since customer requests need to be incorporated.”

In order to execute these work activities, the department primarily uses static knowledge. Most of this knowledge originates from the previous executed project inside the department. The small amount of dynamic knowledge is generated at the R&D department. Over time, this dynamic knowledge becomes static when it has been implemented in a couple of ships.

Task heterogeneity

When comparing the work that needs to be executed in different projects, there is a medium amount of variance for this department. Since the ships are custom built and custom designed, the results of the projects are different. However, there is a low variance in the process and type of work that needs to be executed. The amount of variance increases when more details are considered. The amount of calculations is becoming different and dimensions are changing. However, the primary process is the same, over and over again, which results in a low variance in the tasks of this department.

During the engineering of a ship, many assumptions are being made both explicitly and implicitly. This is, again, possible due to the low variance in the engineering process. The usability of these assumptions is still dependent on the specific requirements of the client. This means they are judged if they are being reused. Other information is reused with a medium frequency. Because of the custom-built character of the product, it is not possible to reuse everything. However, reinventing the wheel is avoided by reusing information when possible.

The occurrence of exceptions is linked to engineering of custom-built ships and the presence of variance in the process. In case of an occurrence, the problem solving process is primarily focused on
employees and involves doing research or asking colleagues for their knowledge. Documents are only used to backup the final results of this problem solving process but are not used to store the results afterwards.

**Causal ambiguity**
The level of complexity of work in this department is considered to be medium. Since there is a lot of experience inside the department, there is not much complexity in the technological part of the engineering process. Nevertheless, because the ships are custom built, the work is more complex compared to the engineering of standard ships. This medium level of complexity is primarily determined by the preconditions of the project.

The amount of subtasks in this department is higher compared to the preceding department. More disciplines are involved in the process and more details need to be added to the design of the ship. The majority of these subtasks are executed simultaneously, as long as the required information is present. Since there are multiple projects running at the same time, there are also multiple different work activities running parallel to each other. For individual employees, the interdependency of their tasks remains clear. However, when looking at the whole department and having multiple employees and disciplines involved in the process, this interdependency becomes more unclear. On an individual level, it therefore is possible to predict the effect of changes on the design. For the whole department it is, however, harder to make these predictions. Additional time and calculations are required to make the effects clearer.

**Knowledge sharing within the department**
The sharing of the knowledge in this department is done primarily through personalization.

Knowledge within this department is shared with new, inexperienced employees through personalization. This employee is paired with a more experienced employee resulting in a master-apprentice relationship. In this way, they get to know each other and knowledge is shared from one person to the other. In order to be less dependent on the experienced employees, some junior employees have created a small introduction folder. In this folder, information is stored on the network structure, the location of the book with standards, and which person knows what. This process of sharing knowledge is well structured and well performing.

The sharing of knowledge between experienced employees is not performing well. Personal experiences are not, or not well enough, shared with others. There is also not enough guidance of the group leaders or lead engineers on the sharing of personal experiences or best practices. In addition to this lower performance on the personalization strategy, there are also some issues with the use of supporting codified knowledge. Due to different demands in quality, it remains unclear if knowledge is usable across different projects.

“A very experienced client demands easy access to critical components of a ship by using stairs or plateaus in order to carry out maintenance. For a client in Africa with far less experience, this is not essential since they will build their own wooden plateau if necessary. It is important to keep track on these different demands of quality. Otherwise the ship will offer a higher level of quality which is more expensive.”

Since there is no explicit storing of these assumptions, the primary strategy for sharing them is personalization. Reusable information from previous projects is shared through both sharing strategies where the alignment of standards and sharing of experiences involves personalization. For these situations, the sharing strategies seem to be working sufficiently. However, they are open to improvements.

In case of any problems during the work activities, the solving process is primarily focused on employees and involves doing research or asking colleagues for their knowledge. Codification is only
used to backup the final results of this problem solving process but is not used to store the results afterwards.

**Concluding**

Based on the collected data the next, conclusion can be drawn for this department.

The task frequency level tends to be low because of the low amount of repetitions per year and only a medium level of standardization of the process. The task heterogeneity level tends to be high. Analyzability is high despite the fact that there is a medium amount of variance and a medium reuse of information. With regard to causal ambiguity, the level tends to be high, although the complexity is medium. There are many subtasks that are executed parallel to each other resulting in an unclear interdependency.

Inside the department, knowledge is shared primarily through personalization. With regard to learning lessons, the knowledge sharing strategy is personalization, which seems to be working well for this department. With regard to knowledge reuse, this strategy is not working well enough for this department. With regard to the reuse of assumptions and other information, the sharing strategy is performing average.

### 6.6 Testing design propositions

In these sections, the design propositions are compared to the data collected from the interviews. In order to easily link to the information from the interviews to the design proposition, an overview was created in MS Excel and added to the appendices (Appendix N).

Again, the next abbreviations were assigned to the different departments in the different PMC’s:

- SC-D1 = PMC Standard – Department 1
- SC-D2 = PMC Standard – Department 2
- CB-D1 = PMC Custom – Department 1
- CB-D2 = PMC Custom – Department 2

There were four different outcomes for the test: ‘supported’, ‘not supported’, ‘partially supported’, or ‘no evidence’. Below, these options are elaborated.

First, a design proposition was supported when there was a match between the theoretical proposition and the practical situation including an average or good performance of this strategy in practice. The performance of the practical situation was deducted from the interviews. The performance needed to be positive, otherwise there was a possibility of an outperforming different strategy, providing no support for the design proposition.

Secondly, there were three circumstances in which no support was found for a design proposition. First, the theoretical and practical sharing strategies were in line, but in practice, this strategy was performing badly. In this situation, there was possibly another strategy performing better in practice. Secondly, the theoretical and practical sharing strategies were different including an average or good performance in practice. In this situation, there was evidence of an outperforming sharing strategy in practice compared to the theoretical strategy. This resulted in an unsupported design proposition. Third, and finally, if both strategies were used in practice and the performance was bad, the design proposition was also not supported.

Partial support was the third outcome of the test for the design propositions. There were three circumstances where this outcome could occur. First, there was no clear primary sharing strategy but both strategies were used equally. When this situation was performing well, supporting evidence was provided for both strategies, resulting in only partially supporting the strategy in the design propositions. Secondly, there was only a partial support when the theoretical and practical strategies were different and the latter was performing badly. This situation showed the used strategy was not
performing well, indicating that it was possibly not the best strategy for this situation. The strategy from the design proposition was likely to perform better. However since there was no direct evidence for this design proposition, there was only a partial support for it. The final situation for partial support occurred when performance of a strategy was unknown. Whether the strategies were in line or not, the proposition was not supported. Since there was some evidence present, the only remaining outcome was partial support.

The final outcome of the test was the absence of evidence on a design proposition. There were two situations where this outcome was used. First, when the design proposition did not apply to the practical situation, for instance, when a task had a high task frequency, no evidence was found on the design proposition with a low task frequency. The second situation when no evidence was found for the design proposition occurred when there was no clear score on the task characteristic. For instance, when task frequency was both high and low (medium), the results of the testing were likely to become contradictory making them unusable.

The next table provides an overview of the possible outcomes when testing the design propositions. Every proposition was first tested per individual department. This was done by using information from the interviews, which results in one of the outcomes from table 3. These partial outcomes of the design proposition test corresponded to a situation number of table 3. This number was added to these partial outcomes. Additionally, the occurrence of every situation was added to the same table. The outcomes from all the independent departments resulted in a final outcome for the whole design proposition.

<table>
<thead>
<tr>
<th>Situation #</th>
<th>Outcome</th>
<th>Theory practice</th>
<th>vs. Practical performance</th>
<th>Occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Supported</td>
<td>In line</td>
<td>Average or good</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Not supported</td>
<td>In line</td>
<td>Bad</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Not in line</td>
<td>Average or good</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Both strategies</td>
<td>Bad</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>Partially supported</td>
<td>Both strategies</td>
<td>Average or good</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Not in line</td>
<td>Bad</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>All situations</td>
<td>Unknown</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>No evidence</td>
<td>Design proposition focus on other characteristics level</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>Both high and low levels on a task characteristic</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

### 6.6.1 Testing DP1
Design proposition 1 was formulated according to Hansen et al. (1999):

**Design proposition 1**

For high frequent tasks from which knowledge needs to be reused, a codification strategy is required in order to improve knowledge sharing.

The SC-D1 department scored ‘high’ on the task frequency level, and used both the personalization and the codification strategy for sharing knowledge. Despite the fact that the performance of these strategies was average, there was no full support for this design proposition since both strategies were used equally. Therefore, this design proposition was only partially supported for the SC-D1 department. This corresponded with situation 5 in table 3.

The SC-D2 department also scored ‘high’ on the task frequency level, and used primarily a personalization strategy to share their knowledge. Since the performance of the practical situation was unknown, there was only partial support for this design. This corresponded with situation 7 in table 3.
The CB-D1 department scored ‘medium’ on the task frequency level since both high and low frequencies are present. This made it difficult to draw any conclusions on the design proposition. Therefore, the information from this department was not used regarding this design proposition. This corresponded with situation 9 in table 3.

Finally, the CB-D2 department scored ‘low’ in task frequency. The information from this department provided no evidence for this design proposition. This corresponded with situation 8 in table 3.

Overall, the data collected from the interviews provided partial support for this design proposition. The performance of the personalization strategy was unknown where the use of both strategies seemed to be performing average.

6.6.2 Testing DP2
Design proposition 2 was formulated according to Zollo & Winter (2002):

<table>
<thead>
<tr>
<th>Design proposition 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>For high frequent tasks from which lessons need to be learned, a personalization strategy is required in order to improve knowledge sharing.</td>
</tr>
</tbody>
</table>

All the departments characterized their knowledge as being static. Present knowledge was primarily reused and learning was limited to a small amount of new knowledge. This indicated no evidence was found for this design proposition in the research group. This corresponded with situation 8 in table 3.

6.6.3 Testing DP3
Design proposition 3 was formulated according to Hansen et al. (1999):

<table>
<thead>
<tr>
<th>Design proposition 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>For low frequent tasks from which knowledge needs to be reused, a personalization strategy is required in order to improve knowledge sharing.</td>
</tr>
</tbody>
</table>

The SC-D1 and SC-D2 departments scored ‘high’ on the task frequency level and were, therefore, not providing any evidence for this design proposition. This corresponded with situation 8 in table 3.

The CB-D1 department scored ‘medium’ on the task frequency level since both high and low frequencies were present. This made it difficult to draw any conclusions on the design proposition. Therefore, the information from this department with regard to this design proposition was not used. This corresponded with situation 9 in table 3.

The CB-D2 department scored ‘low’ in task frequency and used a personalization strategy to share their knowledge. Despite the fact that this was in line with the design proposition, the performance in practice was poor resulting in no support for this design proposition. This corresponded with situation 2 in table 3.

Overall, the data collected from the interviews provided no support for this design proposition.

6.6.4 Testing DP4
Design proposition 4 was formulated according to Zollo & Winter (2002):

<table>
<thead>
<tr>
<th>Design proposition 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>For low frequent tasks from which lessons need to be learned, a codification strategy is required in order to improve knowledge sharing.</td>
</tr>
</tbody>
</table>
All the departments characterized their knowledge as being static. Present knowledge was primarily reused and learning was limited to a small amount of new knowledge. This indicated no evidence was found for this design proposition in the research group. This corresponded with situation 8 in table 3.

### 6.6.5 Testing DP5

Design proposition 5 was formulated according to Zollo & Winter (2002):

<table>
<thead>
<tr>
<th>Design proposition 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>For tasks with a high level of heterogeneity, a codification strategy is required in order to improve knowledge sharing.</td>
</tr>
</tbody>
</table>

The SC-D1, SC-D2, and CB-D1 departments scored ‘low’ on the task heterogeneity level and were therefore not providing any evidence for this design proposition. This corresponded with situation 8 in table 3.

The level of task heterogeneity for the CB-D2 departments was considered ‘high’. Furthermore, this department used the personalization strategy to share their knowledge. This provided no support for the design proposition. Additionally, the performance of this contrary strategy was average. This corresponded with situation 3 in table 3.

Overall, the data collected from the interviews provided no support for this design proposition. Additionally, the performance of the strategy used in practice provided evidence for a slightly outperforming practical situation compared to the theoretical proposition.

### 6.6.6 Testing DP6

Design proposition 6 was formulated according to Zollo & Winter (2002):

<table>
<thead>
<tr>
<th>Design proposition 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>For tasks with a low level of heterogeneity, a personalization strategy is required in order to improve knowledge sharing.</td>
</tr>
</tbody>
</table>

The SC-D1 department scored ‘low’ on the task heterogeneity level and used for their knowledge sharing both the personalization and the codification strategy. Despite the fact that the performance of these strategies was good, there was no full support for this design proposition since both strategies were used equally. Therefore, for the SC-D1 department this design proposition was only partially supported. This corresponded with situation 5 in table 3.

The SC-D2 department also scored ‘low’ on the task heterogeneity level and used primarily a personalization strategy to share their knowledge. Since this strategy was performing well, there was support for this design proposition. This corresponded with situation 1 in table 3.

The level of task heterogeneity of the CB-D1 department was also low. Since this department also used a personalization strategy, which was performing averagely, this again provided support for the design proposition. This corresponded with situation 1 in table 3.

Finally, the level of task heterogeneity of the CB-D2 department was considered ‘high’ and therefore not providing any evidence for this design proposition. This corresponded with situation 8 in table 3.

All together, the information from the interviews provided support for this design proposition. The used strategy in this situation was in line with the design proposition and performed well.
6.6.7 Testing DP7
Design proposition 7 was formulated according to Zollo & Winter (2002):

Design proposition 7
For tasks with high causal ambiguity, a codification strategy is required in order to improve knowledge sharing.

The SC-D1 and SC-D2 departments scored ‘low’ on the causal ambiguity level and were therefore not providing any evidence for this design proposition. This corresponded with situation 8 in table 3.

Both the CB-D1 and CB-D2 departments scored ‘high’ on the causal ambiguity level. In order to share knowledge, both departments used a personalization strategy. For the CB-D1 department, the performance of this strategy was unknown, resulting in no support for the design proposition. This corresponded with situation 7 in table 3. For the CB-D2 department, the performance of this strategy was average, also resulting in no support for the design proposition. This corresponded with situation 3 in table 3.

All together, the information from the interviews provided no support for this design proposition. The information indicated an average performance of the practical situation.

6.6.8 Testing DP8
Design proposition 8 was formulated according to Zollo & Winter (2002):

Design proposition 8
For tasks with low causal ambiguity, a personalization strategy is required in order to improve knowledge sharing.

The SC-D1 department scored ‘low’ on the causal ambiguity level. In order to share knowledge, this department used both the codification and the personalization strategy. Since the combination of these strategies seemed to be performing well, the design proposition was partially supported. This corresponded with situation 5 in table 3.

The SC-D2 department also scored ‘low’ on the causal ambiguity level. This department primarily used a personalization strategy to share knowledge. Since the performance of this strategy for this department was average, the information provided support for the design proposition. This corresponded with situation 1 in table 3.

The scores of causal ambiguity level for both the CB-D1 and CB-D2 departments were ‘high’. Therefore, these departments were not providing any evidence for this design proposition. This corresponded with situation 8 in table 3.

All together, the information from the interviews provided support for this design proposition. The same strategy was used and the performance was ‘average’ to ‘good’.

6.7 Conclusion and implications
In table 4, the results of the design proposition testing are summarized. The remainder of this section focuses on drawing conclusions on the testing, trying to explain some of the results.

The general tendency from the tests showed no support for design propositions where a codification strategy was used. Only the first design proposition was partially supported due to the presence of both the codification and personalization strategy.

The departments used both the personalization and codification strategy to reuse knowledge from high frequent tasks (DP1), which performed reasonable. This only partially supported the work of Hansen
et al. (1999). The current practice could be justified by Chai & Nobus (2012). The departments with high task frequency were relatively small, making the use of codification very expensive. Additionally, employees are easily connected making the sharing of implicit knowledge possible even for high frequent tasks. This justifies the use of personalization next to codification in case of knowledge reuse from high frequent tasks in this context.

Table 4: results design proposition testing

<table>
<thead>
<tr>
<th>#</th>
<th>Design proposition (DP)</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>DP1</td>
<td>For <strong>high frequent</strong> tasks from which knowledge needs to be reused, a codification strategy is required in order to improve knowledge sharing.</td>
<td>Partially supported</td>
</tr>
<tr>
<td>DP2</td>
<td>For <strong>high frequent</strong> tasks from which lessons need to be learned, a personalization strategy is required in order to improve knowledge sharing.</td>
<td>No evidence</td>
</tr>
<tr>
<td>DP3</td>
<td>For <strong>low frequent</strong> tasks from which knowledge needs to be reused, a personalization strategy is required in order to improve knowledge sharing.</td>
<td>Not evidence</td>
</tr>
<tr>
<td>DP4</td>
<td>For <strong>low frequent</strong> tasks from which lessons need to be learned, a codification strategy is required in order to improve knowledge sharing.</td>
<td>No evidence</td>
</tr>
<tr>
<td>DP5</td>
<td>For tasks with a <strong>high level of heterogeneity</strong>, a codification strategy is required in order to improve knowledge sharing.</td>
<td>Not supported</td>
</tr>
<tr>
<td>DP6</td>
<td>For tasks with a <strong>low level of heterogeneity</strong>, a personalization strategy is required in order to improve knowledge sharing.</td>
<td>Supported</td>
</tr>
<tr>
<td>DP7</td>
<td>For tasks with <strong>high causal ambiguity</strong>, a codification strategy is required in order to improve knowledge sharing.</td>
<td>Not supported</td>
</tr>
<tr>
<td>DP8</td>
<td>For tasks with <strong>low causal ambiguity</strong>, a personalization strategy is required in order to improve knowledge sharing.</td>
<td>Supported</td>
</tr>
</tbody>
</table>

All the departments were characterized by primarily re-using knowledge. This implies no evidence was found on learning from knowledge from high frequent tasks (DP2).

The result from DP3 justified the use of codification for knowledge reuse at low task frequency. This is contradictory to Hansen et al. (1999). The personalization strategy performed poorly due to the absent structure and procedures but also the dependency on employees. The use of codification would be justified for two reasons. First, knowledge would become independent on the limited individual memories (Zollo & Winter, 2002). Second, as the group size was large in this context, this would justify the use of codification, as there is a large amount of knowledge consumers at the department (Chai & Nebus, 2012).

Similar to design proposition 2, none of the departments was characterized by learning lessons from knowledge. This implies no evidence was found on learning from knowledge from low frequent tasks (DP4).

DP5 was not supported as the personalization strategy performed well, in contrast to Zollo & Winter (2002). Woodward (1958) provides some support for the results, stating non-routine work requiring an organic structure instead of a mechanistic structure for employees to work in. This explanation is only true if high heterogeneity is similar to non-routine work.

The testing of DP6 provided support for Zollo & Winter (2002) as personalization was used in case of low task heterogeneity. However, with an increase of group size, the performance seemed to drop. This could indicate the need for using a combination of both the work of Zollo & Winter (2002) and Chai & Nebus (2012): a low heterogeneity level within a small group requires a personalization strategy where a low heterogeneity level at a larger group requires a codification strategy.

In case of a high causal ambiguity, personalization was used instead of codification (DP7). Since the performance was only ‘average’, this could indicate the need for codification in order to cope with the high causal ambiguity. These improvements would support Zollo & Winter (2002) and also Chai & Nebus (2012) due to the group size.
The results for DP 8 supported Zollo & Winter (2002). Additionally, low ambiguity occurred within the smaller departments, supporting the work of Chai & Nebus (2012) to use the personalization strategy.

6.8  **Answering sub question 2 and the research question**

The second sub question for this research was formulated as follows:

| How are task characteristics linked to strategies for knowledge sharing? |

According to the results, it was difficult to provide a clear link between the task characteristics and the strategies for knowledge sharing. The main reason of the unclear relationship was the absence of codification as the primary knowledge sharing strategy within any department of the research group. All the design propositions concerning codification were unsupported unless the codification strategy was used together with the personalization strategy. Due to the absence of the codification strategy as a primary strategy, the corresponding design propositions all favoured personalization.

The link between the task frequency and the knowledge sharing strategy seemed not to be determined by the high or low frequency scores. According to the results, the sub characteristics ‘knowledge reuse’ and ‘learning lessons’ were linked to the sharing strategies. For ‘knowledge reuse’, a codification strategy was favoured, regardless of task frequency. For ‘learning lessons’ no evidence was found to favour any knowledge sharing strategy.

For task heterogeneity, the results only showed a supported link between low heterogeneity and personalization.

The results on causal ambiguity only showed a supported link between low ambiguity and personalization.

The research question of this study was formulated:

| Research question: |
| How can knowledge sharing be tailored to task characteristics? |

The test of the design propositions showed the knowledge sharing strategy could be tailored by causal ambiguity, task heterogeneity, and the purpose of sharing knowledge from tasks. The codification strategy needs to be used when knowledge from executed tasks needs to be reused. The human mind is unable to retain unlimited amounts of knowledge (Zollo & Winter, 2002) requiring the use of knowledge repositories to store explicit knowledge.

The personalization strategy needs to be used when tasks were very similar (low heterogeneity) and the cause-effect relation between tasks was clear (low causal ambiguity). For low heterogeneity, inferences were easily made. These could be shared through personalization and did not require any codification. The same reasoning hold for the low causal ambiguity. The effects of any changes were easily understood and communicated, not requiring any costs and effort to clarify it through codification.
Chapter 7 focuses on the fourth part of the reflective redesign by solving the research objective of this study:

**Research objective:**
*Provide the company with advice how to close the gap between the current situation of knowledge sharing ("ist") and its requirements ("soll").*

The advice for improvements was generated using the general model for a design process (Aken et al., 2012) (figure 9). The problem analysis part of this model is covered by chapter 5 and 6. The requirements are covered by the “soll”-situation in the next sections. These requirements were gathered in the brainstorm sessions per department. The sketching part of the design process was focused on determining a possible improvement point for the gap between the current and desired situation. The outline design focused on the initial advice for improvement points on which detailed information is provided.

The “soll”-situations were determined using a brainstorm session for each involved department. In these sessions, different targets, barriers, solutions, and limitations were formulated. These were used to determine the functional requirements, user requirements, boundary conditions, and design restrictions. The points of improvement were determined by analysing the low scores from the KM-scan, extended by comments from the interviews, and matching these points with the requirements of the desired state.

The improvement points are focused on two different organizational levels: corporate level and department level. On corporate level, improvement points are selected which are similar across all the departments. Additionally, these improvement points are too difficult to tackle by the individual departments. At the department level, the other, more easily adjustable, improvement points are selected that are similar across all the departments. The remaining improvement points for a specific department are discussed in Appendix O, Appendix P, and Appendix Q.

One remark is made before proceeding. Since Department 2 of the PMC Standard was unable to provide additional information, it was impossible to provide this department with a grounded advice on how to improve their performance regarding knowledge sharing.

### 7.1 Desired (“soll”) situations

This section is focused on answering the first sub objective:

**Determine the requirements of knowledge sharing at the involved departments of COMPANY X.**

The desired situations of the departments regarding knowledge sharing showed some differences and similarities. Table 5 shows which requirements were similar across all the departments. Next, these similar requirements are elaborated.

#### 7.1.1 Similar desired (“soll”) situations

**Functional requirements**

For all the involved departments, knowledge management initiatives needed to improve the efficiency at which work is executed. The efficiency was hindered due to multiple barriers. For some projects, fundamental knowledge to execute daily activities was unavailable, which increased the processing time of the activities. Additionally, essential technical personnel were not involved at the start of the projects decreasing the efficiency of these projects. This resulted redoing some work, which increased
the time and costs for the project. Table 5 shows all the functional and user requirements linked to improving the efficient work execution.

<table>
<thead>
<tr>
<th>Similarities</th>
<th>Functional requirements</th>
<th>User requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Reducing the amount and costs of mistakes</td>
<td>- Easy accessibility of tacit and explicit knowledge</td>
</tr>
<tr>
<td></td>
<td>- Centralized storing of fundamental knowledge</td>
<td>- Search for tacit and explicit knowledge using IT-systems</td>
</tr>
<tr>
<td></td>
<td>- Reusing available knowledge from colleagues</td>
<td>- Personal opportunity to learn from tacit and explicit knowledge</td>
</tr>
<tr>
<td></td>
<td>- Sharing knowledge within and across departments</td>
<td></td>
</tr>
<tr>
<td>SC-D1</td>
<td>- Retaining or increasing current knowledge level</td>
<td></td>
</tr>
<tr>
<td>CB-D1</td>
<td>- Collecting knowledge from different employees and IT-systems</td>
<td></td>
</tr>
<tr>
<td>CB-D2</td>
<td>- Maintaining knowledge through clear procedures</td>
<td></td>
</tr>
</tbody>
</table>

Supported by the scores in the KM-scan, the desired situation on knowledge sharing needed to make sure less errors and mistakes are made. Reasons for the amount and costs of mistakes were time pressure, the hesitation to ask questions, the inability to track changes during projects and absent case evaluations of completed projects.

The storing of designing and engineering knowledge was also regarded as a functional requirement by all the departments. Fundamental knowledge, which was used for multiple projects, needed to be stored at centralized locations, instead of in personal and decentralized disks in order to retain it, share it, and manage it. By storing the knowledge on a centralized position in the company, it becomes available, accessible, or visible to all employees. This is likely to improve the performance and efficiency of the work activities.

Tacit and explicit knowledge also needed to be reused in order to prevent wasting time on reinventing the wheel. Dredging is a very specific maritime sector making it difficult to find well-educated personnel. The redesign needed to make sure specialised employees are working as efficient as possible by reusing both tacit and explicit knowledge residing in the company.

Within all the involved departments, there was a need for more sharing of knowledge across the departmental boundaries. A lot of expert knowledge on technical and financial work activities was not shared across departments. In addition, knowledge on new technological developments stayed at individual employees or within individual departments. Additionally, the sharing of knowledge was not structured enough leaving it open to an employee’s own initiative.

**User requirements**
The similarities on user requirements focused on the usability of the knowledge that was shared. Two interrelated user requirements are the accessibility of knowledge and search ability of knowledge. There needed to be a clear and accessible structure to share knowledge. The systems that were going to be used to make tacit and explicit knowledge accessible, needed to be user-friendly and containing the option to search for knowledge. Explicit knowledge needed to be stored in one system requiring procedures on how to store and reuse this knowledge. For tacit knowledge that was only implicitly available at colleagues, another system was needed providing an overview of what knowledge is available at which employee.
The final user requirement on knowledge sharing for all the departments was the personal training for employees. More focus was required on the training of technical personnel instead of only management personnel. Additionally, employees needed to be provided with the possibility to extend their own tacit and explicit knowledge.

**Limitations**

Before proceeding to the points for improvement, one important limitation needs to be considered. When looking for solutions, special attention needed to be focused on internal solutions. Within the company, successful solutions were implemented locally. These solutions needed to be considered when looking for a solution to the points of improvement.

### 7.2 Points for improvement

This section is focused on answering the second sub objective:

Design the advice according to the requirements by using results from the problem analysis and other (situational) factors that are linked to knowledge sharing.

From the analysis of the current situation, the design propositions, and the departmental requirements on knowledge sharing, the following improvements points were selected. These points are selected by considering the similar functional requirements and the lowest scores from the KM-scans.

1. Promotion of knowledge management throughout the company
2. Clear corporate KM strategy
3. One knowledge sharing system for explicit knowledge
4. Employees rotation across departments to share implicit knowledge
5. Overview of required knowledge
6. Visible tacit and explicit knowledge
7. Errors and mistakes prevention

The first improvement point is essential and pre-conditional to all the other improvement points: the promotion of knowledge management throughout the company. With regard to the other improvement points, there are some that need to be improved on departmental level. Other improvement points need to be addressed on corporate level. Points 2 to 4 focus on redesigns at corporate level. The last 3 points (5 - 7) focus on redesigns at departmental level.

The advice for the improvements points is divided into two parts. One part is focused on general information about the advice and the other is focused on the implementation of the advice. The implementation of the advice is based on the Integral Organizational Model of Weggeman (1985). The solutions to the improvements points have been selected from internal solutions at departments of COMPANY X and tested method from the academic literature fitting best with the present circumstances.

### 7.3 Pre-conditional improvement: promotion of KM (point 1)

The organization of the company was hindering knowledge management initiatives. First, the work activities focused primarily on the development process of vessels, ships and other related products. Additionally, the employees were not provided any time to start knowledge management or sharing initiatives. These two characteristics were reinforced by performance assessments focused on the development processes and finance. No attention was paid to knowledge management activities since indicators on KM were not considered in performance assessments. This is negatively affecting knowledge management outcomes such as the efficient use of resources, and the performance and innovative power of the organization (Darroch, 2005).

The objective is to create a corporate support for knowledge management in order to make any knowledge sharing initiatives successful. Top management needs to take a leading role in the
promotion, motivation, and stimulation of knowledge management. The importance of knowledge management needs to be promoted to all the employees of the company. Additionally, the employees need to be motivated and stimulated to use the structured knowledge management activities.

The strategy is to start with the senior management support. This support contains sending messages throughout the entire company about the importance of KM to the company’s success and providing funding and other resources (Davenport et al., 1998). The importance of KM is embedded into the second success factor by linking it to business strategies and core values. The messages of senior management need to explain why and how KM helps COMPANY X to improve internationalisation, growth, cooperation, and innovation. This makes KM a natural step in accomplishing the corporate strategy requiring less persuasion of the employees (McDermott & O’Dell, 2001). Finally, there needs to be an alignment of the motivational practices to support KM. Reward and recognition of knowledge management show the importance of it to the company and demonstrates that the time and energy people spend on it accounts in their performance (McDermott & O’Dell, 2001). Knowledge management needs to become a criterion for the key performance indicators (KPI) in order to get the highest rating on the performance evaluation of employees (McDermott & O’Dell, 2001). Short-term incentives need to be highly visible since high-profile events generate considerable discussion among those not rewarded immediately increasing participation. Intrinsic motivation needs to be used by improving the confidence that shared knowledge is useful for the organization (knowledge self-efficacy) and to improve enjoyment in helping others (Lin, 2007).

In the structure of the organization, the board of directors and PMC managers need to incorporate knowledge management in their strategic plans for the company and make sure their vision on knowledge management is communicated throughout the organization. The HR managers need to develop KPI’s to see how well knowledge management is being implemented in daily work. The departmental managers need to provide the employees with the resources to start executing knowledge management activities. At the same time, they need to keep track on these activities to make sure they are executed correctly and effectively. The employees need to use the available resources to start managing knowledge and sharing it with colleagues and justifying the used resources to their superiors.

Assessment and control systems need to be used to determine whether the promotion, motivation, and stimulation of knowledge management are working effectively. From the top down, HR managers use KPI’s on knowledge management to determine whether the provided resources are used effectively and that knowledge management is improving. Strategic knowledge management KPI’s need to be focused on the performance of the KM activities in the Knowledge Value Chain. Operational knowledge management KPI’s need to be focused on the use of knowledge management facilities like archives, informal meetings, and presentations. From the bottom up, the assessment and control systems need to be used to determine whether the motivation is performing well enough and whether employees get enough time and freedom to execute structured knowledge management activities.

The management style for this advice needs to focus on coaching (Hersey & Blanchard, 1969) as it is characterized by a high directive and high supportive behaviour. Employees need to be informed about the importance of knowledge management and management needs to make sure knowledge management activities are executed. Employees also need to be supported by the motivation and stimulation from the managers.

Personnel need to be informed about knowledge management and its importance to the company. In order to effectively executed knowledge management activities, both knowledge workers and managers need to be trained on how to execute these activities. Managers also need to be trained on checking the outcomes of knowledge management activities and improving their coaching competences to make the required management style work effectively. HR managers need to focus on incorporating KM activities in individual performance assessments. Other business analysts need to incorporate the KM in the other KPI’s of the company, showing its importance and performance.
Within the organization there needs to be a culture in which not only physical labour and product development activities are regarded as important. Management of knowledge also needs to be regarded as important since knowledge is very important for knowledge workers to complete their tasks (Weggeman, 2001). Corporate level advice (points 2 – 4)

7.3.1 Clear KM strategy (point 2)
There needs to be a clear knowledge management strategy for the entire company. The analysis of the “ist”-situations at each department indicated there was no clearly defined and distributed knowledge management strategy for the entire company. Only some local ad-hoc strategies were used at the departments. Additionally, low scores on the first activity in the Knowledge Value Chain (required knowledge) were likely the result of the absence of mission, vision, objectives, or strategies regarding knowledge management. By formulating a corporate KM strategy, the KM activities become more structured and both the knowledge awareness and Knowledge Value Chain are likely to improve.

RESEARCH CENTER, the knowledge centre of the company, has successfully used the guideline of Co-Capacity B.V. (2010) to determine their KM strategy. This guideline focuses on the collective ambition in the area of knowledge, the current KM status, and the creation of solutions and implementation plans.

The advice is to have a corporate knowledge management strategy before June 2014 including department level work plans. At least 50% of all knowledge workers need to be involved in the development process of this strategy, representing all the business unit of the company.

The strategy is to develop the knowledge management strategy for the whole company by using the guideline of Co-Capacity B.V. (2010). All the business units in the company need to be represented in this process to ensure the current KM status of the company is accurate. Additionally, the work plans need to be developed by those employees who are going to execute them.

The structure to organize this advice begins at the top managers of the company. They need to create a work group in which all the PMC’s, business units, and departments are represented. PMC and business unit managers need to delegate information gathering activities to department managers and employees and need to be involved in the development of working plans. The department managers need to provide the work group with all the information on the current KM status and monitoring the execution of the working plans.

The guideline from Co-Capacity B.V. (2010) provides a detailed system on how to create a corporate knowledge management strategy and the corresponding work plans for the departments. This guideline is based on the systems of Weggeman such as the Integral Organizational Model (1985), the Knowledge Value Chain (2001) and the Knowledge Management scan (2006).

For this advice, a directing leadership style is required (Hersey & Blanchard, 1969) as management needs to tell what needs to be done. This leaves no room for supportive behaviour. Additionally, there needs to be a high control on the execution of the guideline through a detailed description of what information is required and what kind of strategy is going to be implemented.

No change is necessary in the personnel of the organization. All employees and managers need to be involved in the process. Management is involved in all steps of the guideline where lower level employees are involved by providing information on the current situation.

The organization needs an open culture to determine their KM strategy. This open culture involves being approachable and honest about the current situation in the company but also about what needs to be improved and how. The organization also needs to motivate involvement by conducting individual or small group interviews complemented by reporting afterwards. Additionally, indicating the importance of knowledge contribution to the company (knowledge self-efficacy) and praising the
involvement in knowledge management activities need to be used as intrinsic motivations (Kankanhalli et al., 2005).

### 7.3.2 One knowledge sharing system for explicit knowledge (point 3)

The company needs a corporate and user-friendly IT-system to share explicit knowledge across departmental boundaries. In the “ist”-situation, the explicit knowledge was stored in multiple systems. This made it difficult to search for the correct knowledge, since it was unclear which system needed to be used and what knowledge was reliable and up to date. Additionally, the systems seemed to be user-unfriendly. One, central IT-system needs to provide more structure to the sharing of codified knowledge, both across departments and within individual departments. Since the knowledge sharing system needs to cross all the department borders and needs to be used throughout the company, this improvement point requires cross-departmental and therefore corporate level attention.

The advice is to have a one corporate IT-system ready for implemented before June 2015 in order share explicit knowledge. Together with this system, procedures need to be available to guide the codification process.

The strategy for this advice is to facilitate the sharing of codified knowledge. This requires the creation of procedures to codify knowledge but also an IT-system serving as a knowledge repository. The procedures for codification need to be focused on theories, formula, procedures, manuals, schemes, etc. Specific information on products needs be stored in a product data management (PDM) system. The procedures also need to guide the codification process in order to create one singular structure for the codified knowledge. This process is supported by creating standardized input frameworks for the knowledge repository. The eventual IT-system needs to make sure knowledge is structured clearly and supporting knowledge workers to easily add, change, reuse, and find codified knowledge.

The structure of the system needs to be focused on communities-of-practice (COP) instead of departments or business units. Employees with similar knowledge throughout the company need to be put into a virtual community. A clear knowledge base is created for each COP that is shared between employees and even between departments. One of the experts in the community is assigned to be the knowledge champion who is responsible for maintaining the structure within the COP.

The system needs to provide clear procedures to codify explicit knowledge and needs be user-friendly. All the explicit knowledge needs to be codified using the same procedure containing topics like a summary, detailed information of the knowledge, and who contributed to this knowledge. Search abilities and clear layouts combined with structured knowledge make the system user-friendly.

Management needs to coach the employees in the usage of this advice (Hersey & Blanchard, 1969). There needs to be high directive behaviour by management to make sure the employees are going to use the knowledge repository. At the same time, there needs to be a supporting behaviour of management to the COPs regarding what fundamental knowledge needs to be codified.

To make the implementation of the system successful, a couple of groups need to be consulted. First of all, some knowledge workers need to be involved since they are able to indicate which functionalities need to be facilitated in the IT-system and what procedure is required for codified knowledge. Department managers also need to be consulted since they have a good overview of the available knowledge at the department and how it needs to be categorized. Finally, IT-specialists need to be consulted to determine the actual IT-system and how it is going to be managed.

After the entire system is operational, all the users of the system need to be trained in using the system to make sure it is used in the right way for both sharing and reusing explicit knowledge.

The system needs to become the primary knowledge repository of the company. Users need to appreciate the explicit knowledge being shared and need to be willing the add knowledge spontaneously. Intrinsic benefits like knowledge self-efficacy and enjoyment of helping others have
proven to improve the use of electronic knowledge repositories (Kankanhalli et al., 2005). In addition, operational KPI’s like contribution and usage of the knowledge repository need to be used to create a supporting culture for the sharing of explicit knowledge.

7.3.3 Employee rotation across departments to share implicit knowledge (point 4)

In order to improve the sharing of knowledge through personalization, there needs to be more rotation of employees. In this way, employees become more aware of available tacit knowledge at other employees and departments. Additionally, this improvement point improves organizational learning and the interpersonal relationship between departments and business units. Since there needs to be agreements between departments with regard to the rotation of employees, this is an improvement point that requires higher organizational involvement.

There are some advantages and disadvantages to the application of job rotation (Kennedy, 1993). By rotating experts away from their current position, the work at this department is likely to suffer from a decrease in efficiency. For experienced employees this decrease in efficiency might be larger in comparison to inexperienced employees (Ortega, 2001). Another important disadvantage is the increase of costs due to job rotation. However, job rotation also increases collegiality, understanding of the company, knowledge sharing, and innovation while reducing work stress and boredom (Kennedy, 1993).

The objective is to have job rotation operational within the business units for every new inexperienced employee before June 2014. For more experienced employees, job rotation within and across PMC’s needs to be available at the end of 2014.

The strategy for this advice is twofold. New inexperienced employees rotate through all the consecutive departments of the PMC to become familiarized with the development process. This provides these employees with a better overview of the business unit and the interdependency of the departments and functional groups. These new employees will stay at each department for a couple of months, completing the rotation across the entire product development process in one year. For more experienced employees, rotation needs to be available within and across PMC’s. This supports the option either to use expert knowledge at the same department in a different PMC or to acquire new knowledge at a different department, regardless of the PMC. By making this rotation last for a longer period (12 to 18 months), employees are provided enough time to be acquainted with the new knowledge or situation.

The structure of this advice is focused on human resources management and department managers. Human resources need to keep track on the amount of employees rotating and the possibilities for rotating inside and outside the business unit. The departmental managers need to provide support for rotating employee such as structures training or linking to experts.

The procedures for job rotation need to guide both strategies for job rotation. New employees need to be provided with guidance during the rotation through the development process. For more experienced employees the system needs to identify the specific reasons for rotation and the available positions for rotation within the company. The human resources departments monitor both systems.

The management style for this advice needs to be focused on supporting job rotation (Hersey & Blanchard, 2005). Together with the employee, a plan is made on the entire rotation process including the objectives of the rotation. This means that there is a low degree of directive behaviour and a high degree of supportive behaviour.

For the personnel, changes need to be made at the human resource department of the company. They are structured according to the division structure of the company. To make job rotation usable throughout the company, a work group needs to be created containing one HR employee from every division.
This advice requires a supporting culture. All organizational members need to believe that job rotation will improve knowledge sharing on the long run despite of the lower efficiency level of a rotating employee at the short run.

7.4 Department level advice (points 5 – 7)

7.4.1 Overview of required knowledge (point 5)
The scores of the KM-scan showed a low performance on the required knowledge at multiple departments. One possible explanation for this low score could be the absence of a clear strategy with regard to knowledge sharing. When this strategy is missing, it is difficult to determine the required knowledge at the department. This effect is likely to keep on going through the Knowledge Value Chain (Weggeman, 2006) and also affect knowledge sharing. Since the overview of required knowledge is different for each department, this point needs to be improved within each individual department. The presence of a corporate KM strategy is a requirement for this advice. From this strategy, the following parts need to be determined: required information, required technical capabilities, and the desired experience and attitude. When combined, these parts provide an overview of the required knowledge to execute the strategy.

The objective is to have an overview of the required knowledge for each department at the end of June 2014 categorized into functional groups. This overview needs to be supported by 50% of the employees in the department to make sure most of the required knowledge is incorporated in the overview. Additionally, updating this overview needs to be part of the medium and long term plans of the departments.

The strategy is to have a brainstorm session with employees from all levels of the department. In this session, an overview is created of the required information and technical capabilities including the desired experience and attitude to execute the work activities of the department. This activity needs to be executed explicitly and linked to the mission and vision of the company and the objectives of the department. Weggeman (2001) states that a poor execution of this activity has negative consequences on other activities in the Knowledge Value Chain (Weggeman, 2006). Since this overview is only a snapshot, frequent updating is required which needs to be part of the medium and long term plans.

Department managers are responsible for the execution of this advice. They need to plan the brainstorm session, assign an independent session leader, and make sure all different levels of employees are involved in the process. The employees have the responsibility to check the eventual overview and make sure all the required knowledge is represented.

There is no specific system required for this advice besides several steps of the brainstorming session. First, all different products of the department need to be listed. For every product, all the required work activities need to be added to this list. For all these work activities, the required knowledge is determined. All the required knowledge is finally aligned to create an overview for each functional group.

Management needs to use a supporting leadership style (Hesley & Blanchard, 1969) since there needs to be collaboration with employees of all levels of the department. Together a complete overview needs to be created of the required knowledge. This management style consists of a low degree of directive behaviour and a high degree of supportive behaviour, which is needed to get full involvement of all concerned employees.

This advice does not require any changes in personnel or the work force, except for assigning an independent brainstorm session leader. An internal knowledge management expert would be preferable, as this employee knows the company and the purpose of the brainstorm session.
Department managers need to emphasize the value of the involvement and employees need to believe their contribution is useful, appreciated, and not judged on being good, bad, right, or wrong. This signals the need for an open and supporting culture.

7.4.2 Visible tacit and explicit knowledge (point 6)
The implicit and explicit knowledge in the organization needs to be visible within and across departments. The scores in the KM-scans showed low scores on the distribution of available knowledge and the use of archives. Next, there were also some requirements focused on sufficient contact and communication between employees, good accessibility and search ability of tacit and explicit knowledge, and a good balance between storing knowledge and individual creativity.

The visibility, availability, and accessibility of explicit knowledge can be facilitated by the IT-system to share explicit knowledge (section 7.3.2). This makes the codified knowledge available and accessible for other direct or indirect colleagues.

For the visibility of implicit knowledge, another system is required. Since this type of knowledge resides in the mind of the employee, other employees have to know which employee has knowledge on what topic (“Who knows what?”). By extending a yellow pages system (who is who) with transactive memory, knowledge topics are linked to employees making it possible to know who knows what. This system works in two ways. First, employees are able to search on a specific knowledge item and see who is a knowledge carrier of this topic. The other way around, this system provides information on employees regarding what knowledge they possess.

The objective is to have 75% of all employees regularly searching for both tacit and explicit knowledge at the end of 2014. With regard to tacit knowledge, at the end of 2014 all employees of the company need to be incorporated in the extended yellow pages system indicating their expert knowledge areas. For the explicit knowledge, the objective is stated in section 7.3.2.

The strategy is to have a corporate transactive memory system operational at the end of 2013. This system needs to have a layout that is user-friendly, clear, and facilitating easy navigation and search abilities. By integrating it into the present yellow pages system (smoelenboek), the total system provides contact information on employees but also their knowledge area(s). In 2014, both the extended yellow pages system and knowledge repository (section 7.3.2) need to be promoted through newsletters including statistics on the usage of the systems. At the end of 2014, all the knowledge workers need to have accurate and up to date information in the extended yellow pages system about their knowledge expertises and need to be assigned to a community-of-practice in the knowledge repositories.

The structure of the system needs to be focused on high responsibilities for the users of the system. They need to keep their information up to date and check whether information from colleagues is correct and complete. Department managers or human resources management also need to keep track on the correctness of the information and the usage of the system.

The transactive memory of the yellow-pages system needs to be filled and maintained using specific instructions. The entering of information into the system needs to be done using a specific, predetermined form containing personal contact information and specific knowledge areas. To validate the entered information, an option needs to be available for colleagues to leave a comment or rating on the knowledge area.

Two different management styles are required for the implementation of this advice. With regard to the transactive memory in the yellow-pages system, a directive management style is required (Hersey & Blanchard, 1969) as employees need to be told to enter their information into the system and to keep it up to date. With regard to knowledge repository, the management style needs to be focused on both high directive behaviour and high supportive behaviour, which is a coaching leadership style (Hersey & Blanchard, 1969). The active use of the system needs to be supported and checked.
There are no specific requirements for personnel in order to implement this advice.

The required culture for this advice is focused on a high amount of trust, knowledge self-efficacy, and enjoyment of helping colleagues among the employees. Interpersonal trust is necessary for this experience as well as the effort of knowledge workers to share the correct tacit and explicit knowledge. Additionally, the contribution of knowledge and helping others needs to be fostered and improved.

7.4.3 Errors and mistakes prevention (point 7)

At all the departments, existing problems and mistakes need to be corrected and prevented in the future. The KM-scans showed low scores on making mistakes due to missing knowledge and learning from mistakes of others. One possible cause for these scores is the absence of case evaluations of completed projects. In order to learn from mistakes, they need to be identified, which is possible through evaluations. Additionally, employees have to be motivated to report mistakes in order for others to learn from them.

The objective of this advice is to report 80% of all errors and mistakes by the end of 2016. Before June 2014, a system needs to be ready for implementation to provide corrective and/or preventive action to the reported errors and mistakes.

The strategy is focused on logging and solving as many errors as possible using a structured system. This implies the employees need to be motivated to report errors without hesitation. After a fixed period, reported errors and mistakes need to be analysed. Underlying problems and similar errors need to be identified and the magnitude of the problem needs to be determined. After temporary solving critical errors, investigation plans need to be created for all the underlying problems. These plans need to be executed including thorough analysis of direct and indirect causes of the problem. Afterwards, the completion of the plan and all the related documents need to be evaluated.

A committee needs to be created containing a fixed group of employees of the department. This group is responsible for the analysis of the reported errors and mistakes. They meet once every 3 months to initiate all steps of the system and make sure the reported errors are handled. The outcomes of the system need to be communicated throughout the department or company. Additionally, department management needs to make sure all preventive actions are known with all employees.

The system needs to contain all the required procedures and guidelines to make sure errors are investigated thoroughly and corrective and preventive action is developed, implemented, and evaluated. Additional to this system, there needs to be a repository that can be used to store identified errors as well as the implemented corrective and preventive action. This second system is required to make sure employees and managers are able to learn from the mistakes of others, regardless of the position in the organization.

The management style for this advice needs to be focused on high directive behaviour and high supportive behaviour. There needs to be a high support for the collective effort to collect all the errors made in the department and trying to uncover the causes for the errors and mistakes. Additionally, management needs to monitor the execution of the corrective and preventive action as development through the system.

There is no special training needed for the employees. Human resources management and department management should only keep in mind that employees involved in the committee require time to execute all the steps in the error prevention system. This implies less time is spent on the development process activities of the department.
The required culture for this advice is focused on maintaining job security for all employees. Managers need to convince subordinates to report errors without having to worry about individual consequences.

7.5 An implementation plan

The section provides a preliminary implementation plan of the improvements points. The (sub) tasks are determined from the improvement point descriptions from the previous sections. The total duration of the tasks is determined by using existing guidelines (when available), making estimation of required elaboration of collected data, and assuming the task are not executed full-time but part-time.

The execution of the (sub) tasks is divided among several groups of employees. Next, a table of these resources is provided.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>All employees</td>
<td>All the employees need to be involved in this task</td>
</tr>
<tr>
<td>BoD</td>
<td>Board of Directors</td>
<td>The board of directors of the company</td>
</tr>
<tr>
<td>D/BU Man.</td>
<td>Department or Business Unit Management</td>
<td>The managers of the different business unit or departments in the company</td>
</tr>
<tr>
<td>Error com.</td>
<td>Error committee</td>
<td>The committee responsible for the analysis of errors and mistakes</td>
</tr>
<tr>
<td>HRM</td>
<td>Human Resource Management</td>
<td>The managers and employees of the human resource department</td>
</tr>
<tr>
<td>IT spec.</td>
<td>IT Specialist</td>
<td>One or more specialists of the IT department</td>
</tr>
<tr>
<td>PG1</td>
<td>Project group 1</td>
<td></td>
</tr>
<tr>
<td>PG2</td>
<td>Project group 2</td>
<td></td>
</tr>
<tr>
<td>PG3</td>
<td>Project group 3</td>
<td></td>
</tr>
<tr>
<td>PG4</td>
<td>Project group 4</td>
<td></td>
</tr>
</tbody>
</table>

The board of directors have a high amount of involvement in the first two improvement points. They need to express the importance of knowledge management to the company and need to provide a base for the creating of a corporate KM strategy. The next figure shows a screenshot from the planning of the two implementation points in MS Project. The link between the two improvement points is made to have a good alignment between them.
The other two corporate improvement points are started after the completion of the previous two points. This is done to guarantee a good alignment with the promotion of knowledge sharing and the corporate knowledge management strategy. Figure 12 shows the plans for the third and fourth improvement points.

Figure 13 shows the plans of the last three improvement points. Points 5 (overview of required knowledge) and 6 (visible tacit and explicit knowledge) start after the completion of points 1 and 2 to make sure the KM strategy is created and the promotion is in place. The last improvement point on the prevention of errors and mistakes can be started directly after completing point 1 since the KM strategy is not yet required. The plan shows parts of this improvement point repeating 4 times a year in order to regularly correct and prevent mistakes and errors.
8 DISCUSSION

This chapter focuses on the last part of the reflective redesign. The first section is focused on a summary of the conclusions of this research project. Afterwards, an academic reflection is provided on the conducted research. This chapter is concluded with the limitations of the project and recommendations for future research.

8.1 General conclusion
This study focused on answering the next research question and research objective:

<table>
<thead>
<tr>
<th>Research question:</th>
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<tbody>
<tr>
<td>How can knowledge sharing be tailored to task characteristics?</td>
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</table>

<table>
<thead>
<tr>
<th>Research objective:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide the company with advice how to close the gap between the current situation of knowledge sharing (“ist”) and its requirements (“soll”).</td>
</tr>
</tbody>
</table>

The answer on the research question is primarily focused on the personalization strategy as the codification strategy was used insufficiently at the research group. The reuse of knowledge requires a codification strategy, partially supporting Hansen et al. (1999). Low causal ambiguity and low heterogeneity require a personalization strategy, supporting Zollo & Winter (2002). This study provided no evidence for a different strategy at different task frequencies or which strategy needs to be used in case of learning lessons (Zollo & Winter, 2002).

The solution of the research objective was based on a scan of the “ist”-situation, brainstorm sessions on the “soll”-situation and academic literature to support the advice to the improvement points. The results of the scan signalled the absence of sharing explicit knowledge, resulting in only an average performance of knowledge sharing in the Knowledge Value Chain. The requirements for knowledge sharing seemed to be different across the departments. However, all the requirements and low scores on the scan were covered by the next improvement points:

1. Promotion of knowledge management throughout the company
2. Clear corporate KM strategy
3. One knowledge sharing system for explicit knowledge
4. Employees rotation across departments to share implicit knowledge
5. Overview of required knowledge
6. Visible tacit and explicit knowledge
7. Errors and mistakes prevention

8.2 Academic reflection
This section focuses on the academic reflection of the design propositions as tested in this research project.

The first reflection focuses on design propositions 1 and 3. Design proposition 1 was partially supported by the data from this project. For high frequent task from which knowledge needed to be reused, the data showed an average performance when using both KS strategies. Design proposition 3 was not supported by the data from this project. For low frequent tasks from which knowledge needed to be reused, the data showed a bad performance when using the personalization strategy. Taking these results together, it is likely that the codification strategy performs best for reusing static knowledge, regardless of task frequency. For high frequent tasks, this is in line with Hansen et al (1999) since high-quality and reliable knowledge is reused every time. For low frequent tasks, this is in line with Zollo & Winter (2002) since knowledge is stored. This makes the knowledge independent of the limited storing capability of the human mind. Additionally, it is hard to reuse experience, skills, and
attitude since they are different for every person. This would indicate explicit knowledge is reused, requiring a codification strategy. The next design proposition is open for future testing:

**Future design proposition 1:**
For a good sharing of static knowledge that needs to be reused, use the codification strategy to make knowledge explicit and available.

The second reflection focuses on design propositions 2 and 4. The data from this project did not provide any evidence for the design propositions. The shared knowledge within the context was primarily static and being reused. There was, however, a small presence of dynamic knowledge of which lessons were learned. When this knowledge was shared through personalization, the performance was good. When more codification was used, the performance dropped. Taking these results together, it is likely that the personalization strategy performs best for learning lessons from dynamic knowledge. Learning is focused on improving experience and skills, which is implicit knowledge. This type of knowledge is primarily shared through personalization. The next design proposition is open for future testing:

**Future design proposition 2:**
For a good sharing of dynamic knowledge of which lessons need to be learned, use the personalization strategy to share experiences and skills from person to person.

The third reflection focuses on design propositions 5 and 6. Design proposition 5 was supported by the data indicating a good performance of the personalization strategy at low task heterogeneity. However, the data did not support the use a codification strategy at high task heterogeneity. This research used the dimensions of Perrow (1967) and Woodward (1958) to determine heterogeneity, which implies it to be similar to routineness. Woodward (1958) uses an inverted U-shape to link complexity to routineness where low routineness requires an organic structure (personalization) and high routineness requires a mechanistic structure (codification).

![Figure 14: the link between complexity and routineness](image)

When linking Woodward (1958) and Zollo & Winter (2002), low routineness is linked to high heterogeneity and high routineness is linked to low heterogeneity. However, the design propositions of Zollo & Winter (2002) are contradictory to Woodward (1958) as shown in Table 7.

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Low heterogeneity</td>
<td>Personalization</td>
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<tr>
<td>High heterogeneity</td>
<td>Codification</td>
</tr>
</tbody>
</table>

Table 7: the link between Zollo & Winter (2002) and Woodward (1958)
This leaves the next reflection:

It is unknown if the use of Perrow (1967) and Woodward (1958) is justified to determine the heterogeneity levels of Zollo & Winter (2002).

Finally, the design propositions 7 and 8 assume a linear relationship between the knowledge sharing strategies and the level of causal ambiguity of a task. The personalization strategy is linked to a low causal ambiguity where the codification strategy is linked to a high causal ambiguity. These links are however not supported by the collected data. This could indicate the presence of a non-linear link between the strategies and ambiguity levels, as shown in figure 15. Knowledge from task with a low causal ambiguity may be easily shared through personalization. With an increase in causal ambiguity, more codification needs to be used to share knowledge. For high causal ambiguity, expert knowledge is required supported by the explanation of the knowledge expert. This would indicate the use of the personalization strategy, completing the inverted U-shape.

![Figure 15: an alternative link between causal ambiguity and the KS strategies](image)

Regarding this reflection, the next design proposition is open for future testing:

**Future design proposition 3:**
For a good sharing of knowledge, use the personalization at low and high causal ambiguity level and codification at a medium causal ambiguity.

### 8.3 Limitations
There are some clear limitations to this research project. These limitations focus on the generalizability of the results, the used KM-scan, the involved employees, the selected departments, and the limited combination of task characteristics.

First of all, it is not possible to generalize the results of this research project and make it automatically applicable for other contexts. The data is collected in a specific research context, which makes the results also limited to this research context. The results are not directly applicable to other research contexts without testing the results or design propositions first.

The current situation of knowledge sharing was determined using a limited set of questions from the KM-scan. All the questions related to knowledge sharing were used, where only a limited set of questions were used for ‘knowledge awareness’ and the other activities in the Knowledge Value Chain. Therefore, conclusions drawn on the limited set of questions and answers need to be used with caution.
At each department, a limited amount of employees was involved in this study. For a small department like SC-D1 (seven employees), the three involved employees account for almost 43% of the department. For the CB-D1 department, the three involved employees only account for 15%. At the CB-D2 department, 16% of the department was involved in the KM-scan and 3% in the interviews. The SC-D1 is represented well but the involvement of the CB-departments is very small and limited. This also limits the results of the scans, interviews and the eventual advice for the larger departments.

The selection criteria for the research group focused on standard and custom products and two consecutive departments. The first criteria was based on the estimation that codification was heavily used for standardized products were personalization was used for customized products. The second criterion was based on the knowledge sharing between two consecutive departments. However, not enough attention was focused on making sure both knowledge-sharing strategies were actually used at the selected departments. This limited the eventual testing of the design proposition. Additionally, not enough attention was focused on keeping a variable like group size constant, making it hard to compare departments with each other.

Finally, when considering the three task characteristics and the subdivision at task frequency, it is possible to make 16 different combinations. Appendix R shows all the possible combinations including those represented in this research project. Since only a limited set of combinations is represented in this project, the results are also limited to these combinations.

8.4 Recommendations
The recommendations focus on improving the reliability of the results in this study.

First, the study was conducted in a research group with many differences among the departments. Some of these differences were required such as differences in task frequency, heterogeneity, causal ambiguity, and the strategies for sharing knowledge. However, there were several other differences such as group size and composition, which were likely to affect the methods for sharing knowledge. In order to improve the reliability of the results, the research group needs to be selected more carefully, to eliminate several factors affecting the knowledge sharing strategy.

Second, the research group was selected by ensuring some differences in the task characteristics. However, not all different combinations of the task characteristics were present in the research group (see Appendix R). This made it very difficult to link the level of a task characteristic to the knowledge sharing strategy. Take, for instance, a situation with a high frequency and low heterogeneity and causal ambiguity, which resulted in a certain strategy. It remains unclear what happens to the knowledge sharing strategy if only one of these task characteristics is changed. By selecting a research group in which all different combinations of these task characteristics are available, better conclusions could be drawn from the results.

The final recommendation focuses on improving the reliability of the information from the departments. In this study, a limited amount of employees was involved into the process. In order to get a better overview of the current and desired situation of knowledge sharing at each individual department, more employees need to be involved in the data collection phase.
REFERENCES


### 9.2 Internet references


Appendix A. The Problem Solving Cycle

Figure 16: The Problem Solving Cycle (Aken, Berends, & Bij; 2012)
Appendix B. Regulative cycle within the reflective cycle

Figure 17: The regulative cycle within the reflective cycle (Aken, Berends, & Bij; 2007)
Appendix C. Integral Organizational Model (Weggeman, 1985)

Formulate:
- Mission
- Vision
- Objectives

Organize
- Strategy
- Structure
- Culture
- Management style
- Systems
- Personnel

Realize:
- From quality to planning
- From research to service
Appendix D. The actual research group
### Appendix E. Question from the KM-scan (Weggeman, 2001)

#### Knowledge awareness of the organization

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>disagree strongly</th>
<th>disagree</th>
<th>neutral</th>
<th>agree</th>
<th>agree strongly</th>
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</thead>
<tbody>
<tr>
<td>A.1</td>
<td>Our organization has explicit targets with regard to the planning, controlling and managing of the product factor knowledge.</td>
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<td>A.2</td>
<td>Our knowledge on technologies (methods, procedures) important to our work, is of high quality.</td>
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<td>A.3</td>
<td>We appreciate knowledge from other departments or external partners and use this knowledge in our own procedures within any problems (no not-invented-here syndrome).</td>
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<td>A.4</td>
<td>Within our organization there is more respect for the leading specialist in stead of the lead manager.</td>
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<td>A.5</td>
<td>In our organization it is easy to connect with each other, regardless of seniority, gender, department or function.</td>
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<td>A.6</td>
<td>Employees are deployed according where their knowledge is required, regardless of department of business unit.</td>
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<td>A.7</td>
<td>My manager knows which (core)competences are present among the employees</td>
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<td>A.8</td>
<td>My manager prefers focussing management on output in stead of controlling throughput</td>
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<td>A.9</td>
<td>New employees are assigned to a coach or mentor for a certain time.</td>
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<td>A.10</td>
<td>In our organization there is a balance between thinkers and doers.</td>
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<td>A.11</td>
<td>Rules and procedures are functional and not hindering our work</td>
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<td>A.12</td>
<td>ICT is an important tool for knowledge management in our organization</td>
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#### Knowledge management in general

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<th>disagree strongly</th>
<th>disagree</th>
<th>neutral</th>
<th>agree</th>
<th>agree strongly</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.1</td>
<td>In our organization it is known which knowledge is required in order to execute our tasks</td>
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<td>B.2</td>
<td>In our organization it is known which knowledge is available inside the organization</td>
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<td>B.3</td>
<td>In our organization we know which knowledge needs to be developed or acquired</td>
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<tr>
<td>B.4</td>
<td>New developed and acquired knowledge is used spontaneously after sharing it throughout the organization</td>
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<tr>
<td>B.5</td>
<td>Since we know which knowledge is available and which is required, we also know which knowledge is no longer useful.</td>
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</table>
Knowledge sharing in more detail

| C.1 | We formally pay a lot of attention to the distribution of available knowledge to departments and employees of which/whom it is expected that they need this knowledge to perform their tasks. |
| C.2 | Knowledge workers feel free to spontaneously and informally share their knowledge with others. |
| C.3 | By sharing knowledge with others, you do not weaken your own position (No 'knowledge = power' game) |
| C.4 | A knowledge worker who is frequently prepared to share his or her knowledge with others, is rewarded for doing so (either materially or immaterially). |
| C.5 | Someone who is searching for certain knowledge will in most cases end up with the person in our organization who knows the most about the subject in question. |
| C.6 | With respect to acquiring and distributing knowledge, in our organization each knowledge worker has both a 'give' and 'take' obligation. |
| C.7 | It rarely happens that expensive mistakes are made because the required knowledge was not available at the right time in the right place. |
| C.8 | We learn from each other's mistakes. Mistakes are rarely repeated. |
| C.9 | In our organization knowledge sharing is facilitated by means of internal lectures, seminars, discussion meetings etc. |
| C.10 | In our organization knowledge sharing is facilitated by means of education and training. |
| C.11 | In our organization knowledge sharing is facilitated by means of reports, manuals, instruction leaflets and other documents. |
| C.12 | In our organization knowledge sharing is facilitated by means of case evaluations of completed projects. |
| C.13 | In our organization knowledge sharing is facilitated by means of on-the-job-training and in a master-trainee-apprentice context. |
| C.14 | In our organization knowledge sharing is facilitated by means of rotating valuable, scarce knowledge carriers through different departments. |
| C.15 | In our organization knowledge sharing is facilitated by means of archive, library and documentation services. |
| C.16 | In our organization knowledge sharing is facilitated by means of information technology (e.g. Intranet). |
| C.17 | In our organization knowledge sharing is facilitated by means of a communication-promoting layout of the building. |
| C.18 | In our organization knowledge sharing is facilitated by means of informal face-to-face interactions. |
Appendix F. Interview questions problem analysis

General
1. What is your name and position/function within the <add department name> department?
2. Are there any questions with regard to the KM-scan?
3. What do you consider to be the primary task of this department?
4. What can you tell me about this task?
5. How many people are involved in this task?
6. How do you get the information needed to execute this task?
   a. Which information do you get from the previous department and how do you get it?
   b. How well is this process currently performing?
7. What is the primary way of sharing knowledge? Codification or personalization? Why?

Task frequency
8. What can you tell me about the frequency of this task? (how many times in the last 10 years)
9. Is this task executed every time by the same people?
10. What can you tell me about the level of standardization of this task?
11. Could you explain why the knowledge of this task is either static or dynamic?
12. Case example: A new employee with no knowledge about this task is going to execute it.
   a. How does he or she know what needs to be done and how?
   b. How would you rate the current performance of this method?
13. Case example: There are multiple people executing a specific task.
   a. How does the department guard for similar quality result every time this task is executed?
   b. How well is this method currently performing?
14. The primary task is considered to be high/low frequent. What is the reason for codification/personalization?

Task heterogeneity
15. What can you tell me about the variance of this task over different projects?
16. Are you able to use assumptions and inferences from previous runs?
   a. If yes, how do you reuse them? How is knowledge or information shared and/or stored?
   b. How well in this process of sharing performing?
   b. If no, why are your notable?
17. Are you able to reuse information from a previous execution?
   a. If yes, where can you find it? How does it fit?
   b. If no, why not and how do you cope with this situation?
18. What can you tell me about the amount of exceptions in this task over different projects?
19. Case example: An exception occurs during the execution of this task
   a. How do you search for a solution? (logical and analytical or intuition and guesswork)
   b. Where do you search for a solution? (focus on persons or systems)
   c. How well is this information stored, shared, and accessible?

Causal ambiguity
20. How would you classify this task with regard to complexity?
21. What can you tell me about sub-tasks for this task?
   a. How many are there approximately?
   b. How are they executed?
   c. How are subtasks related to each other?
22. Case example: You have started executing your part of this task. After completing a few the sub-tasks a change needs to be made in one sub-task since there is a change in the design.
   a. Are you able to predict how this is going to influence all the remaining sub-tasks?
General
23. How is the knowledge (information, experience, skill or attitude) of this task improved?
24. Is any information from this task stored after completion?
   a. If yes, what is stored? Why is it stored? Where is it stored?
   b. If no, why not?
25. Is any knowledge shared to the next department?
   a. If yes, how is it shared? How well is this process performing?
   b. If not, why not?
26. How are employees motivated to share knowledge (rewarding, grading)
Appendix G.  Brainstorm questions solution design

1. What should knowledge management do for this department?
2. What should knowledge sharing do for this department?
3. What should knowledge sharing do for the employees?
4. What should knowledge sharing do with regard to the statement “knowledge = power”?
5. What should knowledge sharing do to improve knowledge quality?
6. What should knowledge sharing do to knowledge accessibility?
7. What are the limitations with regard to:
   a. Available resources for knowledge sharing?
   b. Available time for employees for knowledge sharing?
   c. Available rewards for sharing knowledge?
   d. Available time scope for improvements on knowledge sharing?
## Knowledge awareness of the organization

| A.1. | Our organization has explicit targets with regard to the planning, controlling and managing of the product factor knowledge. | 2 3 4 3 2 4 3 4 1 4 4 2 3 2 4 | 3.00 | KM Strategy | 3.20 |
| A.2. | Our knowledge on technologies (methods, procedures) important to our work, is of high quality. | 3 4 4 4 2 5 5 4 3 3 3 2 3 2 4 | 3.40 |
| A.3. | We appreciate knowledge from other departments or external partners and use this knowledge in our own procedures within any problems (no not-invented-here syndom). | 3 3 4 4 3 4 3 2 3 4 3 2 2 3 | 3.13 | Culture | 3.23 |
| A.4. | Within our organization there is more respect for the leading specialist in stead of the lead manager. | 4 2 4 4 3 5 5 4 3 4 4 2 2 2 | 3.33 | Structure | 3.53 |
| A.5. | In our organization it is easy to connect with each other, regardless of seniority, gender, department or function. | 4 4 4 4 4 5 4 4 4 4 3 4 4 4 | 4.00 | Structures | 3.53 |
| A.6. | Employees are deployed according where their knowledge is required, regardless of department of business unit. | 2 3 3 3 2 4 3 3 4 3 4 3 3 2 4 | 3.07 |
| A.7. | My manager knows which (core)competences are present among the employees | 4 4 4 4 3 4 3 4 4 3 3 4 3 4 4 | 3.87 | Management style | 3.60 |
| A.8. | My manager preferes focussing management on output in stead of controlling throughput. | 4 4 4 4 4 3 4 2 4 4 2 2 3 3 3 | 3.33 |
| A.9. | New employees are assigned to a coach or mentor for a certain time. | 2 4 3 4 4 5 2 4 4 4 2 2 3 2 3 | 3.20 | Personel | 3.27 |
| A.10. | In organization there is a balance between thinkers and doers. | 4 4 3 4 4 3 1 5 3 2 3 2 4 4 | 3.33 |
| A.11. | Rules and procedures are functional and not hindering our work | 4 4 3 4 3 3 4 4 3 2 4 3 2 4 | 3.33 | Systems | 3.40 |
| A.12. | ICT is an important tool for knowledge management in our organization (reversed importance) | 2 2 2 3 2 3 3 4 2 3 3 4 2 3 | 2.53 |

### Knowledge management in general

| B.1 | In our organization it is known which knowledge is required in order to execute our tasks | 2 2 3 4 4 5 3 4 1 3 3 2 2 2 4 | 2.93 | Required knowledge |
| B.2 | In our organization it is known which knowledge is available inside the organization | 4 4 4 4 2 4 4 4 4 3 4 2 4 4 | 3.73 | Available knowledge |
| B.3 | In our organization we know which knowledge needs to be developed or acquired | 2 3 3 4 4 4 2 3 3 3 4 3 2 4 | 3.20 | Knowledge development |
| B.4 | New developed and acquired knowledge is used spontaneously after sharing it throughout the organization | 2 3 4 2 2 4 4 2 3 4 3 3 2 2 3 | 2.87 | Knowledge application |
| B.5 | Since we know which knowledge is available and which is required, we also know which knowledge is no longer usefull. | 2 3 3 3 2 3 4 4 4 3 3 3 3 2 3 | 2.93 | Knowledge evaluation |
Knowledge sharing in more detail

<table>
<thead>
<tr>
<th>C.1</th>
<th>We formally pay a lot of attention to the distribution of available knowledge to departments and employees of which/whom it is expected that they need this knowledge to perform their tasks.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.2</td>
<td>Knowledge workers feel free to spontaneously and informally share their knowledge with others. (No 'knowledge = power' game)</td>
</tr>
<tr>
<td>C.3</td>
<td>By sharing knowledge with others, you do not weaken your own position</td>
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<td>Someone who is searching for certain knowledge will in most cases end up with the person in our organization who knows the most about the subject in question.</td>
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| Score on knowledge sharing | 3.09 |
## Knowledge awareness of the organization

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<td>A.1.</td>
<td>Our organization has explicit targets with regard to the planning, controlling and managing of the product factor knowledge.</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>3.00</td>
<td>KM Strategy</td>
<td>No explicit targets</td>
</tr>
<tr>
<td>A.2.</td>
<td>Our knowledge on technologies (methods, procedures) important to our work, is of high quality.</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>3.67</td>
<td>Culture</td>
<td>More towards specialists</td>
</tr>
<tr>
<td>A.3.</td>
<td>We appreciate knowledge from other departments or external partners and use this knowledge in our own procedures within any problems (no not-invented-here syndom).</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>3.33</td>
<td>Structure</td>
<td>Not done</td>
</tr>
<tr>
<td>A.4.</td>
<td>Within our organization there is more respect for the leading specialist in stead of the lead manager.</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>3.33</td>
<td></td>
<td>Desirable across departments</td>
</tr>
<tr>
<td>A.5.</td>
<td>In our organization it is easy to connect with eachother, regardless of seniority, gender, department or function.</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4.00</td>
<td>Management style</td>
<td>Focussing on output within time</td>
</tr>
<tr>
<td>A.6.</td>
<td>Employees are deployed according where their knowledge is required, regardless of department of business unit.</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2.67</td>
<td>Personel</td>
<td>Not structured enough</td>
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<tr>
<td>A.7.</td>
<td>My manager knows which (core)competences are present among the employees</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4.00</td>
<td>Systems</td>
<td>Good balance</td>
</tr>
<tr>
<td>A.8.</td>
<td>My manager preferres focussing management on output in stead of controlling throughput</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4.00</td>
<td></td>
<td>Not one coach, but everybody is helping</td>
</tr>
<tr>
<td>A.9.</td>
<td>New employees are assigned to a coach or mentor for a certain time.</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>3.00</td>
<td></td>
<td>Not 50-50, but more 20-80</td>
</tr>
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<td>A.10.</td>
<td>In organization there is a balance between thinkers and doers.</td>
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<td>4</td>
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<td>3.67</td>
<td></td>
<td>Personel</td>
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<tr>
<td>A.11.</td>
<td>Rules and procedures are functional and not hindering our work</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>3.67</td>
<td>Systems</td>
<td></td>
</tr>
<tr>
<td>A.12.</td>
<td>ICT is an important tool for knowledge managment in our organization (reversed importance)</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2.00</td>
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## Knowledge management in general

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<tr>
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<th>average</th>
<th>comments</th>
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<tbody>
<tr>
<td>B.1.</td>
<td>In our organization it is known which knowledge is required in order to execute our tasks</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2.33</td>
<td>Required knowledge</td>
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</tr>
<tr>
<td>B.2.</td>
<td>In our organization it is known which knowledge is available inside the organization</td>
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<td>4</td>
<td>4</td>
<td>4.00</td>
<td>Available knowledge</td>
<td>Based primarily on retiring personnel</td>
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<tr>
<td>B.3.</td>
<td>In our organization we know which knowledge needs to be developed or aquired</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2.67</td>
<td>Knowledge development</td>
<td>Focus on market, conferences and testing new developments</td>
</tr>
<tr>
<td>B.4.</td>
<td>New developed and acquired knowledge is used spontaneoesly after sharing it throughout the organization</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>3.00</td>
<td>Knowledge application</td>
<td></td>
</tr>
<tr>
<td>B.5.</td>
<td>Since we know which knowledge is available and which is required, we also know which knowledge is no longer usefull.</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2.67</td>
<td>Knowledge evaluation</td>
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</table>
## Knowledge sharing in more detail

<table>
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<tr>
<th></th>
<th></th>
<th>Rank</th>
<th></th>
<th>comments</th>
</tr>
</thead>
</table>
| C.1 | We formally pay a lot of attention to the distribution of available knowledge to departments and employees of which/whom it is expected that they need this knowledge to perform their tasks. | 2 | 4 | 2,67 | 6 | Insufficient for calculation
|   |   |      |   | Not 'a lot' because of work load |
| C.2 | Knowledge workers feel free to spontaneously and informally share their knowledge with others. | 3 | 4 | 3,67 | 2 |
| C.3 | By sharing knowledge with others, you do not weaken your own position (No 'knowledge = power' game) | 4 | 5 | 4,33 | 1 | Not present at the department |
| C.4 | A knowledge worker who is frequently prepared to share his or her knowledge with others, is rewarded for doing so (either materially or immaterially). | 3 | 4 | 3,33 | 3 | Knowledge is being shared |
|   |   |      |   | Unknown rewards |
| C.5 | Someone who is searching for certain knowledge will in most cases end up with the person in our organization who knows the most about the subject in question. | 4 | 2 | 3,33 | 3 | Harder for new employees, Hard to find persons across departments |
| C.6 | With respect to acquiring and distributing knowledge, in our organization each knowledge worker has both a 'give' and 'take' obligation. | 4 | 2 | 3,33 | 3 | No resistance |
|   |   |      |   | Both 'give' and 'take' are present |
| C.7 | It rarely happens that expensive mistakes are made because the required knowledge was not available at the right time in the right place. | 3 | 2 | 2,67 | 6 | Reports of errors are not reused |
|   |   |      |   | Errors are repeated |
| C.8 | We learn from each other's mistakes. Mistakes are rarely repeated. | 3 | 2 | 2,67 | 6 |

Score on knowledge sharing 3,25
Appendix J. KM-scan results: SC-D2
Standard – Department 2: results KM-scan + comments from interviews (1 of 2)

### Knowledge awareness of the organization

| A.1. Our organization has explicit targets with regard to the planning, controlling and managing of the product factor knowledge. | 3 | 3.00 | KM Strategy |
| A.2. Our knowledge on technologies (methods, procedures) important to our work, is of high quality. | 4 | 4.00 | Culture |
| A.3. We appreciate knowledge from other departments or external partners and use this knowledge in our own procedures within any problems (no not-invented-here syndrom). | 4 | 4.00 | Structure |
| A.4. Within our organization there is more respect for the leading specialist in stead of the lead manager. | 4 | 4.00 | |
| A.5. In our organization it is easy to connect with each other, regardless of seniority, gender, department or function. | 4 | 4.00 | |
| A.6. Employees are deployed according where their knowledge is required, regardless of department of business unit. | 3 | 3.00 | Management style |
| A.7. My manager knows which (core)competences are present among the employees | 4 | 4.00 | Personnel |
| A.8. My manager prefers focussing management on output in stead of controlling throughput | 4 | 4.00 | Systems |
| A.9. New employees are assigned to a coach or mentor for a certain time. | 4 | 4.00 | |
| A.10. In organization there is a balance between thinkers and doers. | 4 | 4.00 | |
| A.11. Rules and procedures are functional and not hindering our work | 4 | 4.00 | |
| A.12. ICT is an important tool for knowledge management in our organization (reversed importance) | 3 | 3.00 | |

### Knowledge management in general

| B.1. In our organization it is known which knowledge is required in order to execute our tasks | 4 | 4.00 | Required knowledge |
| B.2. In our organization it is known which knowledge is available inside the organization | 4 | 4.00 | Available knowledge |
| B.3. In our organization we know which knowledge needs to be developed or acquired | 4 | 4.00 | Knowledge development |
| B.4. New developed and acquired knowledge is used spontaneously after sharing it throughout the organization | 2 | 2.00 | Knowledge application |
| B.5. Since we know which knowledge is available and which is required, we also know which knowledge is no longer useful. | 3 | 3.00 | Knowledge evaluation |
### Knowledge sharing in more detail

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>C.1</strong></td>
<td>We formally pay a lot of attention to the distribution of available knowledge to departments and employees of which/whom it is expected that they need this knowledge to perform their tasks.</td>
<td>4</td>
</tr>
<tr>
<td><strong>C.2</strong></td>
<td>Knowledge workers feel free to spontaneously and informally share their knowledge with others.</td>
<td>4</td>
</tr>
<tr>
<td><strong>C.3</strong></td>
<td>By sharing knowledge with others, you do not weaken your own position (No 'knowledge = power' game)</td>
<td>4</td>
</tr>
<tr>
<td><strong>C.4</strong></td>
<td>A knowledge worker who is frequently prepared to share his or her knowledge with others, is rewarded for doing so (either materially or immaterially).</td>
<td>3</td>
</tr>
<tr>
<td><strong>C.5</strong></td>
<td>Someone who is searching for certain knowledge will in most cases end up with the person in our organization who knows the most about the subject in question.</td>
<td>4</td>
</tr>
<tr>
<td><strong>C.6</strong></td>
<td>With respect to acquiring and distributing knowledge, in our organization each knowledge worker has both a 'give' and 'take' obligation.</td>
<td>4</td>
</tr>
<tr>
<td><strong>C.7</strong></td>
<td>It rarely happens that expensive mistakes are made because the required knowledge was not available at the right time in the right place.</td>
<td>3</td>
</tr>
<tr>
<td><strong>C.8</strong></td>
<td>We learn from each other's mistakes. Mistakes are rarely repeated.</td>
<td>4</td>
</tr>
<tr>
<td><strong>C.9</strong></td>
<td>In our organization knowledge sharing is facilitated by means of internal lectures, seminars, discussion meetings etc.</td>
<td>2</td>
</tr>
<tr>
<td><strong>C.10</strong></td>
<td>In our organization knowledge sharing is facilitated by means of education and training.</td>
<td>4</td>
</tr>
<tr>
<td><strong>C.11</strong></td>
<td>In our organization knowledge sharing is facilitated by means of reports, manuals, instruction leaflets and other documents.</td>
<td>4</td>
</tr>
<tr>
<td><strong>C.12</strong></td>
<td>In our organization knowledge sharing is facilitated by means of case evaluations of completed projects.</td>
<td>4</td>
</tr>
<tr>
<td><strong>C.13</strong></td>
<td>In our organization knowledge sharing is facilitated by means of on-the-job-training and in a master-trainee-apprentice context.</td>
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</tr>
<tr>
<td><strong>C.14</strong></td>
<td>In our organization knowledge sharing is facilitated by means of rotating valuable, scarce knowledge carriers through different departments.</td>
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</tr>
<tr>
<td><strong>C.15</strong></td>
<td>In our organization knowledge sharing is facilitated by means of archive, library and documentation services.</td>
<td>3</td>
</tr>
<tr>
<td><strong>C.16</strong></td>
<td>In our organization knowledge sharing is facilitated by means of information technology (e.g. Intranet).</td>
<td>1</td>
</tr>
<tr>
<td><strong>C.17</strong></td>
<td>In our organization knowledge sharing is facilitated by means of a communication-promoting layout of the building.</td>
<td>1</td>
</tr>
<tr>
<td><strong>C.18</strong></td>
<td>In our organization knowledge sharing is facilitated by means of informal face-to-face interactions.</td>
<td>4</td>
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</tbody>
</table>

**Score on knowledge sharing**: 3.58
### Appendix K. KM-scan results: CB-D1

**Custom – Department 1: results KM-scan + comments from interviews (1 of 2)**

#### Knowledge awareness of the organization

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<tr>
<th>Item</th>
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<th>Culture</th>
<th>Culture comments</th>
<th>Structure</th>
<th>Structure comments</th>
<th>Management style</th>
<th>Management style comments</th>
<th>Personel</th>
<th>Personel comments</th>
<th>Systems</th>
<th>Systems comments</th>
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<td>A.1. Our organization has explicit targets with regard to the planning, controlling and managing of the product factor knowledge.</td>
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<td>No explicit targets</td>
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</tr>
<tr>
<td>A.2. Our knowledge on technologies (methods, procedures) important to our work, is of high quality.</td>
<td>4</td>
<td>Broad but of high quality</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>A.3. We appreciate knowledge from other departments or external partners and use this knowledge in our own procedures within any problems (no not-invented-here syndrome).</td>
<td>3</td>
<td>A bit more towards the specialist</td>
<td></td>
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</tr>
<tr>
<td>A.4. Within our organization there is more respect for the leading specialist in stead of the lead manager.</td>
<td>4</td>
<td>Persons stay at their department/group</td>
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</tr>
<tr>
<td>A.5. In our organization it is easy to connect with each other, regardless of seniority, gender, department or function.</td>
<td>5</td>
<td>Persons stay at their department/group</td>
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<tr>
<td>A.6. Employees are deployed according to where their knowledge is required, regardless of department or business unit.</td>
<td>3</td>
<td>Persons stay at their department/group</td>
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</tr>
<tr>
<td>A.7. My manager knows which (core)competences are present among the employees</td>
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<td>Most of the time on output</td>
<td></td>
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<tr>
<td>A.8. My manager prefers focusing management on output instead of controlling throughput</td>
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<td>Most of the time on output</td>
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<tr>
<td>A.9. New employees are assigned to a coach or mentor for a certain time.</td>
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<td>Good training of new employees</td>
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<tr>
<td>A.10. In our organization there is a balance between thinkers and doers.</td>
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<td>Intensity dependent on person</td>
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<td>A.11. Rules and procedures are functional and not hindering our work</td>
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<tr>
<td>A.12. ICT is an important tool for knowledge management in our organization (reversed importance)</td>
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#### Knowledge management in general

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<th>Knowledge application</th>
<th>Knowledge application comments</th>
<th>Knowledge evaluation</th>
<th>Knowledge evaluation comments</th>
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<tr>
<td>B.1. In our organization it is known which knowledge is required in order to execute our tasks</td>
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<td>Knowledge evaluation</td>
<td>Knowledge evaluation comments</td>
<td>Knowledge evaluation</td>
<td>Knowledge evaluation comments</td>
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<td>B.2. In our organization it is known which knowledge is available inside the organization</td>
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<td>Available knowledge</td>
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<td>Knowledge evaluation</td>
<td>Knowledge evaluation comments</td>
<td>Knowledge evaluation</td>
<td>Knowledge evaluation comments</td>
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<td>B.3. In our organization we know which knowledge needs to be developed or acquired</td>
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<td>Knowledge evaluation</td>
<td>Knowledge evaluation comments</td>
<td>Knowledge evaluation</td>
<td>Knowledge evaluation comments</td>
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<tr>
<td>B.4. New developed and acquired knowledge is used spontaneously after sharing it throughout the organization</td>
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<td>Conservatism</td>
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<td>Knowledge evaluation</td>
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<td>Knowledge evaluation</td>
<td>Knowledge evaluation comments</td>
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<td>B.5. Since we know which knowledge is available and which is required, we also know which knowledge is no longer usefull.</td>
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<td>The danger of using outdated knowledge</td>
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</tr>
<tr>
<td>C.1 We formally pay a lot of attention to the distribution of available knowledge to departments and employees of which/whom it is expected that they need this knowledge to perform their tasks.</td>
<td>3 5 3</td>
<td>3.67 4</td>
<td>Low feedback from outside Keep making mistakes</td>
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<tr>
<td>C.2 Knowledge workers feel free to spontaneously and informally share their knowledge with others.</td>
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<td>4.33 1</td>
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<td></td>
</tr>
<tr>
<td>C.3 By sharing knowledge with others, you do not weaken your own position (No 'knowledge = power' game)</td>
<td>3 5 4</td>
<td>4.00 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>C.4 A knowledge worker who is frequently prepared to share his or her knowledge with others, is rewarded for doing so (either materially or immaterially).</td>
<td>3 2 3</td>
<td>2.67 6</td>
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<td></td>
</tr>
<tr>
<td>C.5 Someone who is searching for certain knowledge will in most cases end up with the person in our organization who knows the most about the subject in question.</td>
<td>2 5 4</td>
<td>3.67 4</td>
<td>Depending on time at the department Hard to find persons</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>C.6 With respect to acquiring and distributing knowledge, in our organization each knowledge worker has both a 'give' and 'take' obligation.</td>
<td>4 4 4</td>
<td>4.00 2</td>
<td>Not enough priority Checklist and standard specification</td>
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<tr>
<td>C.7 It rarely happens that expensive mistakes are made because the required knowledge was not available at the right time in the right place.</td>
<td>2 4 2</td>
<td>2.67 6</td>
<td>Keep making mistakes</td>
<td></td>
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<td>C.8 We learn from each other's mistakes. Mistakes are rarely repeated.</td>
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<tr>
<td>C.9 In our organization knowledge sharing is facilitated by means of internal lectures, seminars, discussion meetings etc.</td>
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<td>3.33 5</td>
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<td>3.33 5</td>
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<td>C.14 In our organization knowledge sharing is facilitated by means of rotating valuable, scarce knowledge carriers through different departments.</td>
<td>3 2 3</td>
<td>2.33 10 Not being done Open for it, but dependent on workload</td>
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<td>C.15 In our organization knowledge sharing is facilitated by means of archive, library and documentation services.</td>
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<td>C.16 In our organization knowledge sharing is facilitated by means of information technology (e.g. Intranet).</td>
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<td>3.33 5</td>
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<tr>
<td>C.17 In our organization knowledge sharing is facilitated by means of a communication-promoting layout of the building.</td>
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<td>3.33 5</td>
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<td>C.18 In our organization knowledge sharing is facilitated by means of informal face-to-face interactions.</td>
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<td>Dependent on persons</td>
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Score on knowledge sharing **3.46**
Appendix L. KM-scan results: CB-D2
Custom – Department 2: results KM-scan + comments from interviews (1 of 2)

### Knowledge awareness of the organization

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<th>Comment</th>
<th>score</th>
<th>KM strategy</th>
<th>comments</th>
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</thead>
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<td>A.1. Our organization has explicit targets with regard to the planning, controlling and managing of the product factor knowledge.</td>
<td>4 1 4 4 2 3 2 4</td>
<td>3,00</td>
<td>Unclear or not determined Clearer for personnel</td>
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<tr>
<td>A.2. Our knowledge on technologies (methods, procedures) important to our work, is of high quality.</td>
<td>4 3 3 2 3 2 4</td>
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<tr>
<td>A.3. We appreciate knowledge from other departments or external partners and use this knowledge in our own procedures within any problems (no not-invented-here syndom).</td>
<td>2 3 4 4 3 2 2 3</td>
<td>2,88</td>
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<tr>
<td>A.4. Within our organization there is more respect for the leading specialist in stead of the lead manager.</td>
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<tr>
<td>A.5. In our organization it is easy to connect with eachother, regardless of seniority, gender, department or function.</td>
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<td>3,88</td>
<td>Dependent on importance of the project</td>
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<tr>
<td>A.6. Employees are deployed according where their knowledge is required, regardless of department of business unit.</td>
<td>3 4 4 3 3 3 2 4</td>
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<td>A.7. My manager knows which (core)competences are present among the employees</td>
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<td>Management style</td>
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<tr>
<td>A.8. My manager preferes focussing management on output in stead of controlling throughput</td>
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<td>A.9. New employees are assigned to a coach or mentor for a certain time.</td>
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<td>A.10. In organization there is a balance between thinkers and doers.</td>
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<td>A.11. Rules and procedures are functional and not hindering our work</td>
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<td>A.12. ICT is an important tool for knowledge management in our organization (reversed importance)</td>
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<td>Systems</td>
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### Knowledge management in general

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<th>comments</th>
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</thead>
<tbody>
<tr>
<td>B.1. In our organization it is known which knowledge is required in order to execute our tasks</td>
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<td>Required knowledge</td>
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<td>B.2. In our organization it is known which knowledge is available inside the organization</td>
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<td>B.3. In our organization we know which knowledge needs to be developed or aquired</td>
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<td>B.4. New developed and acquired knowledge is used spontaneosly after sharing it throughout the organization</td>
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<tr>
<td>B.5. Since we know which knowledge is available and which is required, we also know which knowledge is no longer usefull.</td>
<td>4 3 3 3 3 3 2 3</td>
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</tbody>
</table>

Knowledge awareness of the organization

- Average comments
- KM strategy
- KM scan results
- CB-D2

Knowledge management in general

- Required knowledge
- Available knowledge
- Knowledge development
- Knowledge application
- Knowledge evaluation
## Knowledge sharing in more detail

| C.1 We formally pay a lot of attention to the distribution of available knowledge to departments and employees of which/whom it is expected that they need this knowledge to perform their tasks. | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 2,25 | 6 |
| C.2 Knowledge workers feel free to spontaneously and informally share their knowledge with others. | 4 | 4 | 3 | 3 | 3 | 3 | 4 | 3,38 | 1 |
| C.3 By sharing knowledge with others, you do not weaken your own position (No 'knowledge = power' game). | 3 | 4 | 4 | 2 | 2 | 3 | 4 | 4, 3,25 | 3 |
| C.4 A knowledge worker who is frequently prepared to share his or her knowledge with others, is rewarded for doing so (either materially or immaterially). | 1 | 2 | 3 | 2 | 2 | 2 | 2,88 | 8 |
| C.5 Someone who is searching for certain knowledge will in most cases end up with the person in our organization who knows the most about the subject in question. | 2 | 5 | 4 | 3 | 3 | 2 | 4 | 3,25 | 3 |
| C.6 With respect to acquiring and distributing knowledge, in our organization each knowledge worker has both a 'give' and 'take' obligation. | 2 | 4 | 3 | 4 | 4 | 3 | 4 | 4 | 3,38 |
| C.7 It rarely happens that expensive mistakes are made because the required knowledge was not available at the right time in the right place. | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 3 | 2,63 |
| C.8 We learn from each other's mistakes. Mistakes are rarely repeated. | 1 | 3 | 3 | 2 | 2 | 2 | 3 | 2,25 | 6 |
| C.9 In our organization knowledge sharing is facilitated by means of internal lectures, seminars, discussion meetings etc. | 5 | 3 | 4 | 2 | 3 | 3 | 4 | 3,50 | 2 |
| C.10 In our organization knowledge sharing is facilitated by means of education and training. | 4 | 3 | 4 | 3 | 2 | 2 | 4 | 4, 3,38 |
| C.11 In our organization knowledge sharing is facilitated by means of reports, manuals, instruction leaflets and other documents. | 4 | 2 | 4 | 2 | 4 | 3 | 2 | 4 | 3,25 |
| C.12 In our organization knowledge sharing is facilitated by means of case evaluations of completed projects. | 4 | 2 | 4 | 3 | 2 | 2 | 2 | 3 | 2,75 |
| C.13 In our organization knowledge sharing is facilitated by means of on-the-job-training and in a master-trainee-apprentice context. | 4 | 2 | 4 | 2 | 3 | 3 | 2 | 2 | 2,88 |
| C.14 In our organization knowledge sharing is facilitated by means of rotating valuable, scarce knowledge carriers through different departments. | 1 | 1 | 3 | 2 | 2 | 3 | 2 | 2 | 2,00 |
| C.15 In our organization knowledge sharing is facilitated by means of archive, library and documentation services. | 2 | 4 | 4 | 2 | 2 | 3 | 2 | 4 | 2,88 |
| C.16 In our organization knowledge sharing is facilitated by means of information technology (e.g. Intranet). | 4 | 4 | 4 | 2 | 4 | 4 | 2 | 4 | 3,75 |
| C.17 In our organization knowledge sharing is facilitated by means of a communication-promoting layout of the building. | 4 | 1 | 2 | 2 | 3 | 2 | 2 | 3 | 2,00 |
| C.18 In our organization knowledge sharing is facilitated by means of informal face-to-face interactions. | 3 | 3 | 3 | 2 | 3 | 4 | 2 | 3 | 2,88 |

**Score on knowledge sharing**: **2.84**
### Appendix M. Analysis tables of the interviews

**Per interview**

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## Appendix N. Overview of testing design propositions

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Appendix O. Specific improvements SC-D1 department

This section focuses on the specific improvements and implications for the SC-D1 department. First the additions to the desired “soll”-situation are described. Next, some additional improvements are explained. For this department, these additions focus on improving knowledge sharing within this department and in their collaboration with the SC-D2 department. Finally, the implications of the advice for this department are described.

1. Additions to desired (“soll”) situation

The department had no additional functional or user requirements besides the general requirements from section 7.1.1.

There was only one boundary condition for the “soll”-situation of this department: a good balance between the storing of knowledge and the creativity of employees. Basic knowledge, with regard to standard procedures and calculations, could be codified to make it accessible within and outside this department. For more specific and expert knowledge, freedom and creativity was required for the employees to perform their work. In the redesign, primarily basic knowledge needed to be codified to make it accessible to everybody within and outside the department. This basic knowledge contains everything that was fundamentally important for the designing of a vessel and the making of accurate cost estimations like theories, formula, procedures, manuals, schemes, etc. All the specific expert knowledge needed to remain at the individuals to support personal communication and creativity.

There were some limitations in order to make the design applicable in the current situation. First, the design needed to be time efficient. This meant the design needed to help improve knowledge sharing at this department but without spending too much time on it. There needed to be a good balance between the effort it was going to cost and the benefits it was going to generate. The second design restriction focused on an individual responsibility. Employees needed to share their knowledge without management having to interfere. Finally, the new design only needed to provide a solid framework to sharing knowledge, without reducing the freedom and creativity of the employees.

2. Additional improvement

For this department, the additional improvements were focused on the knowledge sharing within and across the department boundaries. All the low scores on the KM-scan and the functional and user requirements for this department were covered by the improvement points from section 7.2.

The used knowledge sharing strategy was not showing any problems in the current performance. The balance between codification and personalization was working well enough within this department. The testing of the design propositions suggested increasing the use of codification in the case of knowledge reuse. Personalization was still supported by the training of new employees in order to build experience.

Knowledge sharing across the boundaries of this department required more attention on personalization in addition to the currently used codification strategy. By only using codified knowledge there was a possibility of different interpretation of the content. Recent developments showed an increase in work efficiency when using a personalization strategy next to the sharing of codified knowledge.

3. Implications of advice for improvement

This section provides the implications of the improvement advice to the SC-D1 department, which is divided into two different parts. One part focuses on the implications of the corporate and department level advice. The second provides the implications and advice about knowledge sharing within and across the departmental boundaries.
**Implication of advice**

In general, the implications of all the improvements is that all employees need to spend more time on knowledge management activities, which is likely to reduce the time spend on other work activities.

The pre-conditional advice to promote knowledge sharing throughout the company has some implications on the attitude of employees in the department. Department management needs to communicate the corporate view on knowledge management. This implies stating the importance of knowledge management to the corporate strategies. Additionally, management is responsible for the intrinsic and extrinsic motivation of the employees to share knowledge.

From the corporate level advice, both the IT-system for explicit knowledge and the rotation of employees have implications for the SC-D1 department. The corporate knowledge management strategy will, without too much effort, improve the score on ‘KM strategy’ by creating explicit targets on the product factor knowledge. The creation of two IT systems helps the department working more effectively with more available and accessible tacit and explicit knowledge. These two systems also provide the possibility to only codify the basic knowledge of this department and leave details about personalized supporting creativity and face-to-face interactions. The initial codification activities are likely to reduce the time spend on the primary work activities. However, in the end this investment will have a positive outcome since work can be performed more efficiently. The rotation of employees will likely have more implications for the department. Rotating employees are likely to work less effectively in daily activities compared to stationary employees. However, this development will improve knowledge sharing across the departments and makes sure similar design methods and systems are used across departments.

The department level advice has more implications compared to the corporate level advice. Explicit sessions need to be planned to create an overview of required knowledge for this department. The small size of this department will likely make it easy to plan these meetings. Time needs to be made available for employees to make their tacit and explicit knowledge available and accessible. The same holds for the reporting and preventing of errors and mistakes. In order to cope with these implications, it is likely the department temporarily needs to hire an additional employee to make sure the product development activities are still executed. Another solution is to temporarily take slightly less projects in order to have enough time available to execute the improvement points. When knowledge management and knowledge sharing are structured and running, it is likely the original work force is able to handle the workload of the department again.

**Implication and advice for knowledge sharing strategy**

Within this department, both the personalization and codification strategy are used to share knowledge. The balance between these two strategies needs to be maintained since it is performing well. Both knowledge sharing strategies need to be extended by starting to codify the fundamental knowledge of the department, making tacit knowledge available, and increase the use of personalization at transfer meetings with Department 2 to have more interpersonal communication on the design and costs of projects.
Appendix P. Specific improvements CB-D1 department

This section focuses on the specific improvements and implications for the CB-D1 department. First the additions to the desired “soll”-situation are described. Next, some additional improvements are explained. For this department, there is one additional improvement point to those stated in section 7.2. Additionally, there is some focus on improving knowledge sharing within this department and in their collaboration with the CB-D2 department. Finally, the implications of the advice for this department are described.

1. Additions to the desired (“soll”) situation

There were multiple functional requirements that needed to be considered when improving the knowledge sharing processes. Most of these were equal to the overall requirements that are similar across all departments. Additionally, it was important for this department to keep the tacit knowledge at a high level. The quality level of tacit knowledge decreased by employees leaving the organization and not being replaced with new employees with similar knowledge. More specifically, new employees needed to be hired to compensate for employees with specific knowledge who were leaving the department.

The user requirements for this department were similar to those from section 7.1.1.

The redesign needed to consider a couple of boundary conditions. Advice and feedback from other departments needed to be accepted and reused. The knowledge sharing activities needed to be open to output from outside the department. Next, the redesign needed to be flexible to cope with the shift of employees into and away from the entire company. Additionally to the changes in personnel, the redesign also needed to cope with changing priorities at the departments.

The design limitations for this department were focused on the reuse of internal solutions (from other departments), the focus on a better information system and the full agendas of group leaders. Within the company, there were some successful initiatives with regard to knowledge management and sharing. To save both time and money on the development of new initiatives, the solutions from other departments inside the company needed to be considered when redesigning the knowledge sharing activities. With regard to the information systems, some improvements also needed to be made since the current performance and consistency are low. Finally, group leaders had full agendas limiting knowledge sharing to individual responsibilities.

2. Additional improvements

For this department, there was one additional improvement point besides improvements on the used knowledge sharing strategy and knowledge sharing across departmental boundaries.

As stated in the previous section, the primary reason for the drop in knowledge quality at this department was caused by a mismatch between employees leaving and entering the organization. The next additional improvement point needs to be addressed to start improving knowledge quality within this department:

- HR procedures to compensate leaving employees with specific knowledge

All the other low scores on the KM-scan and user requirements for this department were met by improving the general points from section 7.2.

The currently used personalization strategy seemed to be working well. However, several task characteristics of this department focused on personalization and others on codification. The performance of knowledge sharing was likely to improve by making both strategies equally important.
The sharing of knowledge across the department’s boundaries was characterized by the use of both codification and personalization. Documents were shared and implicit knowledge about it was added by discussing the documents in the handover meetings between departments. There was, however, no involvement of the receiving department in the designing process, resulting in the slight presence of the not-invented-here-syndrome at that department. This needed to be addressed to increase the use of shared knowledge.

3. Implications of advice for improvement

This section provides the implications of the improvement advice to the CB-D1 department, which is divided into three different parts. First, the implications of the corporate level and department level advice are provided. Second, additional advice is provided to tackle the additional improvement point for this department. Finally, the implications and advice is provided on knowledge sharing within and across the departmental boundaries.

Implication of advice

In general, the implications of all the improvements is that all employees need to spend more time on knowledge management activities, which is likely to reduce the time spend on other work activities.

The pre-conditional advice to promote knowledge sharing throughout the company has some implications on the attitude of employees in the department. Department management needs to communicate the corporate view on knowledge management. This implies stating the importance of knowledge management to the corporate strategies. Additionally, management is responsible for the intrinsic and extrinsic motivation of the employees to share knowledge.

From the corporate level advice, both the IT-system for explicit knowledge and the rotation of employees have implications for the CB-D1 department. The corporate knowledge management strategy will, without too much effort, improve the score on ‘KM strategy’ by creating explicit targets on the product factor knowledge. The creation of two IT systems helps the department working more effectively with more available and accessible tacit and explicit knowledge. These two systems also provide the possibility to only codify the basic knowledge of this department and leave details about personalized supporting creativity and face-to-face interactions. The initial codification activities are likely to reduce the time spend on the primary work activities. However, in the end this investment will have a positive outcome since work can be performed more efficiently. The rotation of employees will likely have more implications for the department. Rotating employees are likely to work less effectively in daily activities compared to stationary employees. However, this development will improve knowledge sharing across the departments and makes sure similar design methods and systems are used across departments.

The department level advice has more implications compared to the corporate level advice. Explicit sessions need to be planned to create an overview of required knowledge for this department. Time needs to be made available for employees to make their tacit and explicit knowledge available and accessible. The same holds for the reporting and preventing of errors and mistakes. Because the size of this department, a large amount of time will be spend on knowledge management activities. To make sure the regular product development activities will not suffer from these changes, additional personnel is needed to cope with the new situation.

Additional advice for improvement

For this department explicit attention needs to be paid to the human resources management in order to retain the quality level of knowledge. Retaining the current knowledge quality is a target for this department. However, this quality level is being damaged by employees with specific knowledge leaving the department. Additionally, the new employees do not possess the same specific knowledge that is lost. To cope with this situation, the HR department plays a vital part in order to retain the right knowledge quality at the department.
The work of Soliman & Spooner (2000) shows how knowledge management and human resources management are linked to each other. They state the role of human resources management is very significant to knowledge management in two ways. One is the mapping of human resources knowledge and the other is the identification of any strategic of knowledge gaps. Figure 18 shows these two activities and their links.

The employees in an organisation have a certain amount of knowledge available (what organization knows?) with which work can be executed (what organisation can do?). The strategy/strategies of the company indicate what the organisation must do for which a certain amount of knowledge is required. The upper two blocks in figure 18 are likely to remain unchanged for a long time. The two blocks on the bottom are dependent on the knowledge in the work force. The available knowledge in the organisation is likely to change when an employee leaves the company. This could lead to a change in the strategic gap and the knowledge gap. These gaps can be closed by training the remaining work force and/or hiring new employees with the required knowledge.

**Implication and advice for knowledge sharing strategy**
By implementing all the advice, the knowledge sharing strategy will become a balance between personalization and codification. According to the task characteristics of this department, this is an excellent development. Within the department, tacit knowledge is available through face-to-face interactions where explicit knowledge becomes available in the IT-system.

The sharing of knowledge across the departmental boundaries is also likely to improve by implementing the general advice. Both tacit and explicit knowledge will become available in cross-departmental IT-systems. Additionally, there will be improvement on the face-to-face interaction between departments due to the rotation of employees.

The additional advice on the knowledge sharing between departments is to increase the collaboration with the CB-D2 department. When projects are handed over, enough tacit and explicit knowledge is shared to execute the order. However, there is some presence of the not-invented-here-syndrome since Department 2 is not consulted in the designing process. More involvement of Department 2 at the CB-D1 department is likely to reduce the syndrome and improve the collaboration and knowledge sharing.
Appendix Q. Specific improvements CB-D2 department

This section focuses on the specific improvements and implications for the CB-D2 department. First the additions to the desired “soll”-situation are described. Next, some additional improvements are explained. For this department, these are one additional improvement point to those stated in section 7.2. Additionally, there is some focus on improving knowledge sharing within this department and in their collaboration with the CB-D1 department. Finally, the implications of the advice for this department are described.

1. Additions to desired (“soll”) situation
The functional requirements for this department with regard to knowledge management focused on the next activities from the Knowledge Value Chain (Weggeman, 2006); knowledge sharing, knowledge application and knowledge evaluation. As stated in section 7.1.1, knowledge management needed to address the storing and reusing of knowledge. The additional functional requirements for this department focused on the collecting and maintaining of knowledge.

The user requirements for this department were similar to those from section 7.1.1.

The redesign needed to fit within three specific boundary conditions. First, the primary work of the department needed to be executed at all times. However, when there was an opportunity to start executing knowledge sharing activities, this opportunity needed to be stimulated. The second boundary condition for the redesign was the protection of intellectual property. There needed to be a clear framework indicating how intellectual property was protected, and which knowledge required to be protected. The third condition focused on no unlimited accessibility of knowledge to all employees of the company. However, since this boundary condition is hindering the open culture required for knowledge sharing it was not considered when creating the redesign.

Finally, there was one design limitation set by the department on the rewarding of knowledge sharing. Salary was regarded as a reward for all the work being executed, whether for specific product and projects or on knowledge management initiatives. Other rewarding for knowledge sharing needed to be based on intrinsic motivation instead of extrinsic motivation.

2. Additional improvements
For this department, the additional improvements focused on the used knowledge sharing strategy and the knowledge sharing across departmental boundaries.

Additional to the common functional requirements for each department, the CB-D2 departments required the collecting and maintaining of knowledge. This requirement was covered by the combination of a corporate IT system and making both tacit and explicit knowledge available and searchable. All other low scores on the KM-scan and user requirements for this department were met by improving the general points from section 7.2.

The used knowledge sharing strategy at this department showed mixed results. It was showing good and bad performances and the design propositions provided no guidance about which strategy fits best. However, for knowledge reuse codification it was likely to improve performance where personalization was favoured for the training of new employees. Additionally, the size of the department justified the increased use of codification according to Chai & Nebus (2012).

The sharing of knowledge across departments was focused on both codification and personalization. Documents were handed over at transfer meetings and explained by some of the involved employees. Again, additional codification was required to maintain a clear focus on the philosophy of the customer and the eventual purpose of the ship.
3. Implications of advice for improvement

This section provides the implications of the improvement advice to the SC-D1 department, which is divided into two different parts. One part focuses on the implications of the corporate and department level advice. The second provides the implications and advice about knowledge sharing within and across the departmental boundaries.

Implication of advice

In general, the implications of all the improvements is that all employees need to spend more time on knowledge management activities, which is likely to reduce the time spend on other work activities.

The pre-conditional advice to promote knowledge sharing throughout the company has some implications on the attitude of employees in the department. Department management needs to communicate the corporate view on knowledge management. This implies stating the importance of knowledge management to the corporate strategies. Additionally, management is responsible for the intrinsic and extrinsic motivation of the employees to share knowledge.

From the corporate level advice, both the IT-system for explicit knowledge and the rotation of employees have implications for the CB-D2 department. The corporate knowledge management strategy will, without too much effort, improve the score on ‘KM strategy’ by creating explicit targets on the product factor knowledge. The creation of two IT systems helps the department working more effectively with more available and accessible tacit and explicit knowledge. Additionally, it meets the requirements to have good procedures and structures for the sharing of knowledge and making it accessible to everybody. The initial codification activities are likely to reduce the time spend on the primary work activities. However, in the end this investment will have a positive outcome since work can be performed more efficiently. The rotation of employees will likely have more implications for the department. Rotating employees are likely to work less effectively in daily activities compared to stationary employees. However, this rotation will improve knowledge sharing across the departments and innovation activities.

The department level advice has more implications compared to the corporate level advice. Explicit sessions need to be planned to create an overview of required knowledge for this department. Time needs to be made available for employees to make their tacit and explicit knowledge available and accessible. The same holds for the reporting and preventing of errors and mistakes. Because of the size of this department a large amount of time will be spend on knowledge management activities. To make sure the regular product development activities are still completed in time, additional personnel is needed to cope with the new situation. Another solution is to temporarily take slightly less projects in order to have enough time available to execute the improvement points. When knowledge management and knowledge sharing are structured and operational, it is likely the original work force is able to handle the workload of the department again.

Implication and advice for knowledge sharing strategy

By implementing all the advice, the knowledge sharing strategy will shift from solely personalization to a balance between personalization and codification. According to the task characteristics of this department, this is an excellent development. Within the department, tacit knowledge is available through face-to-face interactions where explicit knowledge becomes available in the IT-system.

The sharing of knowledge across the departmental boundaries requires more focus on the codification instead of only on personalization. The implementation of all the advice also helps to make this shift for the sharing of knowledge across departments. Both tacit and explicit knowledge will become available in cross-departmental IT-systems. Additionally, there will be improvements on the face-to-face interaction between departments due to the rotation of employees.

The additional advice on the knowledge sharing between departments is to increase the collaboration with the CB-D1 department. When projects are handed over, enough tacit and explicit knowledge is shared to execute the order. However, there is some client specific information missing that is
important for the engineering part of the project. An early involvement of Department 2 within the CB-D1 department is likely to provide a clearer picture of the request of the client and helps to improve the transfer of the project from the D1-department to Department 2.
## Appendix R. The different combinations of task characteristics

<table>
<thead>
<tr>
<th></th>
<th>Low frequency</th>
<th>High frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reuse (static)</td>
<td>Learning (dynamic)</td>
</tr>
<tr>
<td><strong>Low heterogeneity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low causal ambiguity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High causal ambiguity</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>High heterogeneity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low causal ambiguity</td>
<td>CB-D1 (partial)</td>
<td></td>
</tr>
<tr>
<td>High causal ambiguity</td>
<td>CB-D2</td>
<td></td>
</tr>
</tbody>
</table>