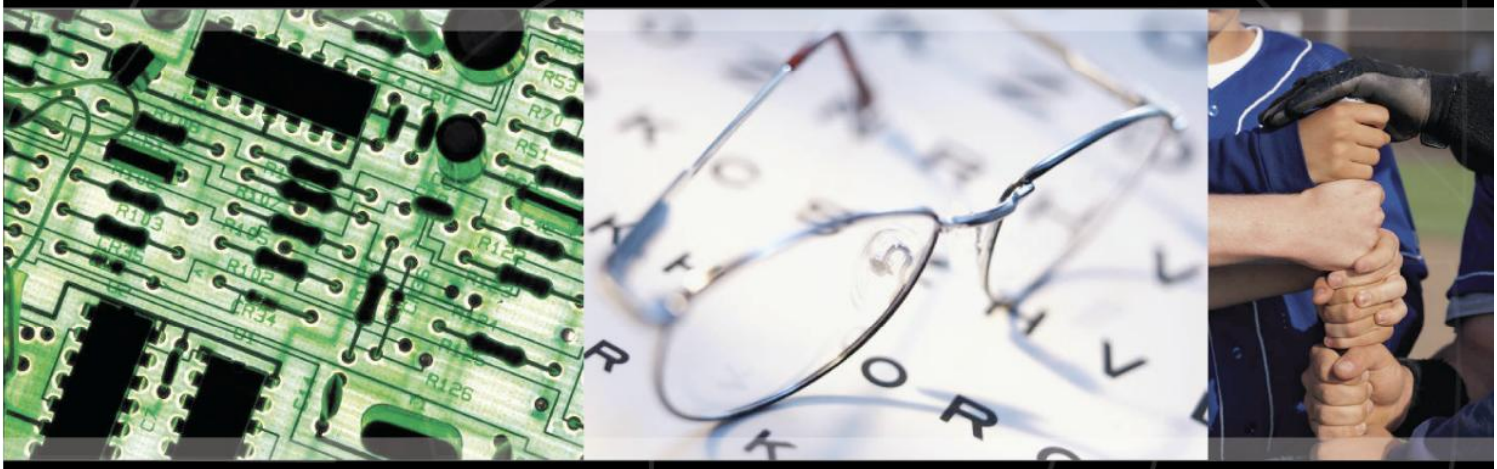

master thesis

# "homogenizing group knowledge"

## knowledge management at Norit Enschede

May 2009

Jeroen Kunst

Norit
leading in purification

University of Twente
Enschede - The Netherlands

***Cover pictures***
*The first picture displays the IT component; the picture in the middle displays codified knowledge in general (text on paper) and also the human component in codifying (the glasses are used by humans to read and write knowledge); the last image displays the importance of social capital, working together brings better results.*

# Colophon

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Het homogeniseren van groepskennis – kennismanagement bij Norit Enschede

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# Preface

The last 9 months have been a wonderful experience, learning the importance of science in a practical environment. Besides that it was also a wonderful experience to participate in that practical environment doing interviews with people from all sorts of cultures, countries and backgrounds. For myself this research has given me great insights in, not only the difficulties and issues around knowledge and information management, but more specifically in the importance of documenting and communicating decisions that are made during projects. Communication is thus a concept that plays an important role in whatever environment.

When I started at Norit Process Technology I had no knowledge in the field of knowledge management because this is not a part of the study of Business Administration. But when I finalised my literature research I felt more confident that I would be able to design a solution to help Norit with its knowledge sharing.

During the (international) Technology Transfer Meeting I also was present, firstly to conduct interviews with the foreigners present, and secondly to become more acquainted with Norit personnel present. This eased the way of approaching and interviewing the respondents. Then I started with the interviews, which was quite exciting because six of the first seven people I interviewed were from abroad, with all different cultures. However, when conducting the interviews I pretty quick found a good level of understanding with the respondents and my level of interview techniques grew with each interview I performed.
However not everything went prosperous. When I started with the external research I found that a benchmark research was very difficult to perform. Not so much because of companies not wanting to participate, not at all actually, but more because of the fact that 15 of the 20 companies that were approached never thought about knowledge management or did not have priority to invest effort in it. The other five were only just starting with knowledge management or chose specifically to not perform knowledge management because of their interesting way of management. In the first place, this was to delay my research for at least four to five weeks. But after contacting my primary supervisor and discussing it with him, we decided to transform the benchmark research into an exploratory study to research the current state of knowledge management at other companies in the Dutch manufacturing industry. I also learned not to be too independent; during the research I kept information on the thesis progress too much to myself, resulting in making mistakes in the analysis of the interviews. Those mistakes have cost me four weeks of delay at the least. While entering the last phase of my thesis, writing my report, I hope I can deliver and present a satisfactory research report.

There are also some acknowledgements I would like to do; in the first place my company mentor Stephan van Hoof for the ongoing inspiration, active involvement and giving me the possibility to interview the engineers, both at the KHC and from the regional offices. Besides that I would like to thank Hans Roosendaal for his concrete advice and his mentorship to help me through this last phase of my study. I also would like to thank Jeroen Kraaijenbrink for being my second supervisor and giving me strong advise on structuring my thesis.
There are some people without whom I would not have been able to fulfil my research. First of all Ruben De lange, for introducing me at Norit Process

Technology! Secondly my parents, my brother and his wife for the ongoing interest in how my research was progressing and supporting me in the many ways they did. Also my friends and classmates are to be mentioned because without them I would not have been able to have the many relaxing moments that I certainly needed, and sometimes without them knowing inspiring me to new insights into the topic. Also I would like to thank all the companies I was in contact with on the matter of knowledge management and being so kind to freely share their ideas, decisions and insights in their company's processes. Also all the colleagues at Norit Enschede who always gave me the feeling of not being 'just an intern' but their colleague! In addition I would like to thank Jeroen Groener for the interesting and elaborating discussions and support with the analysis. Last but not least I would thank Barend Lemans and Rene de Jager for giving me rides to and from Enschede.

Finally, I hope you will enjoy reading this thesis!

Kind regards,

Jeroen Kunst
Enschede, 25 May 2009

# Executive summary

In a world where globalisation and worldwide cost competition are a fact, it is hard to stay ahead of the low cost competitors. On top of that, the worldwide economic crisis has lead companies that have been struck, to lay off employees mostly without retention of their individual knowledge. This knowledge must be managed in order to be useful and moreover, profitable in the future.

In scientific literature a lot is written about knowledge systems. The problems addressed are that critical mass is hard to reach and therefore knowledge systems are deemed to fail. On the other hand, a lot is written about knowledge management and motivations, how people involved can be motivated to use knowledge systems. The scientific relevance of this research is to create a bridge between the hard system part and the softer motivation part, in order to generate an model for the implementation of a knowledge sharing system in a specific company with due observance of the willingness to share of the people involved. The model that is set up that can be used in other settings to implement knowledge management.

Norit Enschede is also coping with problems concerning their knowledge management. As a result of an expanding specialists network throughout sales offices worldwide Norit's knowledge base expands. Because of this expansion it becomes harder to keep track of information, knowledge, and expertise, resulting in efficiency losses.

To overcome previous issues, a literature study, several interviews and a group discussion have been done. The research is focused on engineers in the process technology department "Know-How Centre" of the Norit Enschede location and engineers at Norit Sales Offices worldwide. Besides, an explorative research has been done concerning the application of knowledge systems at other companies.

**Current situation**
Based on interviews with several engineers, it can be stated that the current situation of knowledge sharing at the KHC and the regional engineers is at an insufficient level to be effective and efficient. If documenting at all, the engineers write purely for support of their own memory. There are little project evaluations and therefore no lessons learned are codified, resulting in solving problems again and again. The current IT solution is a start in sharing information and knowledge, but not everyone knows how it works and what they can do with it. Besides previous issues, there is no complete overview on the available knowledge within the company. Another issue is that there are numerous ways of retrieving information or knowledge (up to seven different locations!), which confuses the engineers where to find the information and more importantly where to store the information. Because of these many locations, a lot of different versions are present on the network. Basically, it is easier to ask someone face to face then to go search on the various network locations. More issues that arise are lack of time as a result of priority issues, sporadically undergoing education; facilities to share are present but not sufficient, no clear structure where to save documents, and ad-hoc documenting. Then there is also the lacking relationship between the regional engineers and between the regional engineers and the KHC engineers, since the regional engineers are globally dispersed they do not contact one another much.

Norit is not the only one, trying to implement knowledge management. The most occurring problems at other companies are lack of management support, pushing through IT solutions while the daily work of the end users normally did not contain work on a computer, resulting in a lack of critical mass. Besides that, one company introduced a knowledge matrix, which is a comparison between the strategic goals and the current available knowledge in the organisation. This way knowledge gaps can be identified and acted upon. Of course the system will not be the only way to retrieve knowledge and information, social interaction must be stimulated. Introducing a yellow pages system can stimulate this, this way expertise can be found rather easy.

**Synthesis & design**
According to Hansen *et al.* (1999), knowledge is most effectively shared when using two different strategies, namely a codification strategy, focus on codifying knowledge, and a socialisation strategy, which has a focus on face-to-face communication. The first strategy will be leading since a part of the engineers are located in other time zones and thus social interaction is limited. Since the codification strategy is leading a knowledge system is to be designed.
Found in this research is that a single point of entrance will be important to make sure all engineers will enter through one portal and thus can find and publish all information on that single portal. The interaction with the Salesflow website and the fileserver will thus be of extreme importance to reduce the barriers of use.

To ensure the system is operational, several roles are necessary. The first role is that of *infrastructure management*. The ICT department will fulfil this role and has to make sure that all necessary hardware is present and works properly. Secondly, *application management* is responsible for building and servicing of applications running on the infrastructure. The ICT department will also do this. Thirdly, *functional management* is responsible for the administrative part of the system but is also responsible for the design of new functionalities requested by the end users. Last, *content management* is responsible for all content of the system; the roles concerning this last concept are *producer, consumer, intermediary, and knowledge officer*. The producer will codify knowledge, the consumer will consume that knowledge, the intermediary will review the codified knowledge, and the knowledge officer will have to manage the functionality of the system and will frequently discuss the goals of the organisation and the content on the system.

According to the respondents and literature (Dalkir, 2005; Tyndale, 2002) the content on the system will have to contain several elements. *Yellow pages* will ease the finding of expertise and people in general, *project summaries* to show who has been working on which projects, but also have an overview of lessons learned, a *download page* for standard documents such as drawings, technical bulletins and the like, a *question and answer* forum will have to ease the sharing of troubleshooting and problems in general, and last, a *workspace* where the engineers have a secure site to edit and publish documents and can manage versions of documents. All previous can be supported with the use of push technology to create awareness on changes in the documents and knowledge base, basically alerts will be sent to groups or single users who are subscribed to the specific knowledge area.

Introducing facilities to share is only one piece of the puzzle. The end users will have to be motivated to use them (Bondarouk *et al.*, 2008; Ipe, 2003; Davenport *et al.*, 1998). Motivating the engineers to codify and share

knowledge can be done through several ways. Examples are moral motivations, remunerative motivations, and coercive motivations (Callahan, 2004). Based on the interviews there can be said that the last two motivations are not welcomed by the respondents. Therefore a moral motivation as an expert rating system has to be set up, so that intermediaries and consumers can rate the usefulness of the documents. Based on these ratings a higher status can be gained within the collective, along with this status the engineer will be or become expert in a certain knowledge area. Presentations and working papers, in which engineers can elaborate on i.e. case studies and technologies they have been working on, are also a good tool to earn more status and thus more motivation. In line with this is to invite the best performing engineers to present their working papers at management conferences. As stated before it is important to keep emphasising human interaction, because the engineers still would like to know whom they are talking to (Wasko & Faraj, 2005). Other motivations are training to create the ability to use the IT introduced (Bondarouk, 2008) and increase specific knowledge by education. Since there is recorded how much publications are used and the usability of the publications is rated, this can be used at frequent individual appraisals.

**Gap analysis**
Based on the research performed a large gap has been localised between the current and the desired situation. In the desired situation there are standard protocols to capture, share, and retrieve knowledge, this means that if the knowledge that is searched is present, it can be found easily because of the structured way of recording. Roles and responsibilities are clear within groups. Engineers write working papers about interesting technologies, plants, markets, or the like. When they do, they can present their findings during presentations that need to be held frequently. Everyone within the company can attend these presentations and leads to mutual respect and greater social capital. The best working papers and presentations are invited to give presentations at management conferences. Most importantly, the management has clear strategic goals with which the education is aligned through the knowledge matrix. As one may see, this is definitely not the case in the current situation.

**Implementation scenario**
Before implementing a knowledge management initiative, one must advocate the importance of knowledge management throughout the organisation, disseminate the needs, and perform benchmarks to not make mistakes other companies have made. The management has a central role in advocating and motivating engineers. When the previous actions have been fulfilled, an implementation scenario can be initiated.
The scenario is based on a Capability Maturity Model (Strutt *et al.* 2006) and consists out of five phases: initial, repeated, defined, managed, and optimised. In the first transition – initial to repeated – the technology component is introduced, as discussed in the design paragraph, along with the first structural changes, think of allocation of time to write project evaluations and summaries. Besides that the engineers will need to learn how to work with the software component of the sharing solution. When critical mass is reached in the use of the system, the next transition can be initiated.
The second transition is the change from repeating certain actions to exactly stating what happens, why it happens, and how it can be improved. Tools that need to be introduced in this phase are knowledge groups who supervise the capturing of knowledge according to one protocol, creating the possibility to write working papers, and most important to link the different locations of

information, Salesflow, Technology Team Website, and file server, to one central knowledge repository.
The third transition is in the light of being able to manage everything that happens. Moreover, the engineers motivate each other and themselves to share knowledge because of the fully functional expert rating on the system. In this transition the knowledge groups become review groups who motivate individuals to write working papers. A knowledge officer will be assigned to fully support the functional management of the system. Then there is the frequent appraisal of knowledge activities by the principal engineers.
The last transition is a crystallisation of the previously introduced initiatives. In this last transition, knowledge is directly and easily accessible and knowledge loss is limited to a minimum.

**Recommendations**
To be able to overcome the presented issues, and evolve to a next phase, several recommendations can be made towards the KHC. Following the most important will be discussed:

- Clearly communicate the reasons and goals why to document and share knowledge. It is of utmost importance that all those involved are headed the same way;
- Introduce obliged *project evaluations* so that lessons learned are easily codified;
- Start with a knowledge gap analysis to identify knowledge gaps in the organisation and act upon this by setting up strategic education plans;
- Assign roles to all those involved. The ICT department has to make sure they have the hard- and software up and running, application management must have the ability to design the applications, and content management is done by all engineers by producing, consuming, and reviewing publications;
- Introduce one central portal to knowledge, instead of having seven different locations to search for knowledge and information;
- Invest in training on the use of IT to make sure all involved know how to work with the software introduced;
- Allocate time to the engineers so that they are triggered to document and share knowledge;
- Investment in relational capital between engineers. A feeling of belonging and connection to the community results in a more open environment of sharing knowledge;
- Appoint formal intermediaries who review all publications in the first phases of the implementation.

Basically by investing time, assigning priority to capturing, sharing, and acquiring knowledge, and investing in people and technology, reinventing the wheel will be minimised because repetitive problems are prevented.

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# 1 Introduction

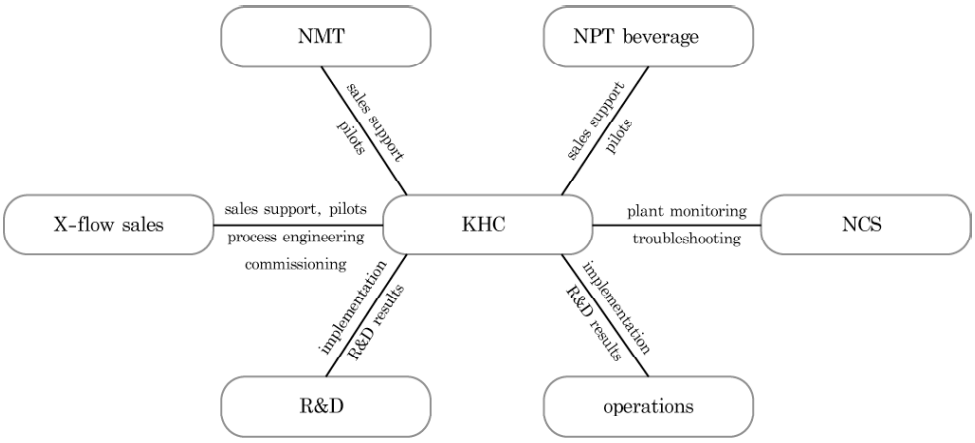
In a world where globalisation and an intense knowledge economy are a fact, it becomes harder and harder to keep track of the knowledge and experience of employees, especially in dynamic markets where (technical) knowledge results in competitive advantage. Besides, there are complex, diverse and fast changing business processes in modern companies. This results in high demands concerning the knowledge level of the specific organisation. This high level of knowledge asks to be managed; otherwise a lot of it can become unavailable resulting in efficiency losses. In addition there is the recent economic crisis that affects organisations all over the world. Companies that have been struck are laying people off, mostly without retention of their knowledge.

Until now information technology has mainly led to improvement of well-structured, mostly administrative company processes. Because of large improvements in information and communications technology (ICT), support of high quality, knowledge intensive work becomes easier. Knowledge management aims at the support of knowledge intensive work: the work of managers, researchers, designers, advisors, salespeople, governance employees and the like. One of the fields of interest of knowledge management is therefore the application of ICT for the support of knowledge work (Mackenzie Owen, 2001: 2).

## 1.1 Background and problem statement

Norit is active in different markets, mainly divided into two different businesses, Activated Carbon (AC) and Process Technology (PT). The Norit office in Enschede is active in Process Technology and focuses on the development and sales of membranes and their filtration applications, mostly in the water and beverage markets worldwide. The Enschede office houses about 350 full time employees (FTE) and worldwide the employee count is more than 1500 (FTE). The office houses different divisions under which the central technology department, the "Know-How Centre" (hereafter "KHC"), which plays an important role. The tasks of this group of people, consisting of process engineers, are to provide design rules, basic designs of plants using Norit membranes, technological support and advice for Norit Sales Offices (NSO's) and customers worldwide, commissioning supervision of plants, troubleshooting etc… as can be seen in Figure 1.

The group has a lot of knowledge and experience, which has to be applied as widely as possible. The KHC therefore wants to document its knowledge and experience properly and disseminate it to its own members as well as third parties. Recently a number of Norit's regional sales offices have hired people with a process engineering capability as well, in order to provide proper technical support locally. The knowledge and experience of these people needs to be integrated into the "knowledge base", moreover an interdependent knowledge transfer between the KHC and regional process engineers is necessary. The knowledge available at KHC needs to find its way to the regional offices but also the other way around.




| *Abbreviation* | *Meaning* |
|---|---|
| *NMT* | Norit Membrane Technology |
| *NPT* | Norit Process Technology |
| *NCS* | Norit Components and Services |
| *R&D* | Research and Development |

*Figure 1 KHC organisation*

Norit Enschede is a knowledge intensive company with diverse, complex and fast changing business processes, as mentioned in the previous paragraph. Besides that, Norit Enschede is growing and is expanding its technical specialist's network globally. As a result of this form of globalisation, the knowledge and experience base expands. To keep track of this (growing) knowledge base it is very important for participants to be able to access and contribute to this knowledge, e.g. at the Singapore branch a solution to a certain problem has been found and the same problem occurs in Venezuela, the knowledge from Singapore must then be available in Venezuela. If this is not possible, efficacy will lose ground and participants need to re-invent the wheel a couple of times. Because of the previous mentioned problems, Norit Enschede wants to research the possibilities how to facilitate knowledge sharing.

## 1.2 Research objective

The objective of this research is to give a functional description of a software solution for sharing knowledge and an implementation plan how to trigger producers and consumers to share their knowledge at the KHC at Norit Enschede and engineers from regional offices. Therefore the research objective can be stated as: designing a functional description of a software solution and the accompanying motivations for sharing knowledge, in order to homogenise the Know-How Centre's group knowledge.

In Figure 2 one may find the relations between the concepts used in this thesis.

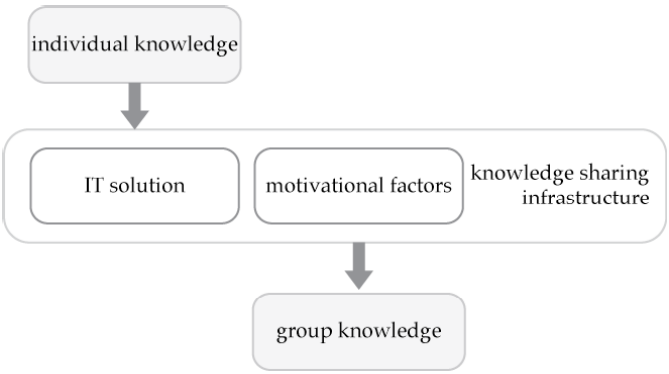



*Figure 2 relation between concepts*

## 1.3 Central question

The functional description of the software application must be in such a form that a software developer can translate it into a tailored Norit Enschede application. As mentioned earlier the knowledge that needs to be published in the system comes from the KHC and needs to find its way from the minds of the knower to a version that can be shared.

The classification of documents is also important: who must be able to access it? Being this only the users at KHC or also customers worldwide? Besides that incentives also play an important role: "how can users be triggered to contribute their knowledge in the system?"

The central question can be stated as the following:

What is the most effective manner of knowledge sharing for the KHC and their regional offices and how is this to be facilitated?

The core concepts of the central question need to be defined, that will be done below.

*Effective*
Efficacy and efficiency are two related terms with an important difference in definition. Efficacy indicates that a certain outcome of a process is realized. Efficiency on the other hand is the amount of resources used to reach a certain goal. A process is called efficient if it uses relatively little means compared to a norm. In contrast with efficiency, effectiveness does not concern the process itself, but the outcome of it.

Efficacy concerning this research is to be measured through the amount of publications and usefulness of the publications by users, how this measurement will be applied will be elaborated further on the research. It is important to research how the total infrastructure needs to be designed in that way that it stimulates knowledge sharing as much as possible.

*Knowledge*
Albert Einstein defined knowledge long ago, he said: "*Knowledge is experience. Everything else is just information*" this view has been changed during time. Wiig (1993) states that: "*knowledge is the total of truths, perspectives, judgements, and methodologies that are available to handle specific situations. Knowledge is used to interpret information about a particular circumstance or case to handle the situation. Knowledge is about what the facts and information means in the context of the situation (pp. 457)*".

This definition shows that knowledge is context specific and enables someone to act and value certain information. Also Davenport *et al.* (1998) define knowledge in their book. They state that: "*Knowledge is a fluid mix of framed experiences, values, contextual information and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of the knower. In organisations, it often becomes embedded not only in documents or repositories but also in organisational routines, processes, practices, and norms.* (pp. 25)".

Davenport *et al.* embed the organisations' knowledge in documents, routines, processes, and norms. This definition shows more connection to the research goal then Wiig does within the light of this research; which is focused on sharing documented knowledge. So from this perspective Davenport *et al.* will be chosen as working definition. However, further on in the research some extra views on knowledge will be presented to expand the understanding on the subject.

### 1.3.1 Research questions

To be able to answer the central question it is necessary to formulate research questions that cover smaller areas of the total research.

1. What is the current state of the knowledge-sharing infrastructure at the KHC at Norit Enschede?

The goals of this part of the research have been to find out how future users of the knowledge sharing system think about knowledge sharing and what motivations they have to share knowledge. Besides that there needs to be researched *what* knowledge is being shared at the moment and *how*, and which problems are being encountered. However this question focuses on knowledge sharing, the other phases, knowledge capturing and creation, and knowledge application are also to be discussed.

The answer to these questions that have been gathered through semi-structured interviews with several employees from the KHC and HRM department at Norit Enschede (Units of Analysis), but also a panel discussion at the "Technology Transfer Meeting". The interviews have given more in-depth knowledge on the way the employees are sharing their knowledge right now. The panel discussion has given more insights on the themes that are emerging with the employees of the KHC and process engineers worldwide. The interview respondents have been sampled on basis op purposive (judgmental) sampling (Babbie, 2004:pp. 184) because of the fact that only the KHC and process engineers from regional offices are in the sample.

2. In what way are other companies applying knowledge systems?

Conducting an explorative study focused on if and how other companies perform in knowledge management has answered this research question. The units of analysis in these companies are individuals who are responsible for the management of knowledge in their company. One may think of Chief Knowledge Officers of the specific company.

3. In what way can a knowledge sharing solution be designed for the KHC?

This research question has been answered by applying the literature and empirical outcomes from the previous research questions to design a complete knowledge sharing solution.

4. What should be done to overcome the differences between the current and the desired situation?

This research question has been answered through the use of the outcomes of the panel discussion, internal, and external interviews. The direction that is given for the recommendations is based on the comparison between the current and desired situation and on observations.

## 1.4 Relevance of the research

A very important question is of course: "what is the use of this research and who can profit from it?" This will be elaborated below.

*Societal relevance*
Companies in Europe, by definition, cannot compete with low wage countries concerning cost prices. To be able to compete, companies need to outsmart their 'low-cost-competitors'. Companies may outsmart them by means of providing higher quality products or providing higher added value towards customers, in which sharing knowledge can play a central role.

*Norit Enschede*
Norit Enschede and especially the KHC, has a central role in the development and distribution of the knowledge base of Norit Process Technology BV. The name Know-How Centre already implies that there is a lot of knowledge located in this department. Norit Process Technology BV may use this research to strengthen her knowledge base and distribution to ensure the company's continuity and profitability.

With the concrete proposals that are given at the end of the research, Norit can implement a (new) knowledge sharing infrastructure, which can make the work of KHC engineers less labour intensive because they may find the information, knowledge or expertise they seek much faster. Besides the KHC engineers there are also regional engineers in regional offices around the globe who may profit from the results of this research. Moreover, by sharing knowledge, a higher quality of services can be gained from which the customers of Norit Process Technology BV may also profit.

*Scientific relevance*
A lot of research has been done concerning knowledge sharing in a variety of industries. A lot of this research is done concerning the systems part (software solutions) of knowledge sharing and about existing systems to let others benefit from it (Ardichvili *et al.*, 2003). However, the people who are needed to share knowledge are often forgotten in this view. Other research indicates the importance of HRM influences (incentives) to motivate the people who need to use IT solution or share knowledge (Bondarouk, 2008; Ipe, 2003). The scientific relevance of this research is located in giving insights in how to implement a knowledge sharing system in a specific company with due observance of the willingness to share of the people involved. With this research, a model will be set up that can be used in other settings to implement knowledge management.

# 2 Theoretical framework

This chapter will be used to create some understanding on the topic at hand, first an overview of the history of knowledge management will be given, and after that the concept of knowledge sharing is discussed. The goal of this chapter is to finally come to a theoretical framework, which is to be used as an instrument in the rest of the research.

Many people thought of knowledge management as another management craze, but when looking at the history of several management theories one may discover that the individual (and also his knowledge) gets an increasingly central role in the management theories. To start with the early days of management, think of Taylor, it was more appropriate to have small individual (repetitive) tasks that could be easily reproduced. This view has been called "Scientific Management", efficiency was the goal and there was only one best way to perform a task. However, this view failed to perceive the experiences and judgements of the workers as a source of new knowledge. Consequently, the creation of new work methods became the responsibility of managers only (Nonaka and Takeuchi, 1995:36). In the following years another view emerged, partly because of the "Hawthorn experiments". This experiment showed that social factors such as morale, a "sense of belonging" to a group, and interpersonal skills to understand human behaviour improved productivity (Roethlisberger and Dickson, 1939). Based on these findings George Elton Mayo, in collaboration with Roethlisberger and others developed a different management theory called "Humans Relations Theory". They criticized the Taylorist view of management for treating the worker as an atomized "economic man," and argued that human beings are social animals who should be understood and treated in the context of the social group (Nonaka and Takeuchi, 1995). So the human being performing a certain organisational task is not merely a tool to get higher profits or better efficiency, it is someone who has knowledge and experience and can advice on how certain organisational processes can be improved.

A theory that emerged in the late 20$^{th}$ century is that of the learning organisation. Garvin (1993) defines: *"a learning organisation is an organisation skilled at creating, acquiring, and transferring knowledge, and at modifying its behaviour to reflect new knowledge and insights."* This definition begins with a simple truth: new ideas are essential if learning is to take place. Sometimes they are newly created, through flashes of insight or creativity; at other times they arrive from outside the organisation or are communicated by knowledgeable insiders. Whatever their source, these ideas are the trigger for organisational improvement. But they cannot by themselves create a learning organisation.
Learning organisations are skilled at five activities: systematic problem solving, experimentation with new approaches, learning from their own experience and past history, learning from experiences and best practices of others, *and transferring knowledge quickly and efficiently throughout the organisation*. Systematic problem solving is based on scientific methods where data is used instead of assumptions as background for decision making and using simple statistical tools to organize data and draw inferences. Experimentation involves systematic searching for and testing of new

knowledge. Experimentation is often motivated by opportunity and expanding horizons, not by current difficulties. Companies must also review their successes and failures, assess them systematically, and record the lessons in a form that employees find open and accessible. Not all learning comes from reflection and self-analysis; sometimes the most powerful insights come from looking outside one's immediate environment to gain a new perspective. This is also called benchmarking. The last skill is *spreading knowledge* quickly and efficiently throughout the organisation. This can be done through a variety of mechanisms, including written, oral and visual reports, site visits and tours, personnel rotation programs, education and training programs, and standardization programs (Garvin, 1993).

Being a learning organisation is one thing, but how to become one is another. Florijn *et al.* (2000) have fitted different levels of ambition into a figure to illustrate a possible path in becoming a learning organisation, as can be seen in the right upper corner of Figure 3.

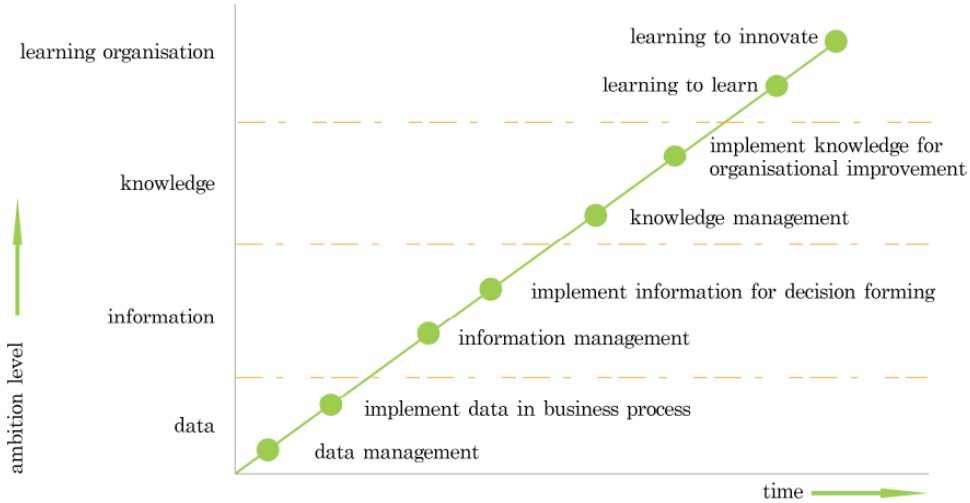



*Figure 3 development of knowledge in organisations (Florijn, 2000)*

In order to define knowledge one needs to go back to the basics, in the following paragraph there will be set out what is meant by data, information and knowledge.

## 2.1 Knowledge

Everyone kind of knows what knowledge is, and what is meant by it. In literature, however, there is no simple definition of knowledge whatsoever. Academics do agree that knowledge is something in people's minds and is not just information that one may find on i.e. the Internet or intranet. It is expanded with the personal experience a person has gained.

According to different literature (Davenport & Prusak, 1998; Bender 2000; Nonaka and Takeuchi, 1995) a distinction can be made between three concepts: data, information and knowledge. Data can be described as non-correlated objective facts on events. Data on itself only describes a part of what happened; do not give a judgement and do not give a durable basis for action (Davenport and Prusak, 1998). To become information, data needs to have meaning for the receiver; information is therefore individual (Florijn, 2000:22, 23). But to be able to make a judgment if data is meaningful, one needs knowledge. Knowledge can be seen as both process as well as inventory. Knowledge engages from information the way information

engages from data. Processing information into knowledge is practically a human's job (Davenport and Prusak, 1998:20-28). Knowledge, during time, evolves itself into experience that eventually generates new knowledge or interpretations of new situations. When experience becomes expertise the following relationship can be presented, see Figure 4.

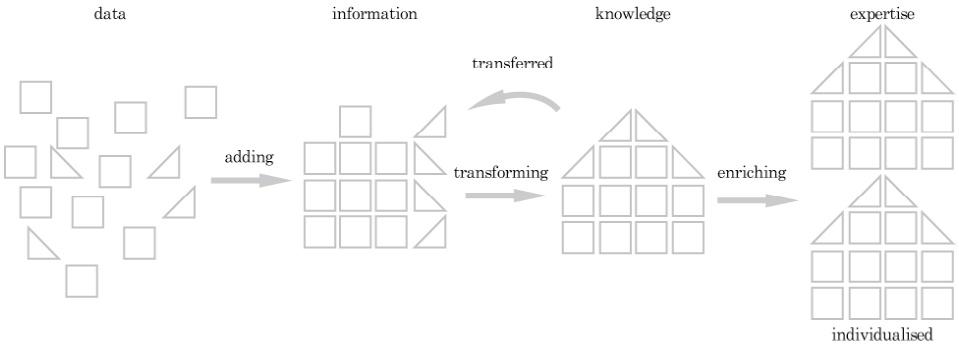



*Figure 4* *knowledge build-up (based on Bender et al. 2000)*

Another way to treat these concepts is to put them together in a simple formula (Baker, *et al.*, 1997).

Knowledge = Information + (Skills + Experience + Personal capability)

There is a strong distinction between the first (*Information)* component and the last ('*Skills* + *Experience* + *Personal capability*') component in this equation. The information component is based on *explicit knowledge*; the other one is based on *tacit knowledge*. This distinction will be elaborated in the next paragraph.

### 2.1.1 Categories of knowledge

The first type of knowledge concerns knowledge that is information recorded in theories, formulas, procedures, etc. or can be recorded into it. This knowledge is not personal and is easily transferrable. Everyone who needs this knowledge can easily obtain it by studying a medium or it is transferred by education. It is knowledge about past events or objects "there and then" and is oriented toward a context-free theory (Nonaka and Takeuchi, 1995). This knowledge is called *explicit knowledge* but, in the literature, also bares the synonyms codified, articulated or public knowledge.

The second type of knowledge is highly personal, hard to formalize and cannot be easily communicated with others. This knowledge is created here and now in a specific, practical context. This knowledge is developed in the course of time and is mostly related to a person or a group. To transfer this knowledge, the knower must start a learning route in which he teaches his 'apprentice' the ins and outs of his knowledge. When the apprentice starts to use this knowledge himself, then the knowledge will be better understood (socialisation; Nonaka and Takeuchi, 1995). So to recapitulate, this knowledge is not yet transferred to communicable shape, and can be gained by copying and imitating. This knowledge is called *tacit knowledge.* Table 1 shows a short reproduction of the two knowledge types (Nonaka and Takeuchi, 1995: 60).

| *Tacit Knowledge (Subjective)* | *Explicit Knowledge (Objective)* |
|---|---|
| Knowledge of experience (body) | Knowledge of rationality (mind) |
| Simultaneous knowledge (here and now) | Sequential knowledge (there and then) |
| Analogue knowledge (practice) | Digital knowledge (theory) |

*Table 1* *two types of knowledge (Nonaka and Takeuchi, 1995:61)*

Based on Polanyi's distinction, Tsoukas (1996) states that tacit and explicit knowledge cannot be considered as two independent forms of knowledge. Tacit knowledge is a necessary component of all knowledge. Knowledge cannot be named a production factor because knowledge is inside the mind of the bearer and is related to its environment. Knowledge is not a marketable production factor like raw materials, capital, or land, but is created as a part of a social process. So knowledge does have some properties that are absent in almost all other resources used in a company. Below a list is shown with some of the most important characteristics that set knowledge apart from other resources, knowledge:

- is intangible and difficult to measure;
- is volatile, that is, it can 'disappear' overnight;
- is most of the time, embodied in agents with wills;
- is not 'consumed' in a process, it sometimes increases through use;
- has wide ranging impacts in organizations (e.g. 'knowledge is power');
- cannot be bought on the market at any time, it often has long lead times;
- is 'non-rival', it can be used by different processes at the same time (Wiig *et al.*, 1997).

Brown and Duguid (1998) state that a great deal of knowledge is both produced and held collectively and knowledge is created through a social process, as Tsoukas (1996) mentions. Such knowledge is readily generated when people work together in the tightly know groups known as "communities of practice." As such work and such communities are a common feature of organisations, organisational knowledge is inevitably heavily social in character (Brown and Duguid, 1998:91).

There is a strong interaction between the two types of knowledge distinguished previously. This interaction is called *"modes of knowledge conversion"* by Nonaka and Tekeuchi (1995: 62) from which they distinct four types, namely:

1. from tacit knowledge to tacit knowledge: *socialisation;*
2. from tacit knowledge to explicit knowledge: *externalisation;*
3. from explicit knowledge to explicit knowledge: *combination;*
4. from explicit knowledge to tacit knowledge: *internalisation*.

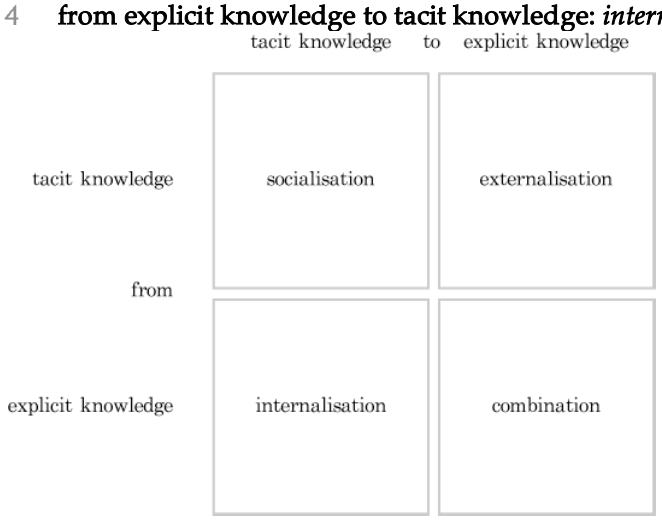



*Figure 5 four modes of knowledge conversion (Nonaka and Takeuchi, 1995:62)*

*Socialisation* is a process of sharing experiences and thereby creating tacit knowledge such as shared mental models and technical skills. An individual can acquire tacit knowledge directly from others without using language. Think of the apprentice-master system, where apprentices learn craftsmanship through observation, imitation and practice. A more recent phenomenon, working conform the same principle, is on-the-job training. The key to acquiring tacit knowledge is experience (Nonaka & Takeuchi, 1995:62-63). *Externalisation* is a process of articulating tacit knowledge into explicit concepts. It is a knowledge-creation process in that tacit knowledge becomes explicit, taking the shapes of metaphors, analogies, concepts hypotheses, or models. The externalisation mode of knowledge conversion is typically seen in the process of concept creation and is triggered by dialogue or collective reflection (Nonaka & Takeuchi, 1995:64-65). *Combination* is a process of systemising concepts into a knowledge system. This mode of knowledge conversion involves combining different bodies of explicit knowledge. Individuals exchange and combine knowledge through such media as documents, meetings, telephone conversations, or computerized communication networks. Reconfiguration of existing information through sorting, adding, combining, and categorizing of explicit knowledge (as conducted in computer databases) can lead to new knowledge (Nonaka & Takeuchi, 1995:67). *Internalisation* is a process of embodying explicit knowledge into tacit knowledge. It is closely related to "learning by doing." When experiences through socialisation, externalisation, and combination are internalised into individuals' tacit knowledge bases in the form of shared mental models or technical know-how, they become valuable assets. For organisational knowledge creation to take place, however, the tacit knowledge accumulated at the individual level needs to be socialised with other organisational members, thereby starting a new spiral of knowledge creation. For explicit knowledge to become tacit, it helps if the knowledge is verbalised or diagrammed into documents, manuals, or oral stories (Nonaka & Takeuchi, 1995:69).

But for these knowledge conversions to take place, knowledge needs to be managed. That is when knowledge management makes its entrée.

## 2.2 Knowledge management

In the early years of knowledge management there was a great emphasis on the possibility to manage knowledge through ICT. However over time an increasingly amount of research has been done on HRM supported knowledge management (i.e. Hislop, 2003; Yahya and Goh, 2002; Choi and Lee, 2002; Oltra, 2005). As can be concluded from these researches, ICT is a mean to perform knowledge management and not a goal on itself. So knowledge management cannot be implemented only by spreading a software application through the organisation. The previous is also supported by Tsoukas (1996); he states that explicit and tacit knowledge cannot be seen separately.

Hansen *et al.* (1999) speak of two possible strategies to pursue: the codification strategy and the personalisation strategy. Choi and Lee (2002) also distinguish these two strategies; however they call them the system and human strategy. The first strategy's focus is mainly centred on the computer and strives to codify knowledge into digital documents and databases, where it can be used by anyone in the company independently of time and space. Thus there is strived to transfer tacit to explicit knowledge in order to save this knowledge into systems, or *externalisation* as Nonaka and Takeuchi (1995) label this conversion. Information technology has an important role in this

approach that is why this strategy is also known as the '*information based*'approach (Demarest, 1997). The second strategy's focus is on face-to-face contact to transfer knowledge. Knowledge cannot be easily transferred but is inevitably linked to a person who, aware or unaware, always adds subjective value to information. Nonaka and Takeuchi (1995) call this *socialisation*. The information technology part of this strategy is to support individuals to communicate knowledge. This strategy is also known as the 'interaction-based view' (Demarest, 1997). Hansen *et al.* (1999) also state that one should pursue only one strategy with support of the other, so an 80% strategy with a 20% support strategy. Moreover, executives who try to excel with both strategies risk failing at both (pp. 112). Gammelgaard (2004) also addresses the two strategies and emphasises that the two should supplement each other instead of oppose, as can be seen in Figure 6. The concepts will be explained further on.

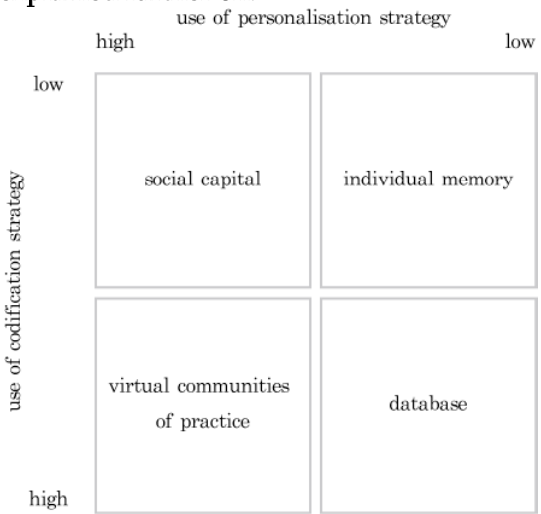



*Figure 6 means of knowledge retrieval (Gammelgaard, 2004)*

In the personalisation strategy one may recognise the role of human resource management (HRM), because this department is mainly responsible to measure the competences of individuals in the organisation. Different writers emphasise the importance of social systems when implementing knowledge management. ICT only solutions tend to fail because of a lack of support from employees (Davenport *et al.* 1998).

The developments of information and communications technology, which are emphasised in the codification strategy, have not just facilitated sharing information across an entire organisation, but almost made it imperative for the continued survival and expansion of an organisation. This concept is clearly supported by the emerging new organisational theories that imply that the only competitive advantage a firm has in the twenty-first century is what they know and how they use it (Gupta, et al, 2000).

By combining the tacit/explicit knowledge and system and human strategy view, one can create the following table in which some examples and emphasises are given.

| *Strategy* | | *Knowledge* |
|---|---|---|
| | *Tacit* | *Explicit* |
| System / codified | Create networks through IT (video conferencing, groupware, and virtual reality)<br>Facilitate face to face meeting | Codify knowledge using traditional information processing technologies<br>Emphasise person-to-documentation |
| Human / personalised | Community of practice, discussion group, and help task<br>Emphasise person-to-person | Help transmit newly created concepts<br>Breakdown of concepts using face-to-face meeting (usually in Japanese firms) |

*Table 2 Knowledge types and strategies (Choi and Lee, 2002:176)*

Wiig (1993) states that successful knowledge management, is supported by a fundament and three pillars. The broad understanding of the term knowledge forms this fundament. The pillars symbolise the functions of knowledge management and are filled with methods and techniques. The first pillar concerns the exploration of knowledge and assessing its adequacy. The second pillar concerns the assessing of the value of the knowledge found in pillar one and the assessing of possible interventions. Pillar three is the proper selection and implementation of knowledge related activities (choosing an intervention) including the consequences assessment of the current knowledge situation Wiig (1993: 419-421).

Alavi (2000) also distinguishes a knowledge management process: capturing or documenting knowledge, packaging knowledge for reuse, distributing or disseminating knowledge, and reusing knowledge. The first, capturing/documenting knowledge can be divided into four items:

- a passive by-product of the work process;
- documenting knowledge for reuse with the help of a facilitating structure;
- creating pre-structured records (i.e. technical support interventions);
- after-the-fact strategy of filtering, indexing of documented knowledge.

The second, packaging knowledge is the polishing, fine-tuning, structuring, formatting and indexing of documents against a classification scheme.
The third, distributing or disseminating knowledge can be passive or active. Examples of passive distribution are newsletters, or browsing in knowledge repositories. Examples of active distribution is convening a review meeting or pushing knowledge to people who need to know. The last, reusing knowledge, involves both recalling stored information and recognition of knowledge that is useful to the user (Markus, 2001: 61)

According to Dalkir (2005:43) the knowledge management life cycle by several authors (under which Wiig, 1993), can be integrated in one model. The model contains several dimensions, similar to that of Alavi (2000), namely knowledge capture and/or creation, knowledge sharing and dissemination, and knowledge acquisition and application, as one may see in Figure 7.

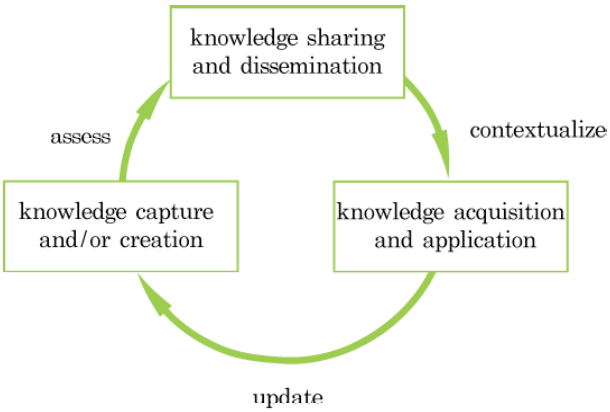



*Figure 7 an integrated KM life cycle (Dalkir, 2005:43-44)*

## 2.3 Knowledge sharing

Like sir Francis Bacon[1] once wrote: "knowledge is power". That can also be said about knowledge sharing. By sharing knowledge, a company can gain higher competitive advantage because of a higher leverage from its knowledge. But if individuals perceive that they, individually, may gain power from the knowledge they possess, they may start or continue with hoarding their knowledge (Davenport *et al.*, 1997). Hendriks (1999) emphasises the importance of knowledge sharing because it provides a link between the level of the individual knowledge workers and the level of the organization, where knowledge gets its economic and/or competitive value.

Sharing in general means that one divides something into smaller parts, so there is less left for the one that is sharing. However by sharing knowledge one does not know less than someone else. Knowledge sharing is based on communication, according to Boer (2005); without communication there would be no sharing of knowledge. However not all communication leads to knowledge sharing. So to share knowledge, communication is essential and parties must be willing to learn from each other. Again, putting information in a database is thus, per definition, no pure knowledge sharing. Investing time, effort and learning is thus necessary.

According to Davenport *et al.* (1997) there should be a division between sharing and reporting. One does not *have* to share information but is *able* to, so sharing is a voluntary act. Reporting on the other hand is the involuntary exchange of information on a routine or structured system, mostly up and down the structural hierarchy (pp. 87). The research at hand will focus more on *sharing* instead of *reporting*, because this research will facilitate the knowledge sharing between individuals at the same hierarchical level.

Knowledge sharing is basically the act of making knowledge available to others within the organisation (Ipe, 2003). Knowledge sharing may be seen as a creative process, which must be stimulated in order to prevent hoarding of knowledge. The use of an incentive system is therefore needed to motivate and encourage individuals to share knowledge. According to Amabile (1997) this can be done through extrinsic or intrinsic motivation. The former is driven by the desire to attain a goal that is apart from the work itself, such as achieving a promised reward or meeting a deadline or winning a

[1] Sir Francis Bacon, Religious Meditations, Of Heresies, 1597, English author, courtier, & philosopher (1561 - 1626)

competition. The latter is driven by deep interest and involvement in the work, by curiosity, enjoyment, or a personal sense of challenge (pp. 44).

According to Ipe (2003) knowledge sharing can be done through two sorts of channels. Namely through formal/purposive channels that are created by the organisation; and informal/relational channels, that groups and individuals have created themselves.

McBriar *et al.* (2003) discuss knowledge gaps that are present in organisations. They state:

> *"A gap is associated with the difference between the knowledge that an organisation needs to fulfil its obligations and the knowledge that an organisation possesses as a result of employing staff, or maintaining other forms of knowledge resource. It should be noted that possessing knowledge in the form of a computerised knowledge archive is not the same as being able to deploy and use knowledge to carry out organisational business. Knowledge gap can refer to knowledge owned and archived or it can refer to knowledge that is deployable. The situation, where a member of staff possesses some knowledge and, because of promotion or redeployment, is no longer in a position to use this knowledge, is not uncommon." (pp. 30)*

An organisation should therefore take care that these knowledge gaps are as small as possible.

### 2.3.1 Knowledge sharing (de)motivators

The most important issue however is how to enable people to share their knowledge. According to Chen and Huang (2009) ICT can have a facilitating role in this matter, because sharing knowledge is a people thing and the only way to transfer knowledge is to communicate, either face-to-face or through technological communications. Every person has his own motivations why to share knowledge, from personal social motivations to corporate efficiency gains. As mentioned before, the use of a knowledge sharing system can be stimulated through intrinsic and extrinsic motivation. This view however, does not consider a negative influence: coercive incentives. Callahan (2004) states a threefold division of incentives:

1. *Remunerative incentives* (financial) where the employee gets a material award (mostly money), to act in a certain way (extrinsic);
2. *Moral incentives* are present when a certain choice can be stipulated as the 'right thing to do' or where choosing different is considered indecent. When acting on a moral incentive the result can be a sense of self-esteem, approval or admiration from the community. However, acting against moral incentives results in sense of guilt and condemnation by the community (intrinsic).
3. *Coercive incentives* are negative incentives. If one fails to act in a certain way, one may encounter a physical force against him by others of the community (i.e. firing) (extrinsic).

In their article, Wasko and Faraj (2005) research the link between social capital and knowledge contribution. They hypothesise that social capital (consisting of structural, cognitive, and relational capital) together with individual motivations influence knowledge contribution.

First, structural capital represented by the connections between individuals, or the structural links created through the social interactions between

individuals in a network. The more individuals are in regular contact with one another, the more likely they are to develop a 'habit of cooperation' and act collectively (Marwell and Oliver 1993). Collectives characterized by high levels of structural capital, dense connections in the collective, are more likely to sustain collective action, and create a moral obligation to one another.

Cognitive capital refers to those resources that make shared interpretations and meanings within a collective possible. According to Nahapiet and Ghosal (1998), it is necessary for some level of understanding to exist between parties, to be able to exchange knowledge. This level of understanding can be gained through communicating with others who have the same practice; consequently an individual's cognitive capital also develops over time (Wasko & Faraj, 2005). In relation to electronic networks researchers have found that people with high expertise are more likely to actively give useful online advice than individuals that have lower levels of expertise (Constant *et al.*, 1996; Wasko and Faraj, 2000). Wasko and Faraj (2005) find in their study that cognitive capital plays a vital role in knowledge contribution and the experience one has can predict the knowledge contributions.

Wasko and Faraj (2005) further discuss that relational capital exists when members have a strong identification with the community, trust others within the collective, perceive an obligation to participate in the community, and recognize and abide by its cooperative norms. Coleman (1990) states that the main function of this relational aspect of social capital is to facilitate actions for individuals within the structure, and that relational capital is an important asset that benefits both the community and its members. Relational capital can be dissected into several dimensions. Two of these dimensions are commitment and reciprocity. The first is a duty or obligation to engage in future action and arises from frequent interaction. Individuals, who are posting valuable advice in an organisational electronic network, are motivated by a sense of obligation (Constant *et al.*, 1996). And the latter, reciprocity means that others also will share their knowledge so that there can be mutual learning (Hendriks, 1999) and those who participate in sharing knowledge can acquire or benefit from some of the value created from their environment (Ipe, 2003). Empson (2001) discusses in her research the fear of exploitation, which is a negative aspect of reciprocity and can be seen as a threat to knowledge sharing between individuals. This fear of exploitation also feeds mistrust of the recipient. "*Trust leads to increased overall knowledge exchange, makes knowledge exchanges less costly, and increases the likelihood that knowledge acquired from a colleague is sufficiently understood and absorbed that a person can put it to use*" (Abrams *et al.*, 2003: 65).

Not only individual motivations are important, but organisational motivations are important as well. Certain types of knowledge have high competitive value, which can contradict the incentives to share knowledge, resulting in withholding it (Ipe, 2003). Withholding knowledge thus can occur because of a competitive advantage. Besides that the geographical location can also play an important role in not sharing knowledge. A difference in location sometimes also means differences in culture, i.e. Martinsons and Westwood (1997) researched information and management systems in Chinese business culture. One of the issues they encountered was that codifying business information into a standardized form has little value for the Chinese people. Computers do not convey the necessary richness of meaning in a high context communication environment. Electronic exchange of information also would erode the status-based hierarchies by diminishing the social context and dynamic communications (pp. 200). However

Cummings (2004) states that because of differences in geographical locations, the structural diversity is positively influenced. Structural diversity means the potential to expose members to different sources of task information, know-how, and feedback, so different knowledge is created.

Hall (2001) depicts that employees only will use knowledge sharing means if they, on the one hand, can provide them with useful content and on the other hand they will only contribute content if they believe that it will be used (140-141). Besides believing that their contribution will be used, there are also rewards for knowledge sharing. These are widely discussed in the literature (i.e. Gupta & Govindarajan, 2000), but as mentioned before, there are intrinsic and extrinsic factors that play an important role (Amabile, 1997). Gammelgaard (2007) found in his research that there is a negative relation between knowledge sharing, the salary individuals receive and the codification strategy.

In an exploratory case study at Caterpillar (Ardichvili *et al.*, 2003) some motivations and demotivators to share knowledge have been found. They researched individuals who were part of an existing community of practice. The majority of the respondents in that research indicated that their knowledge was a public good, belonging not to them individually. Also they found that individuals wanted to gain a sort of (informal) expert status, which could be gained through the use of the electronic means (by i.e. rating quality and the amount of posts). Another reason came from the fact of age; managers and experts arrived in a stage of their lives where they wanted to share their expertise and felt that they could do it through the electronic means provided. The most important demotivators found in that research were that people were afraid that what they post might not be important or inaccurate or not relevant for the discussion in question. Another barrier was that they were afraid of fear to loose face and misleading colleagues. New employees felt intimidated about posting because they did not believe they had "earned the right" to post on a company wide system. Another issue, both for experienced employees and new employees, was that they were afraid of asking a question to which they already should know the answer. The process of getting knowledge entries approved by managers is time consuming. They however need to be checked on relevancy, security issues, etc… Besides that, security issues led to self-imposed censorship. By using the conventional solutions (e-mail, telephone, linking to personal websites) employees tried to solve that barrier.
The benefits to use the system as an encyclopaedia and problem-solving tool also came forward. The top benefits were that the system helps new employees to more quickly integrate into the new place of work; the system provides various geographically dispersed units with a place to work together, and communicate better; and access to best practices and lessons learned databases.
Demotivators for using the system as a source were stated as previous face-to-face groups make knowledge sharing systems redundant. Especially when problems or issues occur they return to their old habits. For quick and accurate answers individuals also are afraid to use the system because they are afraid of getting lost in the great amount of answers.

To recapitulate the outcomes of the case study at Caterpillar:

| *Motivators* | *Demotivators* |
|---|---|
| Gaining informal expert status | Afraid posts not important enough, inaccurate, of not relevant for discussion |
| Age; willingness to educate younger employees | Afraid of loosing face |
| Newcomers can integrate faster | Afraid of misleading colleagues |
| Geographically dispersed units can work together | New employees "not earned the right yet" |
| | Afraid of asking questions to which he/she should have known the answer |
| | Approving by managers |
| | Security issues lead to self censorship |
| | Old habits |
| | Lost in answers (too much reactions) |

*Table 3 knowledge sharing motivators and demotivators (Ardichvili et al., 2003)*

In a dissertation written by Soo (2006), some motivators and demotivators for sharing knowledge arose from a case study, as can be seen in Table 4.

| *Motivators* | *Demotivators* |
|---|---|
| Sharing nature | Protecting one's edge |
| Job insecurity | Job insecurity |
| Professionalism | Personal traits |
| Social ties | Personal animosity |
| Mutual benefits | Shared knowledge not accepted |
| Performance reviews | Harm themselves or others |
| | Confidentiality |
| | Lack of a sharing culture |
| | Making others discover knowledge by themselves |

*Table 4 knowledge sharing motivators and demotivators (Soo, 2006)*

There are a lot of knowledge sharing motivators and demotivators stated in the literature as mentioned in the foregoing paragraphs. A combined overview based on Callahan's (2004) incentive division can be found in Table 5.

| | *Motivators* | *Demotivators* |
|---|---|---|
| *Remunerative incentives* | Money | Money |
| | | Personal traits |
| | | |
| *Moral incentives* | Do the moral right thing | Fear of exploitation |
| | Some level of understanding | Confidentiality (competitive advantage) |
| | Higher level of expertise | Lower level of expertise |
| | Commitment | Afraid of loosing face |
| | Trust | Afraid of misleading colleagues |
| | Mutual benefits | Personal animosity |
| | Performance reviews | New employees have not earned the right to post/share |
| | Reciprocity | Shared knowledge not accepted |
| | Social ties | Lack of sharing culture |
| | Newcomers can integrate faster | Making others discover knowledge by themselves |
| | | Hierarchical approving before sharing |
| | | Old habits |
| | A lot of answers | Too much answers |
| *Coercive incentives* | Job insecurity | Job insecurity |

*Table 5 knowledge sharing motives*[2]

[2] based on Soo, 2006; Ardichvili et al., 2003; Callahan, 2004

As mentioned earlier in this paragraph, only applying an IT solution will probably result in the failure of the knowledge management effort. Therefore, motivating people through HR practices must be addressed to facilitate the use of the IT solution. According to Yahya and Goh (2002) there are several ways of how knowledge management is connected to the practice of HRM, namely in the fields of training, appraisal, and reward and compensation. They find in their research that training in creativity, customer relationship management, quality initiatives and empowerment are important ones to support. They also found that receiving feedback from internal customers (colleagues) correlates positively with knowledge management. Concerning compensation they found that there is a positive correlation between initiating new approaches and tactics in daily work, the work or task itself provides the greatest incentive, the extent of knowledge contribution with knowledge management.

So recapitulating, the most important HRM initiatives are:

- *Training*: creativity, customer relationship management, quality initiatives, and empowerment.
- *Appraisal*: feedback from internal customers, feedback based on needs of customers and the key process indicators.
- *Compensation*: innovating daily work, work or task itself provides the greatest incentive, and the extent of knowledge contribution.

Also Bandarouk *et al.* (2008, p.155) propose a relation between the implementation of an IT solution and HRM. Preventing demotivation of employees when implementing an IT solution originate in three domains:

- HR Policies and practices that remove obstacles to IT use and encourage employees to work with the IT (motivation);
- HR policies and practices that ensure employees' knowledge and build their skills to use the newly introduced IT (abilities);
- HR policies and practices that provide opportunities for employees to work with the newly introduced IT and encourage its use (opportunities).

Using enablers, such as stated in Table 6, may prevent these demotivators on the implementation of an IT solution from surfacing.

| *HR policy domain "Removing obstacles and strengthening motivation":* |
|---|
| specific reward system for learning and practicing with a new IT |
| regular evaluation of the use of IT |
| allocating special time for learning the technology |
| availability of managers' time for the users to discuss IT implementation issues |
| recognition of progress in using the technology |
| strengthening usefulness of IT |

| *HR policy domain "Building abilities, knowledge and skills"* |
|---|
| analysis of users' training needs |
| adequacy of training sessions in terms of their duration, depth, breadth of coverage |
| task-oriented training |
| customized availability of resources to learn |
| regulations to provide newcomers with training |
| peer teaching / training |

| *HR policy domain "Providing opportunities"* |
|---|
| define their training needs |
| contribute to design manuals and training programs |
| plan their work with IT |
| contact IT suppliers |
| re-schedule learning and training of IT |

*Table 6 HRM policy domains for IT implementation*[3]

As can be seen in the table above, Bondarouk *et al.* (2008) plead for a specific reward system for learning and practicing with IT. Dalkir (2005) however, warns for the implementation of incentive schemes. Because they actually can create a negative environment where office politics dominate and overshadow the productive goal of the company.

### 2.3.2 Knowledge sharing roles

Markus (2001) speaks of three different knowledge-reusing roles. These roles have been based on the knowledge reusing process that is described by Alavi (2000), see also paragraph 2.2. The three roles that are performed when sharing and reusing knowledge: the *knowledge producer*, the recorder of tacit knowledge into codified knowledge (the first phase, documenting and capturing); the *knowledge intermediary* who prepares knowledge for reuse (repackaging and distribution phase); and the *knowledge consumer* the one that uses the knowledge in a different context, the knowledge re-user.

From the knowledge producer's view there are three documenting strategies that need to be addressed, namely documenting for ourselves (the *prosumer*, which is a combined name for the *pro*ducer and con*sumer* (Gundry and Metes, 1996)); documenting for similar others; and documenting for dissimilar others. *Prosumers* tend to write very shorthand notes as a by-product of the work itself. When these notes are documented in process working documents it can contain much information about the rationale for various decisions.
When documenting for *similar others* the documents are consciously or unconsciously shaped into public documents. However when writing for similar others this shaping occurs in a minor way, because they share the same vocabulary, similar goals, interests, and jargon. But eventually writing for similar others can become burdensome and of diminishing value.
Then there is documenting for *dissimilar others* where one must be aware of two issues. First there is awareness of the lack of general or technical knowledge and understanding relevant of specific or contextual knowledge.

[3] Bondarouk et al., 2008, p.162

The second is that re-users may misuse explicit knowledge (Markus, 2001: 73-79).

When knowledge is contributed to a system, this contribution must be checked for relevancy but also must be categorised to ensure that the knowledge finds its way to the right people. That is the role of the intermediary and the facilitators, which in knowledge management often have an underappreciated role. One of the tasks that can be done by intermediaries is content authoring to make the knowledge available to larger parts of the company. Some issues concerning intermediaries in knowledge management are the lack of cooperation and lack of appreciation, even with strong organisational support; some tasks likely to facilitate effective knowledge reuse may remain undone; and last intermediaries could play an important role in advocating the use of self reuse documents in shared work environments (Markus, 2001: 83-86).

As Markus also concludes in her article is that repositories created by one group and for one purpose often lack successfulness in reusing by other departments or re-users with other purposes, without considerable rework of the content (2001: 88)

Roosendaal *et al.* (2001) discuss the functions for publishing information. In their model *strategic functions for scientific information*, there are four functions: registration, certification, archiving, and awareness. The publishing of information is not that different between the scientific environment and the business environment so however this model is used for scientific information, it can also be used in a business setting.

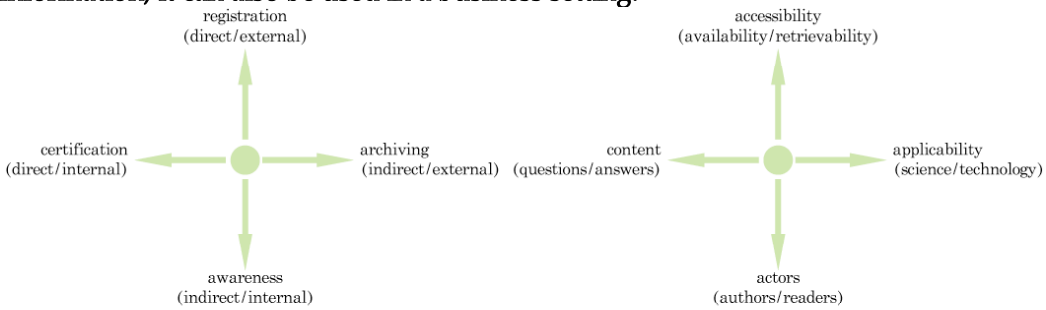



*Figure 8* *strategic functions (left) and forces (right) for scientific information*[4]

There are two external functions: registration and archiving; and two internal functions: certification and awareness. Internal functions are related to the knowledge process and external functions are the functions not directly related to the knowledge process. Then there are also direct functions related the author and indirect functions related to the reader. The reader needs to know (awareness) where to find (archiving) the documents that where published (registration) for the author (certification) (Roosendaal *et al.* 2001).

### 2.3.3 Knowledge sharing instruments

As defined in the central question, a knowledge management infrastructure consists of the total of structures and means which are deployed to support knowledge processes and knowledge management (Florijn, 2008:28). The total of structures and means thus holds several aspects under which people are an important asset. Connections between people make a community or department successful, because without these connections a department

[4] Roosendaal *et al.*, 2001

could loose track of its knowledge. Human interaction makes it possible for knowledge to flow through an organisation. However when a company exceeds a certain size, human interaction could become a problem. When an individual has i.e. 500 colleagues, he cannot know them all and cannot have a connection with all of them. A possible way to stimulate the interactions and create an interaction between these, to each other, unknown individuals is by means of knowledge management tools. Knowledge management tools can be defined as tools, which support the performance of applications, activities or actions such as knowledge generation, knowledge codification or knowledge transfer (Ruggles, 1997).

The goal of a knowledge management tool is not to manage knowledge by itself but to facilitate the implementation of the knowledge process. Such tools can facilitate the process of generating, structuring, and sharing knowledge through the use of information technology. But in general, the role of the tool is purely an enabler with the obligation on humans to conduct knowledge activities (Tyndale, 2002). Malhorta (1998) gives examples in which there is no direct correlation between information technology investments and knowledge management or business performance. This may be caused by organisations' ignorance in which knowledge workers communicate and operate through social processes of collaborating, sharing knowledge and building on each other's ideas.

Knowledge sharing in general is based on communication, according to a model by Bordewijk en van Kaam (Ellis, 1999) a division can be made between one-way and two-way communication and between collective and individual information files. They state four communication patterns:

- *Allocution*: it is the structure of mass media in which a centre distributes a message to outlying receivers. The sender determines the time and place and there is little opportunity for receivers to influence messages. There is little interactivity.
- *Conversation*: is an interpersonal or small group network and in complete control of the individuals. There is no centre, and the participants control time, place, and subject matter. Mail, letters, telephone conversations, and everyday face-to-face communication are examples.
- *Consultation*: individuals can shop at a central store of information. The individual determines subject, time and pace of the communication. Libraries, data banks, newspaper archives, and the Internet are places where information is stored for use.
- *Registration*: it is similar to allocution and consultation because there is a central store of information, but this central store requests information from users. It does not broadcast messages, and it is not available for search and use. Information is 'registered' in a central place and then used to inform or bill individuals. Registration is a matter of record keeping and is a principal means of surveillance in information-age cultures. Examples are exams, survey research, and elections (Ellis, 1999, pp. 62-63).

Most communication media only make one or two of the four patterns available i.e. a book for consultation and television for allocution, and television with videotext for consultation. Intranets and other Internet however make all four patterns possible.

An *intranet* is a company-wide information distribution system that uses Internet tools and technology. It could be a simple HTML file linked on a

LAN, a full-blown system with dedicated server hardware, or anything in between. The content of an intranet may include the corporate directory, calendar of events, policies and procedure manuals, and the company newsletter. *Web portals* are web sites, usually with little content, providing links to many other sites that can either be accessed directly by clicking on a designated part of a browser screen, or can be found by following an organised sequence of related categories. Portals can provide links to all the enterprise relevant sites (internal content providers) and also to some external relevant information can be found through extended search facilities or by following an enterprise defined taxonomy, which is usually created by subject matter experts or competency communicates, and organised by professional librarians. Examples of web portals can also be found in the daily life think of the 'start pages' on the web (i.e. http://www.startpagina.nl). *Groupware* is a technology designed to facilitate the work of groups. This technology may be used to communicate, cooperate, coordinate, solve problems, compete, or negotiate. Examples can be email, newsgroups, videophones or chat. *Workflow technology* allows an organisation to automate its business processes to better manage those processes and therefore better manage their outcomes, be they products or services (Tyndale, 2002).

Community *yellow pages* are a sort of people's profiles in which they give a short description of themselves but also their professional expertise. They may list previous projects, site visits, previous jobs, etc…The most important benefit of such a yellow pages system is that one may easily find the expertise they need, the so called expertise locator (Dalkir, 2005). Yellow pages or expertise location systems were among the earliest knowledge management applications, and they remain one of the best ways to initiate wider scale knowledge sharing in organisations (Dalkir, 2005: pp.119). One of the reasons for this is that it is fairly easy to implement this kind of knowledge management applications. In Table 7 one may see an example of corporate yellow pages. The result of finding someone that holds knowledge, important for a person on a certain time, and learning what he knows is called *socialisation* (tacit to tacit) (Nonaka & Takeuchi, 1995).

| *Directions* | *Libraries* | *Discussion area* | *Support* |
|---|---|---|---|
| *Products* | Best practice library | Discussion themes | Glossary of terms |
| *Projects* | Lessons learned | Project management | Frequently asked questions |
| *External suppliers* | Stories | Risk management | |
| *Network of experts* | Training modules | | |
| | | | |
| *Network of experts* | | | |
| *Function* | *Geographic area* | *Business area* | *Expertise* |
| *Vice president* | Northeast | Sales | *Content management* |
| *Director* | West Coast | Operations | Electronic production |
| *Line manager* | Midwest | Distribution | Knowledge management |
| *Operator* | South | Finance | Publishing management |
| | | | |
| *Content management* | | | |
| *Jane Dennys* | Head Office | 555 434-4564 | j.dennys@example.com |
| *Will Jameson* | Regional Office 6 – Northeast | 555 212-3212 | w.jameson@example.com |

*Table 7* *example of corporate yellow pages (adapted from Dalkir, 2005: pp.120)*

*Wikis* are web pages that are created, managed, and edited by users. Individuals can freely add or edit information and if something is not correct its reader can correct it. The use of it is as simple as using a word editor. People can add hyperlinks to corresponding pages to be able to quickly find information of a similar character. Two sorts of Wiki's exist, public Wiki's and corporate Wiki's. The latter gives companies the possibility to provide

interactive forums for tracking projects and communicating with employees over their in-house intranets (Dalkir, 2005: 231).

As mentioned in paragraph 2.1.1, a *Community of practice (CoP)* is a group of individuals who share their interests and problems with a specific topic, and gains a greater degree of knowledge of and expertise on a topic through their regular interaction (Wenger *et al.*, 2002). This community of practice is not a formal recognised team but crosses the borders of departments and, as mentioned in Wenger's definition shares a common goal, topic or interest. Since such a CoP often is not formally recognized it is mainly self-organising. Online CoP's have many forms, but most of such communities will contain:

1. member-generated content (e.g., profiles, home pages, ratings, reviews);
2. member-to-member interaction (e.g., discussion forums, member yellow pages);
3. events (e.g., guest events, expert seminars, virtual meetings, or demos);
4. outreach (e.g., newsletters, volunteer/leader/mentoring programs, polls/surveys).

However, one must keep in mind that these CoP's are distinguished from other groups such as work teams or project groups. Typically a CoP goal would have something to do with the improvement of the common profession or professional theme of interest to members (Dalkir, 2005: pp. 126).

*Push technology* facilitates relevant information to be sent to the clients automatically without the clients having to make an effort to retrieve information. Push technology, eliminates the need for browsing by pushing Internet content to the desktop (Tyndale, 2002). One may think of Really Simple Syndication (RSS), which is used on the Internet to keep up to date with the latest news, posts on forums, newest music, etc… Microsoft Vista is an example of pushing information to the desktop. A sidebar on the desktop has been included in which one can receive all latest updates through installed 'gadgets'. Apple already had this sort of application a while, they call it the Dashboard, on which you can install all sorts of 'widgets'.

### 2.3.4 Capability maturity models

Since an organisation has to go through several maturity stages before actually be performing a certain management tool, capability maturity models (CMM) have been created. These CMM tools are used to assess the capability of an organisation to perform the key processes required to deliver a product or a service. Significantly they can be used, both as assessment tool and as product improvement tool (Strutt *et al.*, 2006). In relation to knowledge management this could be an important and practical tool to use and can give managers to have something to go by when performing the initial steps into knowledge management. The University of Cranfield has set up a five-stage maturity model (Strutt *et al.*, 2006) that can be used for the use of knowledge management; see Table 8.

| *Level* | *Maturity* | *Description* |
|---|---|---|
| *5* | Optimised | The organisation is "best practice", capable of learning and adapting itself. It not only uses experience to correct any problems, but also to change the nature of the way it operates. |
| *4* | Managed | The organisation can control what it does in the way of processes. It lays down requirements and ensures that these are met through feedback. |
| *3* | Defined | The organisation can say what it does and how it goes about it. |
| *2* | Repeatable | The organisation can repeat what it has done before, but not necessarily define what it does. |
| *1* | Initial | The organisation has limited experience and is at a learning and development stage |

*Table 8 description of maturity levels (Strutt et al., 2006)*

## 2.4 Discussion of theoretical development

To be able to analyse the retrieved information from the interviews and the discussion, several theories will be used, which can be divided under *types of knowledge, motivations to share* and *opportunities to share.*

Figure 9 shows the relation of the different theories to the framework.

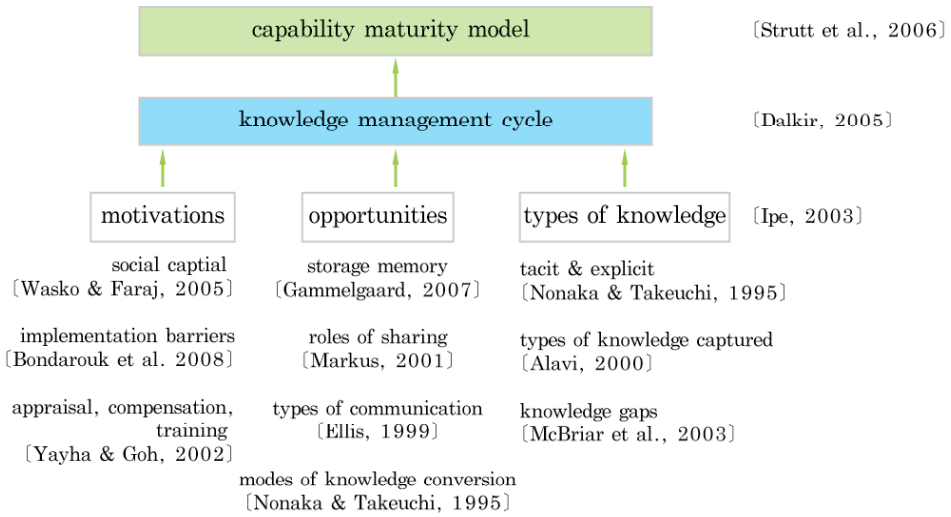
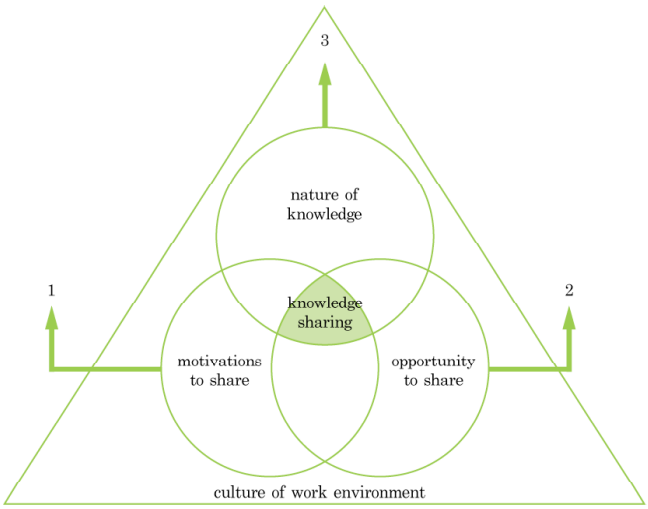



*Figure 9 theoretical framework*

The natures of knowledge that will be analysed are the daily codified and personalised knowledge. Examples of these are technical standards and project information. To come to a thorough analysis of the facilities to share the knowledge conversion of Nonaka & Takeuchi (1995) will be used along with the role typification by Markus (2001), and types of memory by Gammelgaard (2007). Concerning motivations the social capital theory by Wasko and Faraj (2005), implementation barriers (Bondarouk *et al.*, 2008) and appraisal, compensation, and training by Yayha and Goh (2002) will be used.

Following the main theories will be used to build up a useable framework for the analysis. There will be started with an elaboration on Ipe (2003) followed by the knowledge management cycle (Dalkir, 2005) to finally arrive at the capability maturity model (Strutt *et al.*, 2006).




| *(1) Motivation to share* | *Motivators* | *Demotivators* |
|---|---|---|
| *Remunerative incentives* | Money | Money |
| | Career | Personal traits |
| *Moral incentives* | Do the moral right thing | Fear of exploitation |
| | Some level of understanding | Confidentiality (competitive advantage) |
| | Higher level of expertise | Lower level of expertise |
| | Commitment | Afraid of loosing face |
| | Trust | Afraid of misleading colleagues |
| | Mutual benefits | Personal animosity |
| | Newcomers can integrate faster | New employees have not earned the right to post/share |
| | Reciprocity | Shared knowledge not accepted |
| | Social ties | Lack of sharing culture |
| | Performance reviews | Making others discover knowledge by themselves |
| | A lot of information | Too much information |
| | | Hierarchical approving before sharing |
| | | Old habits |
| *Coercive incentives* | Job insecurity | Job insecurity |

| *(2) Opportunity to share* | *(3) Nature of Knowledge* |
|---|---|
| *Formal interactions (sharing solutions set up by the organisation)* | Tacit or explicit |
| *Informal interactions (sharing solutions set up by employees)* | Value of the knowledge |

*Figure 10 relation of literature concepts*[5]

If the knowledge sharing cycle (Dalkir, 2005), see Figure 7 on page 25, is combined with this framework one may see the central role of motivations, opportunities, and nature of knowledge, see Figure 11. One can state that without motivation, opportunities to share, or clarity about the nature of the knowledge, no phase of the sharing cycle will be engaged.

[5] based on Ipe, 2003; Soo, 2006; Ardichvili et al., 2003; Callahan, 2004

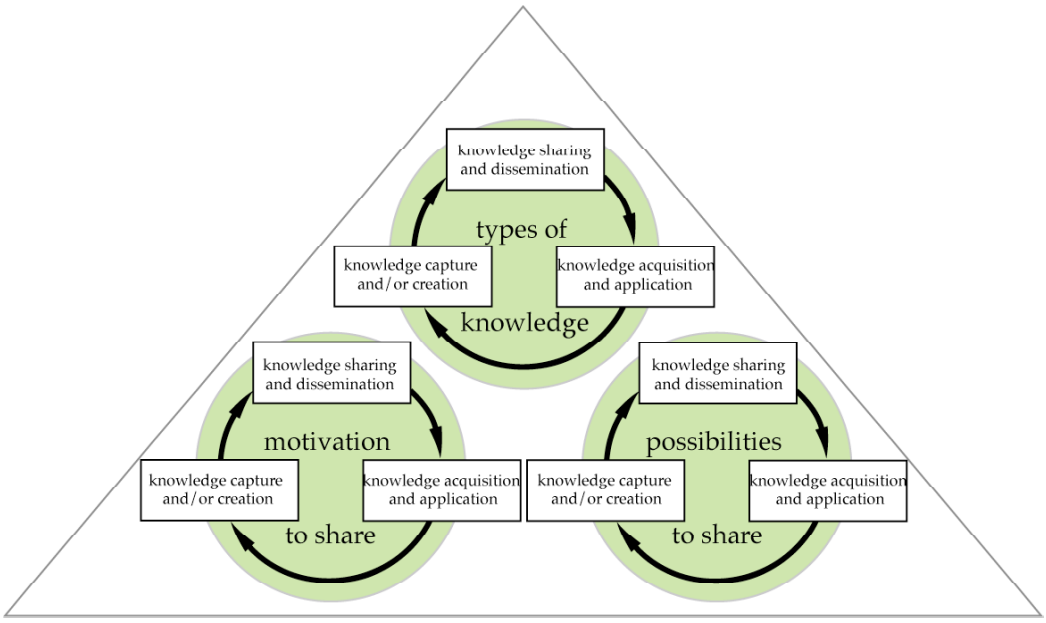



*Figure 11 the KM cycle (Dalkir, 2005) combined with Ipe's (2003) framework*

To identify the degree of knowledge management in an organisation, maturity models have been created, that way managers are able to find the current state of knowledge management of their organisation. Inspired by the Capability Maturity Model (Strutt *et al.*, 2006), the following five-level maturity model has been set up; see Table 9.

| *Level* | *Maturity* | *Capturing knowledge* | *Sharing knowledge* | *Acquiring knowledge* |
|---|---|---|---|---|
| *5* | Optimised | Knowledge is constantly updated | A shared lingo and guidelines lead to effective knowledge sharing | People frequently discuss problems with experts |
| | | Roles and responsibilities are clear within knowledge groups | Knowledge is broadly available and it is easy to locate | Frequent education based on knowledge gaps |
| *4* | Managed | Just in time knowledge is present and easily accessible | Several stakeholders take part in systematically making knowledge available | Knowledge sharing occurs through set meetings between groups |
| | | One individual is responsible for updating and disseminating knowledge | Supportive ICT is used | Supportive ICT is used |
| *3* | Defined | A knowledge group takes responsibility for knowledge and records it according one protocol | The targets of the management are recognisable for people outside the management | Groups are set up top-down |
| | | Searching for knowledge is encouraged | Little distillation | Finding knowledge is through one central protocol |
| *2* | Repeatable | Lessons learned from project evaluations are saved after finishing projects | Sharing knowledge happens because of management motivation | Education happens because of management motivation |
| | | Troubleshooting solutions are saved into a database | Lessons learned are saved for use by others | Knowledge is accessible but hard to find |
| *1* | Initial | A couple of people take time to save lessons learned into a database | Knowledge is little used | People acknowledge the importance of knowledge, but can't find time to do it |
| | | Knowledge is rarely refreshed, or searched | Lacking facilities to share | People only use knowledge for personal purposes |
| | | No clear structure where to save documents | Difficulties to locate expertise and information | Little or no education |
| | | Ad-hoc documenting | | |

*Table 9* *capability maturity model for knowledge management*

In Figure 12 one may find a visualisation of best case and worst-case scenario of the transitions in the maturity model. Every phase passes in the same manner. When the first phase is initiated, in the best case, the producers (light blue dashed line) and consumers (purple line) increase in mass. When a predefined critical mass is reached from both producers and consumers (Condition 1), the next phase is to be initiated. When however, the initiation of the next phase is postponed, the producers will decrease and the initiative will loose its critical mass, where the initiative does not have any right of existence left.

In the worst case, the producers will increase in mass but the users will never reach critical mass; the yellow line (consumers) illustrates this. When this happens it is case for the management to decide whether to re-initiate the phase or abort the whole initiative. If however is decided to evolve to the next phase, knowledge management as a whole is doomed to fail. Concluding, when a new phase is entered prematurely this will decrease the amount of users, resulting in a failing initiative.

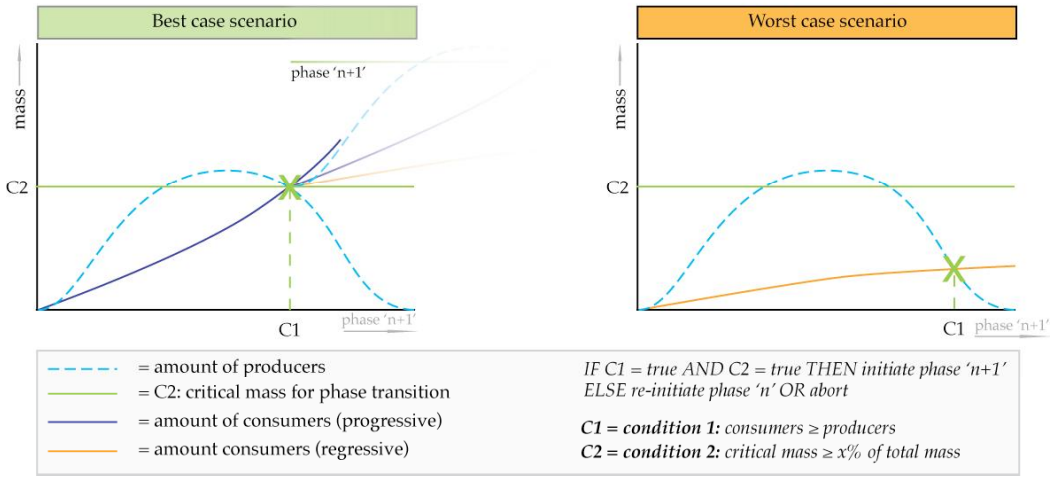



*Figure 12 visual representation best and worst-case scenarios for phase transition*

The most important condition for entering the next stage is thus that the consumer mass is at least equal to the producer mass. Moreover if the engineers only are consumers, they can be transformed to producer but this only works when motivation is used. The other way around is easier; producers can become consumers fairly easy.

# 3 Methodology

This chapter will address research methods and data collection strategies for this research.

## 3.1 Research units

In this study the leading case will be the KHC at Norit Enschede but will be supported by comparative cases. To find the current state of the Dutch manufacturing industry, in the east of Holland concerning knowledge management, an explorative study is performed with five companies that operate internationally and/or are of equal size to Norit. In the next paragraphs it will be set out how the data will be gathered.

### 3.1.1 Questioning

To be able to increase internal validity one may use methods and sources triangulation. By using face-to-face interviews, group interviews and/or participative observation with content analysis of textual and audiovisual material the researcher can get more reliable information, this is called methods triangulation. The same can be done with sources, to get more depth; this is called sources triangulation (Verschuren and Doorewaard, 2000; 169-172). One of the cons that Yin (2003) addresses is that triangulation can be rather expensive, however by triangulating there is an increase in reliability and it can strengthen the evidence. When choosing one research method the researcher becomes dependent on one source of information. When using more sources the reliability increases. Another benefit of triangulation is that it increases construct validity; reason is that multiple measures are done for the same phenomena (Yin, 2003: 97-99).

There will be continued with an explanation on the panel discussion, and then an explanation on interviews.

*Panel discussion*
A first method that will be used in the methods triangulation is that of a panel discussion, that is to be held during the "Technology Transfer Meeting" (TTM), which is organised every six months. The TTM serves as a method to let globally dispersed employees (in this case the regional engineers and the KHC) to get in touch with each other to ease the sharing of knowledge.

The panel in this setting consists of 33 engineers who will be the end users of the system under design. The role of the researcher will first be to give a presentation on the subject of knowledge management and the use of it for Norit and after the presentation the researcher will not participate in the discussion but will have the role of observer. The discussion will be lead by a discussion leader. This discussion also functions as a way to create understanding of the topic, so that the respondents that will be interviewed have a clear picture of what knowledge management is.

*Interviews*
With semi-structured interviews the researcher has prepared several questions, which do not have to be asked in a set order. So they are set up in a way to give the researcher some room to play. Moreover, the researcher has

the possibility to change the interview questions along the way, if necessary. Other advantages occur from the side of the respondents, there will be less reactivity (reactivity occurs when having structured interviews with set answers) and more use of their own lingo. On the other hand there are non-structured interviews in which the researcher only carries some thoughts or concepts about the subject and spontaneously let them out during the interview. To be able to compare the interview data from different respondents, it is necessary to address the same subjects in the interviews. Since there are cultural differences i.e. Americans are mostly straightforward to speak where as Chinese people play a waiting game. That is why, for this phase, semi-structured interviewing will be chosen as data-collection method, as well as for Norit Enschede as for the other case(s).

The KHC consists of four separate groups that individually do projects for their particular market. These groups are:

- *(Potable) water* which does all process engineering for (drinking) water purification;
- *Waste water* which does all process engineering for waste water purification, think of drainage water at waste disposal sites, sewage water purification, etc;
- *Water & waste water pilots* this department is the smallest and mainly focuses on testing rather new purification applications for several purposes;
- *Beverage* this group focuses on purification for the beverage industry i.e. beer filtration.

The first two groups apply similar products and also find support from the same regional technical engineers. The pilot group mainly tests small scale applications that are later applied in full-scale applications at water and wastewater applications. Beverage, the last group of the listed above, is also the youngest group in existence within the department and does not have technical regional engineers yet to support them on site. This should ease the knowledge sharing in general but they also encounter some problems.

The sampling procedure for the KHC and regional engineers will be purposive; namely from each sub department one senior and one engineer will be chosen, whereas for the pilot sub-department only the senior engineer will be interviewed, see Table 10. The regional engineers will be interviewed at the TTM since they then are physically present and the interviewer can also monitor non-verbal reactions that cannot be monitored when having a telephone interview. Being internationally located, the regional engineers all speak English; therefore the interviews will be held in English. The interviews held at the KHC will be held in Dutch, because the respondents then can express themselves more easily, Dutch being their native language. In Table 10 there has been given an overview of the sample selection.

| | *Water* | *Wastewater* | *Beverage* | *Pilots* | *Total* |
|---|---|---|---|---|---|
| *Senior engineers* | 1 | 1 | 1 | 1 | 4 |
| *Engineers* | 1 | 1 | 1 | | 3 |
| *Regional engineers* | | 7 | | | 7 |
| *Total* | | | | | 14 |

*Table 10* *sample selection*

As one may see, the regional engineers are covering most of the technology groups because they sell and implement the technology from all departments mentioned, except for the beverage technologies.

Not only will the future users be interviewed (KHC and regional engineers) but there also will be explorative interviews with other organisations. Given the fact that this part of the research is an explorative study, companies from different markets have been addressed that all have a different product; varying from fast changing electronic products to high technical industrial applications. The companies have been selected on their size; reason for this is that knowledge management in general seems to be a case for larger companies, however medium size companies could also benefit from this. The company names will not be disclosed but will be named 'company #' in which the hash sign stands for the assigned number.

After the data gathering, the findings will be combined and a gap analysis will shed some light on the current status versus the desired situation.

# 4 Current context

In this phase of the study it will be researched what the current context looks like concerning knowledge sharing at the KHC. This chapter will give insights in the sharing motivations of the KHC engineers, the current sharing systems that are used, and what people's mindset is on sharing knowledge.

From each sub group at the KHC there will be at least one respondent. In addition, it is important to interview the middle managers of the KHC because of the fact that middle managers tend to play key roles in knowledge management (Nonaka and Takeuchi, 1995); the middle managers that are interviewed here are in fact the 'principal engineers' of the different groups. In addition several technical engineers will be interviewed from Norit Sales Offices (NSO's) at other geographical locations, namely: China, Russia, Singapore, South America, United Kingdom, and the United States of America; these technical engineers will be addressed to as *regional engineers*. As one may see, the sampling method for the interviews is purposive, as also mentioned in chapter 3.1. All issues that are encountered will be discussed in three main concepts as stated in paragraph 2.4, and represented in the sub-research questions. The research question that will be answered in this chapter will be:

What is the current state of the knowledge-sharing infrastructure at the KHC at Norit Enschede?

This research question will be answered through the following sub questions.

- What knowledge and information is or is not being shared?
- Which opportunities to share are used by employees of the KHC?
- Which motivations to share their knowledge are present with the employees of the KHC?

## 4.1 What knowledge is shared?

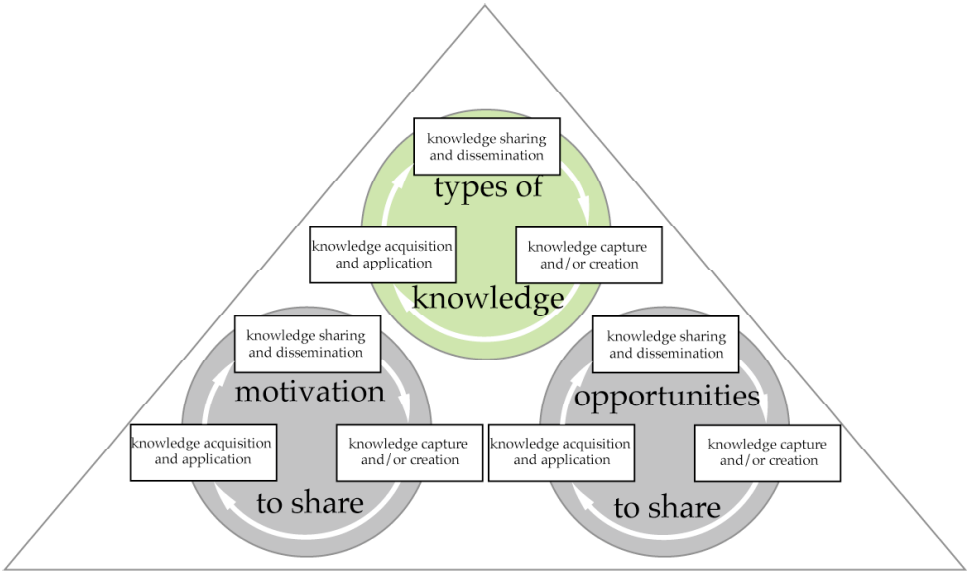



*Figure 13 framework - nature of knowledge*

A condition for sharing knowledge is that it is created and captured, which is the first phase in the knowledge management cycle, stated in Figure 13. Knowledge is created when troubleshooting, answering questions, or the like happens in the daily context. The *creation* of knowledge thus does happen at Norit, however currently there is too little *capturing* of knowledge in documents or the like.

The information that is shared at the moment concerns mostly project information, technical documents, projection tools, technical bulletins, standard drawings and the like. These are thus of explicit nature, there is a technical standard, however this is not applied company wide. The problem with sharing this information is that it is not shared through one central structured flow of information. Currently, there is more emphasis on tacit knowledge sharing then on explicit knowledge sharing, the reason for this emphasis is because of the easiness of sharing that knowledge, one can share something and does not have to document it, which can be profitable in the short run, but in the long run this knowledge is easily forgotten. By documenting this knowledge, it could be more easily reused and archived. The social sharing mostly consists out of coincidences then structural sharing which results in knowledge losses in the processes.

The last phase in the knowledge sharing cycle, the application and acquisition of knowledge, again characterised by tacit knowledge. The level of acquiring knowledge is low, in the first place the engineers perform little education i.e. only one waste water, one pilot, and one beverage engineer follow education at the moment, secondly because of the lacking effectiveness of the previous phases 'knowledge creation' and 'knowledge sharing', as a result the application of *new* knowledge is difficult to perform, i.e. when a person solves a problem, new knowledge is generated, but currently stores this in his individual memory (Gammelgaard, 2004), therefore it will be hard for other people to reapply this individually gained knowledge. In the following table there can be seen which kinds of knowledge are shared.

| *Sorts of knowledge shared (Nonaka & Takeuchi, 1995)* | *Shared by the engineers* |
|---|---|
| *Explicit knowledge (objective)* | |
| *Knowledge of rationality (social sharing)* | 2 |
| *Sequential knowledge (i.e. project reports)* | 1 |
| *Digital knowledge (i.e. technologies at Norit)* | 2 |
| | |
| *Tacit knowledge (subjective)* | |
| *Knowledge of experience (i.e. effects of technology)* | 1 |
| *Simultaneous knowledge (i.e. troubleshooting)* | 1 |
| *Analogue knowledge (i.e. how to install different technologies)* | 2 |

*1 = poor, 2 = mediocre, 3 = strong*

*Table 11 sorts of knowledge shared by engineers*

During the interviews, the engineers stated which information is currently shared and what is not shared; in Table 12 one can find an overview of the current situation of available information and knowledge.

| *Sharing themes* | *Water* | *Waste water* | *Beverage* | *Pilots* | *Regional engineers* | *Availability* |
|---|---|---|---|---|---|---|
| *Technical standards* | | | | | | |
| standard drawings | g/u | g/u | g/u | - | u | 3 |
| standard procedures | g/u | g/u | g/u | g/u | u | 1 |
| Company wide standards | g | g | g | g | - | 0 |
| *Technical troubleshooting* | | | | | | |
| Troubleshooting aids | g/u | g/u | g/u | g/u | g/u | 1 |
| *Technical designs* | | | | | | |
| safe designs | g/u | g/u | g/u | - | g/u | 0 |
| critical designs | - | - | - | - | - | 0 |
| Process control philosophies | g/u | g/u | g/u | g/u | u | 2 |
| general settings | g/u | g/u | g/u | g | u | 1 |
| Design guidelines | g/u | g/u | g/u | - | g/u | 1 |
| Projection tools | u | u | u | - | u | 3 |
| *Technical bulletins* | g/u | g/u | g/u | - | u | 1 |
| *Project information* | | | | | | |
| references | g/u | g/u | g/u | g/u | g/u | 1 |
| case studies | g/u | g/u | g/u | - | g/u | 1 |
| new projects | - | - | - | - | - | 0 |
| best practice | - | - | - | - | - | 0 |
| pilot reports | u | u | u | g/u | u | 2 |
| outstanding projects | - | - | - | - | - | 0 |
| *Finding expertise* | - | - | - | - | - | 0 |

*g = generate knowledge, u = use of knowledge, - = none*
*0 = none, 1 = poor, 2 = mediocre, 3 = strong*

*Table 12* *current availability, generation, and use of information and knowledge*

As can be seen in the table above, there are a lot of things that are not generated or used at the moment, this is mainly due to lacking facilities as will be discussed in the next paragraph.

## 4.2 Opportunities

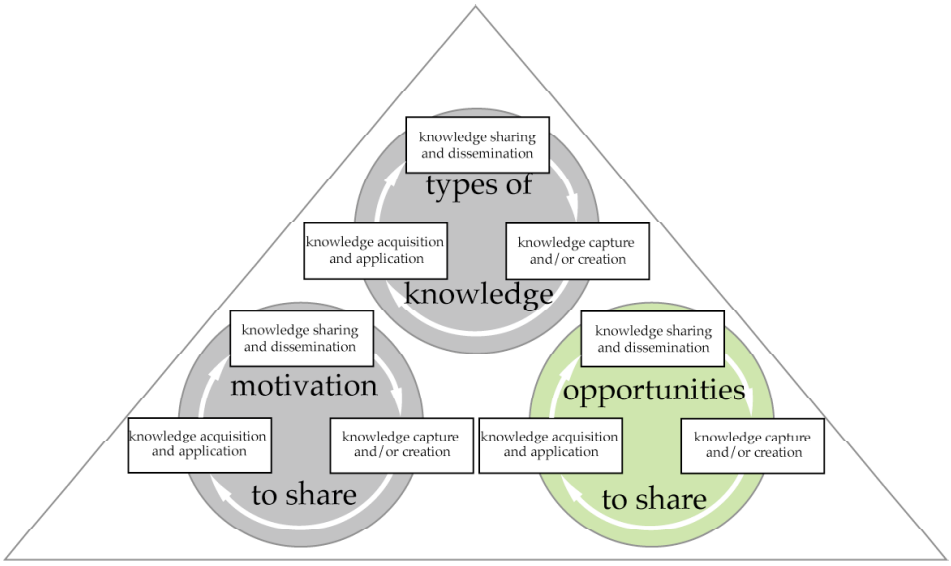



*Figure 14* *framework – opportunities to share*

The opportunities can be typified as the facilities that are used to create, share and apply knowledge; synonym for this is the knowledge infrastructure (Florijn, 2000). As mentioned in the previous paragraph, there is no frequent education at the moment. However, since the organisation has become aware that this is essential for the knowledge levels in the organisation, there have been recent actions to start to encourage education with employees. The opportunities for *capturing* of knowledge are mostly end-user facilities: word processors, spreadsheets, etc… and then can be saved to numerous locations for *sharing*. In general, these are network disks, the technology website, e-mail, Salesflow (website for sales documentation), telephone and the Internet are used to retrieve and share information; as can be seen in Figure 15.

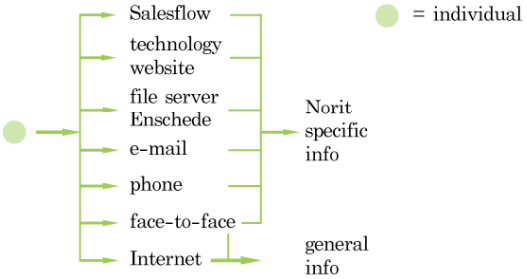



*Figure 15 ways of information retrieval facilities*

According to Nonaka and Takeuchi (1995) there are a couple knowledge conversion modes that can be addressed to the different phases in the sharing cycle by Dalkir (2005). One of these conversion modes *Externalisation* tacit to explicit knowledge occurs when people document their (daily) findings. Every respondent has his own way of documenting information, but is mostly not shared with others. According to Alavi (2000) this act of documenting is a passive by-product of the daily work process and is not often reused, so most information is kept in individual memory (Gammelgaard, 2004); either in their mind or on their local disk drive. Among the engineers there is on the one hand overkill of electronically documenting information, and on the other hand, a lack of electronically documenting information. For the first the China office is a good example, they document everything in Excel. They make a tab for every customer and put in everything they can get their hands on. The second example (for a lack of electronically documenting) is respondent five:

> *"…I put it down in my handwritten book, the things I really want to remember. It's a big book, now I've got a second one, so it may become a problem when I have to find something. The biggest problem for me is to know if I know a certain thing already. Sometimes I read this book, made by myself, I read the answers and I read things I forgot that I have written them down. That is a problem. Sometimes it's good to read through it and find an answer for something you might have found an answer to in the past."*

The engineers are thus writing as a *prosumer* (Markus, 2001), they write for themselves and they are the only ones to reuse that documented knowledge. Possible reasons why the engineers document for their own individual memory is because they often go abroad and do not always have an Internet connection, it gives more effort to write for others, and saving information to the Technology Team Website is still hard to perform and not exercised by everyone, respondent 14 mentions:

> *"…working on the website costs a good deal of trouble in order to make it al go structured and correctly. There are still too much actions needed, i.e. checking documents in and out… if for example, a*

> *regional engineer would get the assignment to make a document on the Technology Team Website that will not work because they don't know how to do it. Until now no single person of the regional engineers has ever created a document through the site… They only use the site for downloading documents."*

When distributing information through the organisation, the KHC comes across some other issues, i.e. when people want to save documents to a set location. As one of the discussion attendees mentions:

> *"…look at standard documents that are accessible to everyone, including sales; we first put them on the network drive on the server. After that we created the technology website, we put the standard documents over there... but hey (?!), that is not accessible to sales, so then we also put it on Salesflow, and if anybody specifically asks for the standard documents then we email it."*

The quote above emphasises the problem that there is no clear structure in saving and distributing information, the facilities to share are not sufficient. Moreover since people only write as *prosumers* (Markus, 2001), this is not likely to improve.

The overall sharing is mostly characterised with one-way traffic; the regional engineers do not share much with the KHC at the moment, they are as Markus (2001) states "knowledge consumers". Moreover, the regional engineers do not contact each other when they have problems because they are unaware of the capabilities and expertise of others. If knowledge is *shared* it is mostly through *socialisation* (Nonaka & Takeuchi, 1995), tacit to tacit knowledge, because it is the quickest way to share knowledge as mentioned in 'sorts of knowledge'. People do not document what they share and can discuss issues face-to-face. However, this form of conversion has its limitations, i.e. the regional engineers do not have the possibility to access the tacit knowledge of others over different time zones. The opportunities of sharing through socialisation are several meetings, of which the Technology Transfer Meeting is the most important, because this one exceeds the Enschede office and includes the regional engineers; in addition the OEM[6] trainings are also a form of socialisation. These are frequent forms of socialisation but do not appear daily. The only daily forms of socialisation that occur are the use of the telephone, meetings, and informal chats. This daily form of communication can be typified as c*onversation* (Ellis, 1999). Moreover there are obstacles in using this way of communication, respondent five mentions:

> *"…I prefer to contact the KHC, because I think they have to collect all information from all the countries. So I contact a sort of hub to get the information. A colleague can answer me but doesn't know all the plant parameters… besides the KHC engineers are limited in numbers so you will find somebody to help you. If you call all other NSO's, which are let's say a 100 and all dispersed over the globe or you call the KHC with 20 people all in one location, subdivided in expertise groups. There are also seniors who can advice whom to go to. For me it works very good to do it through this way. …"*

[6] The term OEM is used to refer to a company that acquires a product or component and reuses or incorporates it into a new product with its own brand name, an Original Equipment Manufacturer. Examples are computer manufacturers that incorporate Intel chips (Intel inside).

What can be derived from the quote above is that when regional engineers have reached the KHC, they mostly do not know whom to turn to, and bounce around the department, this is visualised in Figure 16.

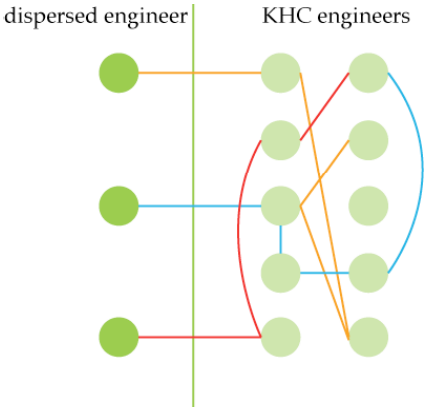



*Figure 16 how regional engineers contact KHC experts*

Throughout the KHC standardisation is not very concrete, however, exceptions occur at the beverage department. This department is still very young in existence; according to respondent nine there still are a lot of contradictions *between* documents and also *in* the documents themselves, but relatively seen their standardisation protocol is very strict although uniformity in documenting still is an issue. Also an issue that the engineers utter is that they do not know what the developments are at the R&D department.

*Acquiring and applying knowledge* happen through combination and internalisation. *Combination,* which is the combining of existing knowledge, of course happens at Norit but could be largely improved. Think of the combination of existing technologies into a new plant or application. But this transformation is difficult when information is hard to find. An overall search engine to ease the finding of digital information has been introduced, however since the documents are not structurally saved and are not given tag names concerning content, it still is hard to find documents. The facilities for saving and retrieving information are not sufficient, since this can be done through too many ways. The acquiring of knowledge through *internalisation,* where knowledge is converted from explicit to tacit, occurs at e.g. OEM trainings and when people read standard documentation about technologies and company information, but mostly when people start new jobs or look into new technologies or other departments. But in general, this kind of conversion does not occur very often because of lacking facilities for retrieving information and knowledge.

In Table 13 one can find a summary of this paragraph in which the strength of different concepts is discussed.

| | *Water* | *Waste water* | *Beverage* | *Pilots* | *Regional engineers* |
|---|---|---|---|---|---|
| *Role* | | | | | |
| *Producer* | 1 | 1 | 2 | 2 | 0 |
| *Intermediary* | 2 | 2 | 2 | 2 | 1 |
| *Consumer* | 2 | 2 | 2 | 2 | 3 |
| *Prosumer* | 3 | 3 | 3 | 3 | 3 |
| *Knowledge conversion through* | | | | | |
| *Socialisation* | 3 | 3 | 3 | 3 | 3 |
| *Internalisation* | 2 | 2 | 2 | 2 | 2 |
| *Combination* | 0 | 0 | 0 | 0 | 0 |
| *Externalisation* | 1 | 1 | 1 | 2 | 1 |
| *Memory* | | | | | |
| *Individual* | 3 | 3 | 3 | 3 | 3 |
| *Database* | 1 | 1 | 1 | 1 | 0 |
| *Social capital* | 2 | 2 | 2 | 2 | 2 |
| *Virtual communities of practice* | 0 | 0 | 0 | 0 | 0 |

*0= none, 1 = poor, 2 = mediocre, 3 = strong*

*Table 13* *sharing roles, conversion, and memory use at different groups.*

## 4.3 Motivations to share

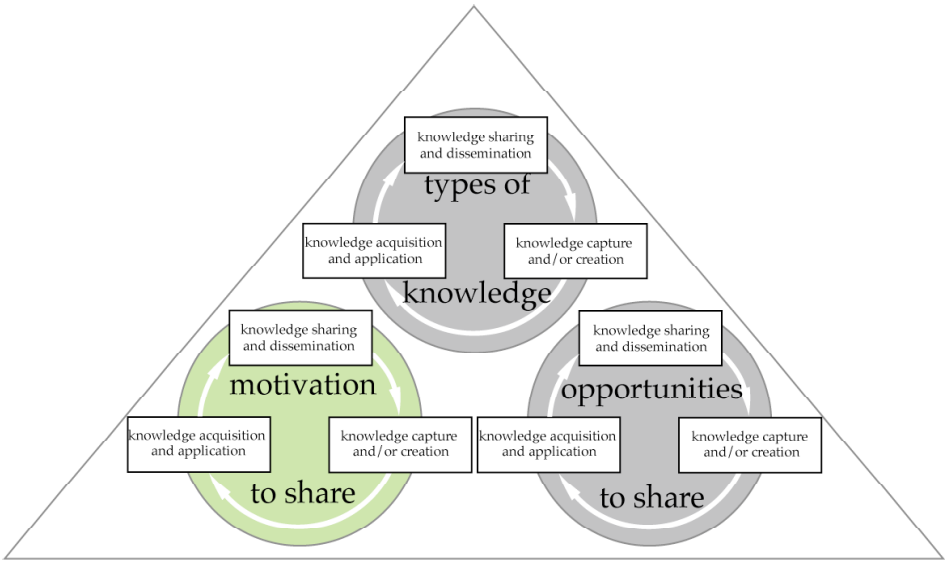



*Figure 17* *framework - motivations*

Motivations to *create or capture* knowledge are hard to find at the KHC. The engineers are quite busy with their daily routine and since the facilities for capturing knowledge are not optimal, these motivations are low; they do not really welcome knowledge management. Of course the most mentioned issues are lack of priority and time to capture information or knowledge. However in the end it is not lack of time, but lack of efficiency in the daily work and the effectiveness of the facilities.

In addition, the motivations to *share* knowledge are not very high. This can be improved according to Yahya and Goh (2002), who state that training, appraisal, and compensation are a condition for motivating people to share knowledge. Training only occurs at the OEM trainings where the subjects mainly are on the use and application of Norit technologies. Appraisal only occurs through yearly performance reviews, but not concerning knowledge sharing. Moreover there is no compensation in sharing knowledge, the daily

work itself is still a difficult task because information and knowledge are hard to find. Errors are still made more then once and constant rework demotivates people to innovate their work. When engineers share their knowledge through e.g. writing an article, their only incentive is that of the feedback of internal customers, but this only occurs if people can retrieve the article and are facilitated to give feedback. So there is the lack of a central library and single point of entrance to find information.

According to Bondarouk (2008), HR policies should remove obstacles, set up motivations, and create abilities to use information technology. When the Technology Website was introduced there have been trainings to let people get acquainted with the software however, since their daily work is not planned with the solution there cannot be spoken of any critical mass. As already mentioned in "opportunities to share" there are too many ways to save information; basically there are too many obstacles to use the IT solution to share knowledge and information.

Wasko and Faraj (2005) speak of the importance of social capital when sharing knowledge. This capital consists of structural, cognitive, and relational capital. Marwell and Oliver (1993) state that individuals, who are in regular contact, are more likely to develop a "habit of cooperation" and act collectively. If this structural capital is strong with dense connections in the collective, a moral obligation is created to each other. This has been tried to accomplish by introducing the Technology Transfer Meeting where both regional engineers and the KHC get together and create structural capital. Exception in this is the beverage department, since they do not have regional engineers deployed in foreign countries; they operate with five (KHC) engineers and some agents worldwide.
Cognitive capital represents itself in the individual and develops over time (Wasko and Faraj, 2005). This type of capital plays a central role when it comes to understanding the knowledge and information that is to be shared. To be able to share knowledge Nahapiet and Gohsal (1998) emphasise the importance of some level of understanding to exist between parties. Seen the fact that this knowledge sharing is within a specific group of engineers who all communicate in the same lingo, this should not be a problem.
The last type is relational capital, which can be seen as the identification of an individual with the community and feeling an obligation to contribute and participate in cooperative norms, this last capital is present within the KHC but is lacking with the regional engineers who mainly operate to reach their own targets.

As mentioned in 'sharing opportunities', there is little motivation for *acquiring knowledge* besides the acquiring of knowledge in the daily work. Currently there are little motivations for education, but there are concrete initiatives to increase the opportunities for education. The knowledge that is gained on the job however, is applied to new situations but again only resides in individuals' minds.

Concluding this paragraph it can be said that in general the cognitive capital is strong with all engineers, since they all speak the same technical language; the structural capital is present at the KHC but since the regional engineers are not physically present in Enschede, they experience a less steady bond with the KHC engineers; relational capital also suffers from this global disperse, the regional engineers mainly focus to reach their own targets.
In addition there are specific demotivators, which have emerged from the interviews and can be seen in the Table 14.

| ***Motivations*** | |
|---|---|
| | Improvement of working efficiency and efficacy, stop reinventing the wheel |
| | Making documenting and sharing part of the working task |

| ***Demotivations*** | |
|---|---|
| *Use of knowledge* | Misuse |
| | Non use |
| | Lack of responsibility |
| | Lack of understanding at receiver |
| | Not sharing in return |
| | Trust of content |
| *Opportunities* | Difficulties in publishing |
| | Too little facilities |
| | Login required |
| | Priorities |
| *Social capital* | Trust (of people one does not know) |
| | Loss of face |
| *Policy* | Non-disclosure agreement |
| | Competitive information |
| *Cultural* | Language barrier |
| *Capturing* | Ad-hoc documenting |
| | Writing in after hours |
| | No wish to spend time on writing reports in general |

*Table 14 sharing (de)motivators*

Differences are found with the regional engineers; they emphasise their insecurity about relational demotivators (trust and loss of face), while the KHC engineers do not see this as a big problem.

## 4.4 Conclusion

In this chapter it has been discussed how the current sharing structure looks like at the KHC and the regional engineers. In this paragraph one may find the conclusions per central concept.

*Types of knowledge*
The engineers do not codify knowledge for others to use, but merely for their own. A lot of tacit knowledge is available but is not shared. Sharing only happens when problems occur. The kind of information that is shared (if it is shared) is codified technical documentation. Within the KHC technical standards are generated and used, but since not the *whole* company uses them, these are not seen as standards. People more easily ask each other where to find something or to help them, than that they go search for something on the various locations, either through the phone or face-to-face. A lot of knowledge and information is generated but not shared, e.g. design guidelines, troubleshooting, project references, new projects, and lists of plants. Especially experts are hard to find, not only in the KHC but also at the regional engineers. The acquisition of knowledge is poor since most knowledge that is generated, resides in individual memory. It takes too much effort for the engineers to acquire knowledge from places on the network or to acquire knowledge from colleagues abroad. Acquiring knowledge through education is also too little, because there is no overview on which knowledge is present at this moment.

*Opportunities*
Opportunities concerning knowledge management are insufficient. The engineers are too much acting as prosumers (Markus, 2001) and produce too little codified knowledge for others. They all do want to consume knowledge

but since the supply of codified knowledge is too little this is hard to perform. Since the engineers consume too little, combination of 'old' knowledge into new is not happening. Basically there is too strong an emphasis on *socialisation* (Nonaka and Takeuchi, 1995). One of the reasons for this prosuming behaviour is that the engineers having a hard time saving and retrieving the information they are looking for because of the many locations on which information can be stored/retrieved. Most knowledge is held as individual memory (Gammelgaard, 2004) and therefore a lot communication goes through socialisation. As a result of this poor amount of capturing knowledge, consultation at a central knowledge repository is hard to perform (Ellis, 1999). Structural and relational capital is created (Wasko and Faraj, 2005) through the Technology Transfer Meeting, but this does not mean that it is present in large amounts. Structural capital between KHC engineers is largely present but between KHC engineers and regional engineers is a different story. Cognitive capital on the other hand, is present because of the fact that the sharing of knowledge occurs between engineers in the same fields of knowledge. There are some systems within the KHC that are used to store and use information, e.g. emailing programs

*Motivations*
Motivations are hard to find among the engineers, but they are positive towards increased easiness of the daily work. Moreover clarity where to store which information will also ease their work. Also demotivations are largely present, the engineers do not want to spend time on writing large reports and are afraid that their knowledge is not used or misused. Regional engineers do feel stronger that they can lose face with others then the KHC engineers. This could be because of the little structural capital (Wasko & Faraj, 2005) that the regional engineers have with the other engineers. Some of the KHC engineers are cautious when it comes to sharing knowledge, because of the non-disclosure agreement they had to sign, resulting in an automated censorship. Then there are the ICT facilities that are hard to work with; when it is not stored on the technology website, the engineers have to call the KHC, "so why bother and look on the website at all?"

If the way the knowledge sharing cycle is currently used is considered, one can see that the first phase (capturing knowledge) is not applied very well, this all makes sharing and applying knowledge difficult. In fact one may say that the last phase of the cycle (applying and acquiring knowledge) is mostly left outside of the loop, as shown in Figure 18. The group does not acquire the earlier created knowledge and therefore knowledge is not completely used.

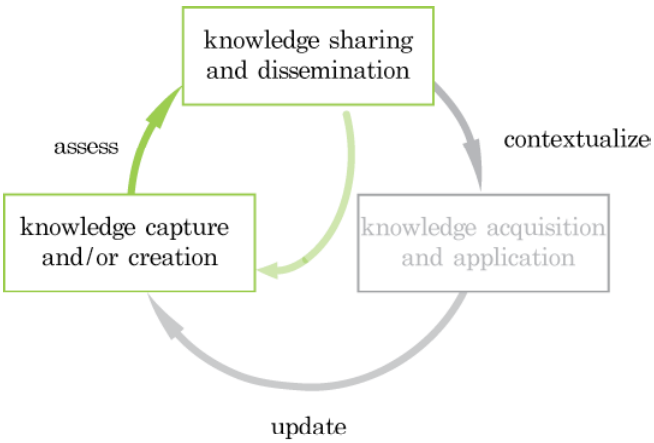



*Figure 18 knowledge sharing cycle (Dalkir, 2005) applied to the engineers*

On top of the previous conclusions, one can judge the current situation according to the maturity model as discussed in 2.3.4. In addition some adjustments to the table have been made originating from the interviews. In Table 15 one may find the analysis of the current situation.

| *Level* | *Maturity* | *Capturing knowledge* | *Sharing knowledge* | *Acquiring knowledge* |
|---|---|---|---|---|
| *1* | Initial | A couple of people take time to save lessons learned into a database | Knowledge is little used | People acknowledge the importance of knowledge, but can't find time to do it |
| | | Knowledge is rarely refreshed, or searched | Lacking facilities to share | People only use knowledge for personal purposes |
| | | No clear structure where to save documents | Difficulties to locate expertise and information | Little or no education |
| | | Ad-hoc documenting | | |

*Table 15 analysis of the current knowledge management maturity situation*

As can be derived from the table above, the knowledge management initiatives are still in a low maturity stage. To improve this, several steps have to be taken, e.g. the set up of supportive ICT and HR tools to motivate the engineers to share more. This will be discussed in chapter 6. First it will be discussed how other companies deal with knowledge management.

# 5 Current situation at other companies

This part of the research will focus on the current situation of other companies in the Dutch manufacturing industry. From the selection five companies came forward which have been contacted and interviewed.

The research question that will be answered in this chapter is:

In what way are other companies applying knowledge systems?

To answer this question, sub questions are formulated as follows:

- What types of knowledge are shared?
- Which motivations were present to implement knowledge management?
- Which opportunities are created to share knowledge?

## 5.1 KM at other companies

During the search for respondents, it became rapidly clear that knowledge management is still in its infancy. A lot of companies do not even know the concept; the few who do know it are either recently involved in performing knowledge management or are aware of its importance but it is not a priority issue. Before turning to the analysis there a short description per company is given, continued with the sorts of knowledge, motivations, and the facilities that are discussed.

- *Company one* is a research and development division (±125 employees) of a large international player in the wind power industry with about 13.000 employees worldwide.
- *Company two* is a large international player in several markets (conglomerate multinational) with about 4.000 employees worldwide;
- *Company three* is an international manufacturing company that does not really have a knowledge sharing system running, size of the company is about 450 employees worldwide.
- *Company four* is an international organisation that is active in the storage technology; size of the company is about 200 employees worldwide.
- *Company five* is an organisation active in the identification products market, with several divisions around Europe and has a size of about 600 employees worldwide.

*Types of knowledge*

The codification strategy (Hansen *et al.*, 1999) is largely applied at the interviewed companies. This codified information varies from patents and datasheets of materials to supplier information. There are however differences along which channels the knowledge is shared. *Company one* is trying to share codified knowledge intra-organisational with departments that are globally dispersed, also *company two* is focussing on intra-organisational sharing but with sub-divisions that all have their own R&D and may gain economies of scale when working together, *company three* wants to share knowledge and expertise within the walls of their department, on the production floor. *Company four* is going to share both intra-organisational and intra-departmental.

As mentioned, all the previous mentioned companies focus on the codification strategy, in contrast with *company five* that completely focuses on the personalisation strategy (Hansen *et al.*, 1999). The focus is on tacit knowledge, to document only the necessary technical documents, and not to make product catalogues for their salespeople. A reason why this company is so different from the others is that their product is in the fast changing electronics market. The other companies have rather slow changing industrial products.

*Opportunities to share*
The facilities at the different companies vary from web-based facilities, like Microsoft SharePoint, to competence matrices to find knowledge gaps in the organisation. The web-based systems are implemented at two companies (one and four) where online collaborative spaces, task lists, profile pages, document managing, and an intranet are incorporated, these are supported by face-to-face meetings to evaluate projects. At company four there are also too many locations to store information in archives.

> *"…someone was talking about **the** archive, but after some stock-taking, we found **fourteen** archives! So we couldn't even speak of a single archive!"*
>
> *(Knowledge Manager, company four)*

Other companies in the sample do not use ICT other than email, phone, etc… to support their knowledge sharing. *Company two* is trying to share knowledge by organising synergy meetings between different R&D departments. *Company five* strongly aims at socialisation (Nonaka & Takeuchi, 1995) with meetings and engaging individual initiatives to create competitive product development in house.

Exceptions occur at *company three,* that had knowledge sharing initiatives in the past but these offered resistance because of the people who were meant to use the ICT solution had no tasks on a computer. Since they did not have to work on the solution in their daily work, the initiative never reached critical mass. However, a competency matrix was set up to identify knowledge gaps (McBriar, 2003) within the organisation. If knowledge gaps are to be discovered in the matrix, opportunities to learn are created: people are schooled to be able to take over each other's tasks.

*Motivations*
The motivations of the companies to implement knowledge management vary widely; some find their initiative in the management while others are bottom up, taken the departments themselves have started initiatives to share knowledge. *Company one* and *four* are organisations at which the bottom up motivation was leading. Top managements were not eager to invest large amounts of money in the initiative but when software with small investments also came available, they agreed to go along with it. Moreover, top management has problems with the use of non-corporate software, at *company one,* there are still not very concrete results because of this top management issue; at *company four,* the top management has agreed on the importance of knowledge management. One of the other companies, *company two,* does not focus its knowledge management on operational knowledge, instead it is trying to improve knowledge flows between small companies, that where acquired in the past, who all have their own R&D departments and do not share knowledge with each other. That way, benefits of scale and a significant cost reduction can be created. Motivational factors at the operational level are increased social interaction with people with similar

cognitive capital (Wasko & Faraj, 2005) to gain new insights, which also increases relational capital. Other ways to perform knowledge management is to aim on competences of employees; if there are too few people who know of certain subjects there is a knowledge gap (McBriar *et al.*, 2003). *Company three* takes this perspective, because their knowledge is mostly on production knowledge (experience). They implemented a competency matrix in which knowledge gaps (McBriar *et al.*, 2003) can be recognised.

As mentioned earlier *company five* is focussing on social capital (Wasko & Faraj, 2005; Gammelgaard, 2004), they try to trigger employees to be entrepreneurial and improve their way of working every day. If employees have ideas for improvement, they are granted the possibility to execute their idea. The financial director, who can be seen as the knowledge leader, has an interesting vision on managing knowledge:

> *"Knowledge is dynamic and volatile; when things get documented on paper people will sit back and sell what is documented, it is human nature; but that is just the thing we do not want to happen. We want people sniffing, looking and searching to make the products they are working on as complete as possible and with a quality as good as possible."*
>
> *(Financial Director, company five)*

The last motivation, which is largely shared among the organisations, is that of the retention of knowledge of key employees. If people are leaving the organisation and there has not been any initiative to retain his knowledge or expertise after he/she has gone, this is a great loss for the company.

## 5.2 Other companies; conclusion

In general one may state that knowledge management is not generally accepted within the manufacturing industry, as it is not applied that much. If it is however applied it mostly concerns a partial implementation. The most common reason for implementing knowledge management is avoiding "reinventing the wheel". Most of the initiatives are supported by web based ICT as e.g. forums and groupware. Besides, there is a growing awareness of the importance of interpersonal relations, think of *company five*.

What can be learned from these companies, from a practical point of view, is in the first place the importance to find support of the top management so their strategies can be anticipated by favour of knowledge management. Secondly, the importance of sharing is emphasised in the fact that if employee attrition appears knowledge gets lost, if there is a knowledge gap matrix or the like, the knowledge gaps can be anticipated. Thirdly it is important not to loose sight of structural and relational capital, since trust is an essential factor of sharing knowledge. Fourthly, it must not be forgotten that facilities will only be used if the end users' daily work demands the use of it, so planning the end users work with the facilities will be of extreme importance.

Following the synthesis of all previous findings will be presented.

# 6 Synthesis

In this chapter the differences from the empirical research and those found in the literature will be combined into a new situation. This chapter consists of two parts, namely a hard synthesis (IT facilities) and a soft synthesis (motivational structure) to be able to emphasise both areas. This paragraph will thus find an answer on the third research question, as stated below:

In what way can a knowledge sharing solution be designed for the KHC?

- How should the facilities of the solution be designed to best serve the knowledge sharing cycle?
- How should the motivational structure be designed to best serve the knowledge sharing cycle?

Before starting with the synthesis, it is important to first formulate the design criteria, which will be done in the next paragraph.

## 6.1 Design criteria

In the design cycle, the analysis phase has been completed. The literature and empirical research have provided several aspects to be the basis of the knowledge sharing solution. Following a *preliminary design* is to be created.

It is important to first identify which knowledge areas are to be addressed, along with the people that are involved. Basically this already has been done in chapter 3, but is important to keep in mind when designing, so an overview of the most important knowledge areas, which processes will be affected, the people involved and the desired effects of the system is shown below.

*Knowledge areas*

- (Potable) water purification;
- Wastewater purification;
- Beverage purification;
- Pilots of (waste) water technology purification;
- Troubleshooting of existing plants (practical experience).

*Knowledge and learning processes*

- Project management;
- Information management;
- Standardisation;
- Individual learning;
- Group learning.

*People involved (i) or affected (a)*

- KHC principal engineers (i);
- KHC senior engineers (i);
- KHC engineers (i);
- NSO engineers (i);
- Sales department (a).

*Desired effects*

- Knowledge is constantly updated;
- A shared lingo and guidelines lead to effective knowledge sharing;
- There is clearly defined which knowledge is important for the organisation;
- Frequent education based on a "knowledge matrix";
- Roles and responsibilities are clear within groups;
- Knowledge is broadly available and is easy to locate.

The design criteria are listed in Table 16.

| *Functionality* |
|---|
| Worldwide accessible |
| Expert finder |
| Document search |
| Central access to all possible storage locations |
| Rights management, so not every user can access everything |
| When publishing a post, able to select which groups may have access to the post |
| Author must be visible, no anonymous publications |
| Users can write texts |
| Users can edit texts |
| Easy to publish documents/posts/questions (fool proof) |
| Approval of documents (publisher) |

| *Content* |
|---|
| Project summaries |
| Project evaluations |
| Technical bulletins |
| References for plants |
| Personal profile pages |
| Yellow page |
| Troubleshooting problems with possibility to add solutions |
| Information of XX months or years old must be archived |
| Expiration alerts to author |
| Expiration alert if use of a document or system in general, is below a certain amount |

*Table 16 criteria of the IT solution*

## 6.2 Synthesis (opportunities)

In the empirical research several issues were present among the engineers concerning knowledge management, e.g. too many locations to save and retrieve information, no motivations to trigger people in sharing knowledge or even to document information, too little education, and the current facilities are too hard to use and it thus takes the engineers too much effort to use it. One may see that a lot of these issues are related to the facilities to share knowledge, the ICT. However, before turning to the design of the solution one must first take a thorough look at the knowledge sharing cycle, because this is the fundament upon which knowledge sharing must be build.

*Creation and capture of knowledge*

Capturing knowledge in documents or presentations is necessary to share knowledge across time zones and other obstacles. Therefore this form of capturing knowledge must be facilitated in the new situation. Creation of knowledge is done on site but also within the walls of the Enschede office and must be done through *consultation* and *conversation* (Ellis, 1999); this means that a balance must be created between the codification and personalisation strategy (Hansen, *et al.*, 1999). The engineers mostly use *conversation*, this is because the engineers are travelling a lot and in that perspective it is not always possible to access the Internet or find time to search through a document database or the like. When on site, the most efficient and effective way is to call the KHC. In the current situation the

KHC also copes with problems in getting the regional engineer in touch with the right person. To create more efficacy in locating expertise, *yellow pages* are to be set up in which every engineer can put his recent projects, fields of expertise, former jobs, etc… in that way expertise can be found more easily and will reduce the bouncing around of calls of the regional engineers. In addition, people at the KHC in Enschede will be better able to locate expertise when facing a problem. However, this must be backed up with a sophisticated search engine to be able to find either the expertise or documents. Yellow pages are a practical and rather cheap way to find expertise and thus to stimulate *conversation* (Ellis, 1999).

In the long run, it is desirable that all engineers put their information into a system so that all can benefit from it in the future. This can also help in creating critical mass. Other departments will also be able to benefit from it in the long run, as can be seen in the schematic figure below.


*Figure 19* *desired sharing situation*

*Sharing of knowledge*

To facilitate sharing as much as possible, it is a necessity for all engineers to have a single point of entry into the system so that there can be no mistakes to where the captured knowledge is to be saved or can be retrieved. Currently, the users are burdened with seven different systems that they all have to scan for up-to-date information. In the desired situation it is clear that if information is not located in the system then there is nowhere else to look, except contacting experts. By applying an overall search engine, finding knowledge can be made easier. One can see in Figure 20 that if an engineer is in need of information he either enters the system or, if there is no Internet connection present or the information is not directly needed, he calls or mails the KHC. The KHC can look into the system or find the expert the engineer needs and can then transfer the information. There needs to be an interaction between Salesflow and the technology website. If someone is browsing Salesflow and is in search of standard documents he must not be bothered by ten clicks to get to the information. There should be either an automated login, or an automated link that the version on Salesflow gets automatically updated. Another connection that should be possible is to browse on the file server because that is where old files are still stored, as is shown in Figure 20.

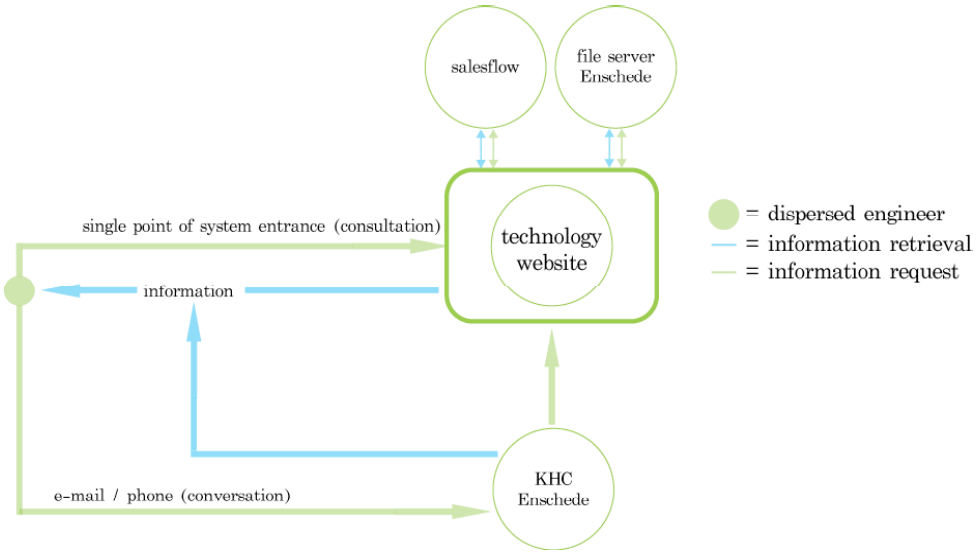



*Figure 20 information flows from and to the system*

To be able to create a balance between *consultation* and *conversation*, as discussed in the previous paragraph, an expert finder or yellow pages system needs to be integrated so to facilitate the engineers to find expertise when they need it. This way *conversation* is promoted through the same system as *consultation*.
Engineers who are abroad can contact the KHC but also can contact other dispersed engineers directly because they know who is expert in what (through yellow pages). When not in the position to access the Internet, they can contact the KHC that is also aware whom to contact for a certain expertise, so the KHC can put them through to the right person.

By setting up yellow pages, the personalisation strategy (Hansen *et al.*, 1999) is facilitated through codification. Sharing through documented information/knowledge can be divided into writing (*externalisation*), reading (*internalisation*), and combining earlier formed knowledge (*combination*). From the interviews it emerged that the regional engineers would like to have technical bulletins available of certain technologies or calculations. These can be saved online in a *Wiki* environment. From the interviews it also emerged that the availability of standard documents for a certain application has to be structurally offered, this can be managed at a download page. A summary per project is used to e.g. address the technologies used, problems encountered, contact information (who was responsible for i.e. commissioning), and links to additional information.

The functions the KHC will have to fulfil are that of certification, registration, archiving, and awareness (Roosendaal *et al.* 2001), which are shown in Figure 21. In this figure one may find the workflow for an upload to the system. An individual employee uploads a knowledge document to the server, the KHC gets an update alert, so they become aware a document is waiting to be reviewed (certification), these reviewers may either be project members or technology experts. Then they either relay feedback to the writer and/or if it meets the quality expectations it can be made public to the rest of the users (registration and archiving), who will get an update alert (create awareness), so basically the KHC will become a sort of publisher that will guard the quality of the knowledge that is shared.

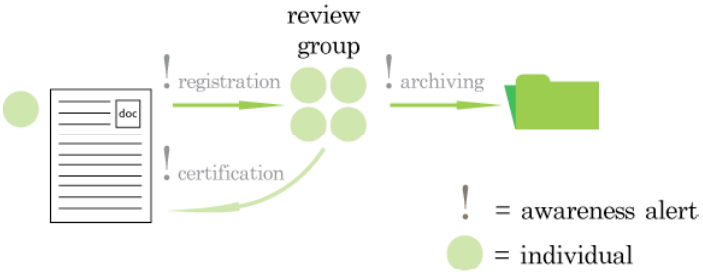



*Figure 21 possible upload workflow (Roosendaal et al., 2001)*

*Applying and acquiring knowledge*
The last phase in the sharing cycle is *applying and acquiring of knowledge*. This phase is not a logical result of the previous phases. The acquiring of knowledge is equally to, if not more important than sharing knowledge, simply because people share knowledge so it can benefit others. If those others do not use the shared knowledge, the initiative will eventually fail. So not only the sharing must be motivated also reading and using the knowledge and information that has been shared, when knowledge is shared it is not said that the receivers will read or use it. Table 17 shows the functions that need to be fulfilled and which role it has to fulfil.

| *Main function* | *1st sub-function*[7,8] | *2nd sub-function* | *By whom*[9] |
|---|---|---|---|
| *Creating and capturing knowledge* | Externalisation | Documenting | Producer |
| *Sharing and disseminating knowledge* | Socialisation | Presentations | Producer / intermediary |
| | | Formal meetings | Producer / intermediary / consumer |
| | | TTM | Producer / intermediary / consumer |
| | | Informal meetings | Producer / intermediary / consumer |
| | | Telephone | Producer / intermediary / consumer |
| | | Email | Producer / intermediary / consumer |
| | Memory | Database | Producer / intermediary / consumer |
| | | Communities of Practice | Producer / intermediary / consumer |
| *Acquiring and applying knowledge* | Internalisation | Reading | Consumer |
| | | Education | Consumer |
| | Combination | Reading / documenting | Producer/consumer |

*Table 17 functions to be fulfilled*

A role division is needed as can be seen in the table above. The KHC will act as some kind of publisher an intermediary, and will also need to produce and consume knowledge. They basically fulfil all roles stated by Markus (2001) (except *prosumer*), while the regional engineers will act as producers and consumers. The reason that the KHC will have the role of intermediary is because of their central and instructive position towards the regional engineers and OEM's.

[7] Nonaka and Takeuchi, 1995
[8] Gammelgaard, 2007
[9] Ellis, 1999

### 6.2.1 Knowledge management roles

There are four general functions that can be distinguished: *infrastructure, application, functional,* and *content management*. The first two are outside the scope of this research but are to be mentioned because they are necessary for a functioning knowledge management solution, the last two lie within the scope of this research and the roles belonging to that will be discussed. This has been graphically displayed in Figure 22.

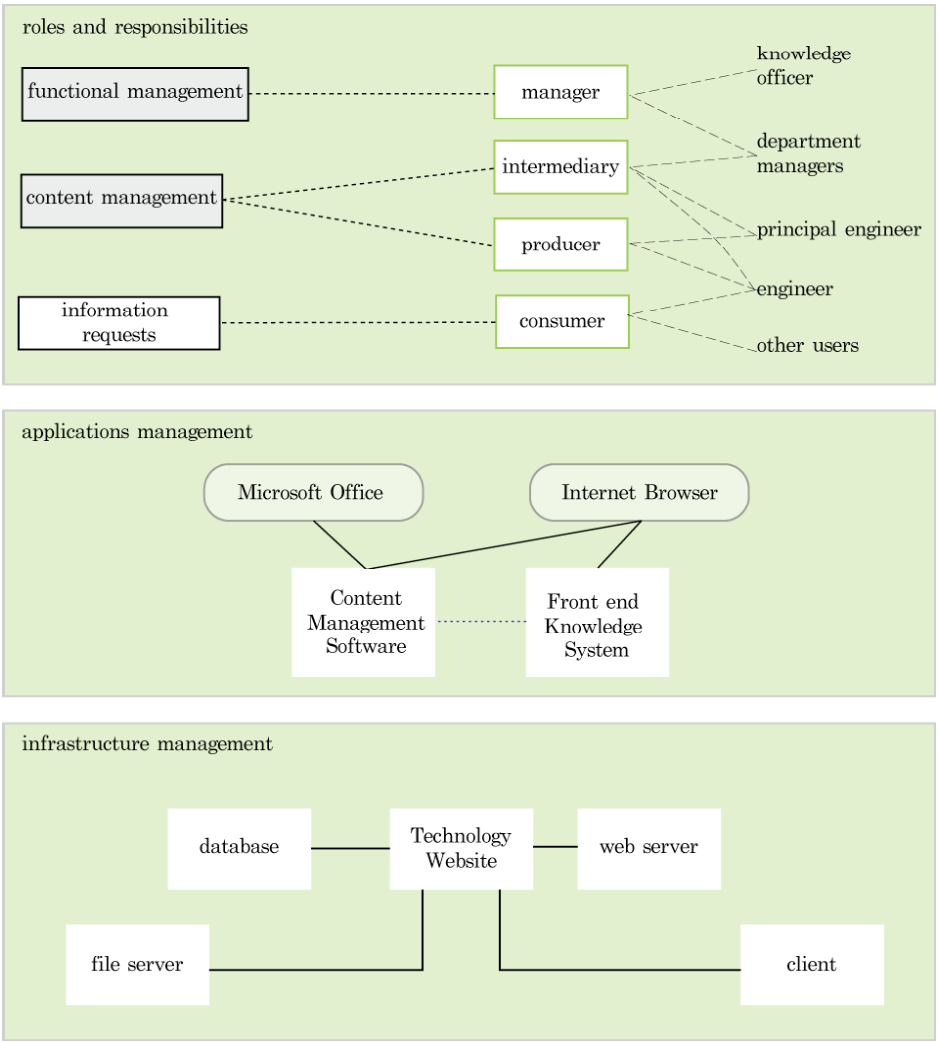



*Figure 22 four sharing functions*

*Infrastructure management* is for the realization and management of the technical infrastructure, which is necessary to let the knowledge management application operate. Normally, the knowledge for this sort of management is available within the organisation, at the ICT department. This is because databases, servers, and web servers already are present they however need to be adjusted to the new environment.

*Application management* is for the realization and management (adjustments of the functionalities as formulated by functional management) of the knowledge management application and is normally fulfilled by an individual in the ICT department in the organisation. If there is no one present with that knowledge, then someone should be acquired, schooled, or this part should be outsourced.

*Functional management* is the configuration of the knowledge management application and formulating of necessary functionalities. A functional manager is responsible for the authorisation of users and the responsible for the management of the information model of the knowledge management solution. The responsibilities for this role can be assigned by a department manager, but when the system will expand a knowledge officer will take over the tasks.

*Tasks and responsibilities*

- Processing and managing knowledge domains;
- Managing the systems' authorisation rights. Every intermediary and producer will get an account with managing rights for a specific part of the knowledge management system;
- Managing groups to which users can apply for information sharing;
- Analysing and formulating new functionalities for the knowledge management system aligned to the demands and wishes of the users and possible new technological developments for web applications. De formulated changes for the functionality will be realised by application management.

*Content management* is a general function for the management of all information that can be requested from the system. Concerning the organisation of the content management, a three-layer design is chosen based on Markus' (2001) role division. The (knowledge) manager is the executive officer concerning the content of the knowledge management system; the intermediaries are responsible for a specific domain in which they optimise the information services by i.e. assessing relevancy of publications per domain, assigning people to publish documents; finally the producers who function as a decentralised editorial board and upload information and knowledge to the system and in addition manage the documents they are responsible for. The system will gain critical mass easier when assigning a large group as producers, this way a large group of people know how to use the system and can encourage others to use their publications, in Figure 23 one may find a graphical representation of the organisational design or in other words, the role division.

**Knowledge officer (chief editor)**
The manager of the KHC department, in the first place, will fulfil this function. When the engineers publish more information and knowledge over time, this function will need to be fulfilled by a full time employee (FTE).

***Tasks and responsibilities***

- Frequent discussions with management concerning the goals and content of the system;
- Based on the goals and content, the knowledge manager will assign intermediaries that are responsible for a specific knowledge area on the system;
- Instructing and support of the producers, both on the functioning of the content management system as on structure, style, and design. The knowledge manager is responsible for a uniform representation of knowledge and information;
- Creating documentation and giving courses that will support producers and intermediaries with independently fulfilling their publication tasks;

- Encouraging intermediaries in a specific domain to check and add new information, to secure quality and to keep the amount of information at an acceptable level;
- Communicate the existence and necessity of the knowledge system in the organisation so that the producers and also the consumers are aware of the existence of the system.

**Intermediary**
The intermediary is responsible for the information in one or more similar knowledge domains, and manages the corresponding team of producers. Such domains consist of projects, products, and technologies. When technologies should change these domains also change and the intermediary must appoint producers to write publications on the matter. In the beginning of the initiative this most preferably is the principal engineer, because he knows what knowledge is present among his engineers. Along the maturity phases the intermediary role will be expanded to experts in certain domains i.e. review groups who will be responsible for certain areas of expertise.

***Tasks and responsibilities***
- Frequent discussion with the knowledge manager on the domains in which information and knowledge must be published;
- Appointing of producers for specific sub-domains, i.e. specific projects or rare applications;
- Feedback on the targets that have been set up in front, so that can be measured how much information and knowledge is shared;
- Support of producers in a specific domain.

**Producer**
The producer is responsible for publications in a specific (sub) domain. The engineers are the main producers, followed by the regional engineers and principal engineers. The domain in which publications are made can be in project related, technology related, market related, etc…

***Tasks and responsibilities***
- Adding new information and removing/archiving outdated or incorrect information;
- Keeping the intermediary informed on the developments in the domain.

Besides all the responsibilities in the content management area, there is also another role that must be discussed, the *consumer*. The consumer is someone who uses the knowledge and information that is found on the system to implement it in their daily work (Markus, 2001), this can either be an engineer but also people from other departments as i.e. sales.

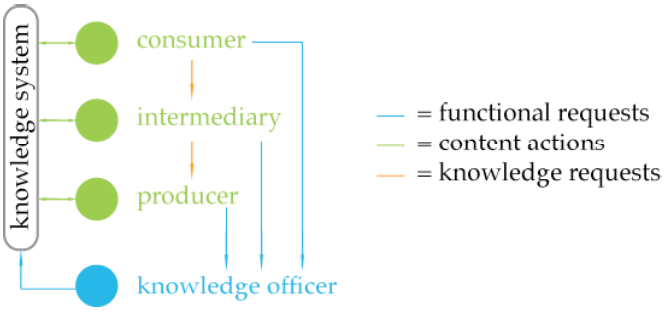



*Figure 23 organisational role design*

### 6.2.2 Technical design

All the previous discussed issues can be put together in a structured system. This system will need to have certain elements in order to facilitate the end users so they will use the system and it will ease their daily routine. In this paragraph there will be discussed which elements are necessary to the system.

*Yellow pages (profile pages)*
Yellow pages are easy and rather cheap to set up (Dalkir, 2005), as mentioned in paragraph 2.3.3. They contain information on personal expertise, former employers, a photo of the individual, and contacting information. In this way it is easier to find expertise on the subject. When looking at the KHC, one may see all process engineers. So the people looking into the yellow pages are all of similar profession. This eases locating specific expertise. They all speak the same lingo so they can use jargon in their yellow pages. All four groups can publish on this part of the system and every person is responsible for its own yellow page.

*Technical bulletins (Wiki or download page)*
This part of the system will consist of Wiki pages on which static information is shown i.e. technical formulas for calculating certain design parameters. Because of the fact that technical bulletins can be very expertise dependent, a review group must be set up with the responsibility for the usefulness of the publication. When looking at the KHC, one can say that a group of experts on Reverse Osmosis (RO) — a water filtration method to filter out i.e. salts — is responsible for publications on RO, however all sub groups (including NSO's) can produce a technical bulletin concerning RO. The group of experts is in this case based on a technology, however a community of practice can also be initiated based on a market segment, i.e. mining. A community of practice is generally not set up by the management but by employees themselves, but since it must be introduced to gain critical mass the management has to do the first steps.

*Project summaries (Wiki)*
This part of the system is set up on Wiki pages, which can be accessed by every KHC member. This summary will consist of a project description, which products and technologies were used, hyperlinks to related documents (drawings, design guidelines, standards) that are located in the download area; besides the previous the links also go to yellow pages or references for example. In addition, pilot reports also can be seen as a project summary. These pilots are placed all around the world and can give useful information about how Norit products perform under certain environmental conditions, but also different kinds of water quality. These pilots form a basis for new full-scale projects and therefore it is very important that these projects are made explicit. The pilot department publishes pilot reports, however can be reviewed by a community of practice that is expert in the field in which the system has been tested.

*Download page*
This page contains all standard documentation, drawings, design guidelines, standards, etc… as already mentioned in the previous paragraph. These documents will be provided by the KHC and can be used by all other parties, under which the NSO's. These documents are listed on more then one page; this because i.e. design guidelines are applicable to certain projects, technologies, etc… When these documents are created they can be assigned to a category and key tags make sure they are linked to the right pages. When

completing a project one may i.e. tag the guidelines used, technologies used, and technical bulletins used, etc…

*Question and answers (groupware)*
Finally there is the last part of the system that will be used. This is a forum on which engineers can post a question that can be answered by all other engineers. This page can be used for a community of practice to share the same interests so they can discuss and can gain more knowledge about the subject.

*Workspace*
As the engineers stated, there is a need to have a secure area on which 'work in progress' can be managed, documents that are still under construction so to speak. The most of them still rely on the well-known Microsoft Windows structure with a partition in maps and files. However, this will still not give the advantage of accessing documents everywhere and making sure that all versions that are worked with are the correct versions, in other words revision management.

*Push technology (creating awareness (Roosendaal et al., 2001))*
This sort of technology is designed to automatically inform people of new issues of i.e. weblog posts or digital magazines. To disseminate the information and knowledge through the organisation, this method can be used to 'push' updates to users with specific content that is relevant to them. The beverage department should i.e. only receive updates concerning their technology and not about wastewater technology. People can get a membership so they get included in the mailings.

Seen from a practical perspective the regional engineers also spoke about a personal dashboard, in which they can get customized messages, updates, etc… in that way the users will be withheld of information that is not interesting for them. This could be one of the building blocks in creating critical mass.

All previous discussed elements can be fitted into a table, so it is clear who has to manage, generate, and authorise what elements, this can be seen in Figure 24.

| | | *Water* | *Waste water* | *Beverage* | *Pilots* | *Regional engineers* |
|---|---|---|---|---|---|---|
| *Yellow pages (individual)* | | m/g/a | m/g/a | m/g/a | m/g/a | m/g/a |
| *Technical bulletins* | | m/g/a | m/g/a | m/g/a | - | g |
| *Project summaries* | *Pilot reports* | - | - | - | m/g/a | - |
| | *References* | m/g/a | m/g/a | m/g/a | m/g/a | m/g |
| | *Hyperlinks* | m/g/a | m/g/a | m/g/a | m/g/a | m/g |
| *Download page* | | m/g/a | m/g/a | m/g/a | m/g/a | m/g |
| *Questions and answers* | | m/g/a | m/g/a | m/g/a | m/g/a | m/g/a |
| *Workspace* | | m/g/a | m/g/a | m/g/a | m/g/a | m/g |

*m = manage, g = generate, a = approve*

*Figure 24 responsibilities for the groups*

However, not only responsibilities play a role, also the representation of the system is important. Because the knowledge is to be homogenised among the engineers, it is important not to divide the ICT solution in different sub-groups but to let engineers have access to all information and knowledge that may concern them, of course with a rights structure so that sensitive

information cannot leave the company. They may filter it to their own likings through several steps that need also to be memorised by the system, so that the use of the ICT will maximally facilitate knowledge management.
In Figure 25 one may find the structure for the website to let the engineers use the system.

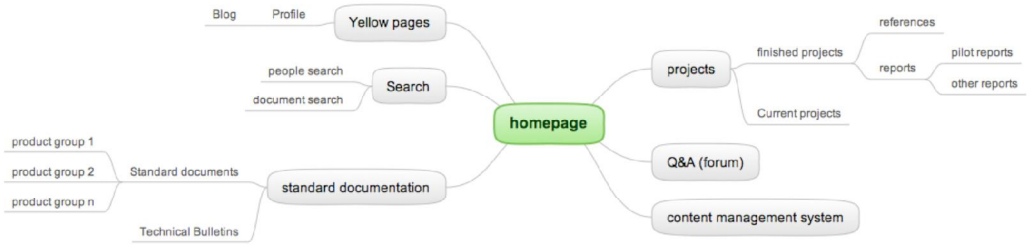



*Figure 25 functional design of the knowledge sharing ICT solution*

*Blog*
As one can see in Figure 25 is that under the *personal page*, there is a blog. This blog can be used to write daily summaries of problems that arose during the day, so that the individual engineer has a sort log on what happened during the day. That way the generating of evaluation reports and the like can be eased.

## 6.3 Sharing motivation synthesis

As discussed in the literature (Davenport *et al.,* 2000; Ipe, 2003) only implementing a software solution will result in a scarcity of knowledge sharing; thus the technical design is only a fragment of the total solution. However this tool *is* a necessary condition to facilitate knowledge sharing. The following paragraph will elaborate on the ways to motivate the engineers to use that tool.

*Knowledge creation and capture*
An incentive scheme must be set up to motivate the engineers to share knowledge. By combining both the outcomes of the interviews and the research of Yahya & Goh (2002) the following can be stated. A solely remunerative based incentive structure (Callahan, 2004) will not work when implementing an IT solution or sharing knowledge in general (this is supported by multiple respondents); it can even lead to fierce knowledge competition where the sharing only will occur when being rewarded for it. Previous is contradictory with Bondarouk *et al.* (2008), reason for that can be that Bondarouk *et al.* (2008) only discuss the implementation of IT solutions, not in combination with knowledge sharing. That is why it is more likely to choose for a moral based incentive structure (Callahan, 2004).

On a (new) system it may be difficult to publish items; the system may not be "fool proof" in operation. This may thus result in an obstacle to use the system; therefore trainings should be set up how to use the system effectively (Bondarouk *et al.,* 2008).

*Knowledge sharing and dissemination*
In relation to the current situation, where seven or eight systems are used, they are more likely to use only one system since this will ease their search actions. Other ways to ensure the use of the system is to provide training on its usage. Also appointment of key users who may be approached for questions about the usage of the system may help to increase the usage. Other ways to make sure people will use the system is to measure their inputs into the system and the use of others' inputs. If this is done people can be judged

on their contribution and can be rewarded and compensated, as can be seen in Figure 26 on page 70.

To create a larger motivation for people to share information, a review group needs to be set up, in order to perform certification (Roosendaal et al., 2001). This group of people can be a formal formed group, as in a project team, or a community of practice, this can also take away the problem with the non-disclosure agreement, censorship is not performed by the individual but by the review group. When this group reviews the documents that are turned in for uploading into the system, they can assess the usefulness and therefore can consider publishing it, returning it for rewriting, or give it a no go. That way the quality of publishing can be guarded and the information overload can be limited, a downside however can be that the publication threshold gets too high and the engineers will not codify their knowledge. Because of the fact that measuring knowledge is a very difficult task, it is not very likely that people get rated on the amount of knowledge shared, but more on the fact that they are participating. This can be brought up at the yearly performance review of the employees. The regional engineers are only judged on sales targets but of naturally the appraisal of the NSO's must be extended to knowledge sharing as well; otherwise they would not be triggered to share knowledge in general. Incentives for the regional engineers are very hard to determine because of the fact that they do not fall under hierarchical responsibility of Norit Enschede. However, the demotivators to share knowledge are similar to the KHC engineers' so by using similar positive motivations the regional engineers could be triggered to use the system.

Knowledge initiatives are very hard to measure; because most sharing occurs through socialisation (Nonaka and Takeuchi, 1995) this is mostly not documented. One way to make sure everybody can contribute to this act of socialisation is to have the opportunity to have presentations once and a while on various subjects, e.g. project related issues and solutions, new technologies (general or from R&D), or technical calculations. These presentations can be based on the engineers' working papers. This solution also meets the wishes of the KHC engineers to become more aware of developments at the R&D department.

In addition, not only can a knowledge sharing solution give an increase in efficiency, but by implementing yellow pages as an expertise finder one can also indicate knowledge gaps (McBriar *et al.*, 2003). If there is only one or no individual familiar with a certain knowledge domain then there is a knowledge gap and it can be acted upon i.e. with means of education.

*Knowledge acquisition and application*
One thing the regional engineers emphasize is that they like to know whom they are talking to. This means that human interaction must be kept central in sharing information/knowledge, when two people are acquainted with each other (have a social relation) they are more willing to help then when two people do not know each other (Marwell and Oliver, 1993).

Other motivations are that of the motivation through education and training (Bondarouk *et al.*, 2008; Yahya and Goh, 2002), when engineers encounter problems in the usability of the system, they must be trained to acquire the knowledge to use it properly. In addition, the need for education must not be forgotten, because when there is no education, little new insights or ideas will be created.

| *Main function* | *1st sub-function*[10] | *2nd sub-function*[11] | *By whom*[12] |
|---|---|---|---|
| *Motivating people* | Appraisal | Moral (ICT) | Consumer to producer |
| | | Moral (face-to-face) | Manager towards consumer and producer<br>Consumer to producer |
| | | Career | Manager towards consumer and producer |
| | Compensation | Allocate facilities | Company wide |
| | | Allocate time | Manager |
| | Training | To use software | Company wide |
| | | Education | HR department / manager |

*Table 18 functions and responsibilities for sharing*

In general motivating the use of documents must be by measuring the amount of use. By stating which documents are published by whom and which documents are used per project, the use and relevancy can be assessed. The rating system consists of two parts, a closed and an open system. Firstly, the reviewing intermediary will rate the document before publishing it on the system, an initial rating so to speak. Secondly, the engineers *must* rate the documents they use. That way the author gets a rating on his documents and if his document on i.e. RO filtration is used a lot and rated high, he can be rated expert on RO, this is visualised in Figure 26.

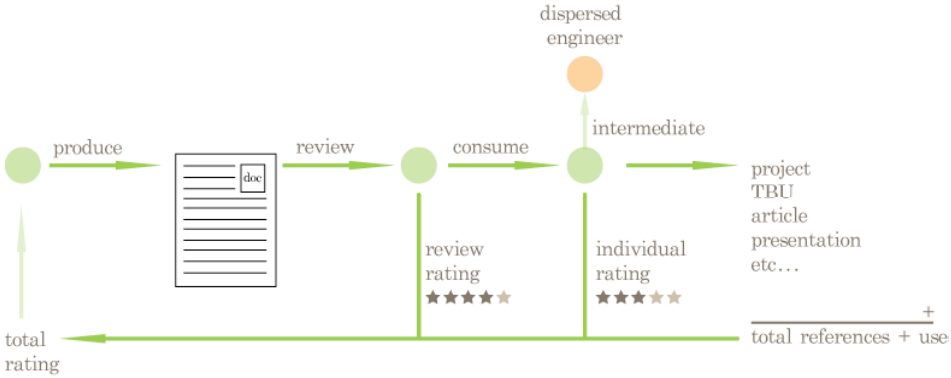



*Figure 26 expert rating*

When this rating system is used, an overview of the people who are highest rated must be generated. That way the moral incentives will be more emphasised, condemnation by the community (Callahan, 2004) can occur because people are triggered by a list of top producers, of course this must be related to the time working at the company, otherwise there would be false competition. An example of a rating is shown in Figure 27. However, there must be kept in mind that office politics have to be prevented. Principals must check the ratings given by consumers, so that reviews stay authentic and honest.

| | | published | retrieved | published/year | rating |
|---|---|---|---|---|---|
| 1. | Michael Alpha | 1200 | 800 | 50 | ★★★★★ |
| 2. | Brian Gamma | 500 | 250 | 20 | ★★★☆☆ |
| 3. | Eva Beta | 800 | 400 | 10 | ★★☆☆☆ |

*Figure 27 statistics of rating (example)*

[10] Yahya and Goh, 2002
[11] Bondarouk *et al.*, 2008
[12] Ellis, 1999

The last motivation that can be used is that of career opportunities. If the engineers have actively participated in sharing knowledge and the usability of their codified knowledge is high, they may receive privileged career opportunities.

## 6.4 Conclusion

This chapter has sketched a possible way to build the knowledge sharing solution, both in ICT and by HRM instruments. It is clear that the KHC and Norit in general are still very low levelled in knowledge management and a lot of improvements can be made. The research question that was to be answered in this chapter was stated as the following

In what way can a knowledge sharing solution be designed for the KHC?

- How should the facilities of the solution be designed to best serve the knowledge sharing cycle?
- How should the motivational structure be designed to best serve the knowledge sharing cycle?

*Opportunities*
It is very easy to see that the facilities are one of the biggest issues that prevent the engineers from capturing, sharing, and acquiring their knowledge. Therefore the design has several tasks: maximal facilitate the ease of capturing knowledge, think in this perspective of project summaries, project evaluations, but also articles and presentations that are given. Introducing a single point of entry to all information, a search engine, and keeping the possibility to call the KHC stimulates the sharing of knowledge. The sharing of correct documents is facilitated by the interactions between Salesflow, the current file server, and the website. The sharing of knowledge is also stimulated with help of the expert locator (yellow pages).

In addition, the assigning of roles is key when implementing knowledge management. For this research, the producers, intermediaries, consumers, and overall knowledge officer are important roles that need to be assigned.

*Motivations*
The motivational synthesis has led to a system to help the engineers learn to use the system with help of training and allocation of facilities and appraisal. The facilities have already been discussed in the previous paragraph. The training and education of the engineers are central aspects when it comes to knowledge management. If there is no knowledge acquired through education or the like, no new insights are created from a theoretical perspective, which can generate a biased view on problems (only practical judgement). On the other hand the use of the facilities must be motivated by introducing moral appraisal; this will be an expert rating where all uploads and downloads are registered in the system. This will be coupled with the years of working experience within the company, because when people work in the organisation for 20 years they have had more problems, time and experience to write about. In addition when having yearly performance reviews, engineers can also be rewarded to comply with their education needs. If the engineers have shared enough knowledge they can be rewarded with knowledge. In that perspective there also can be created more career opportunities for the engineers that share more than the others.

Another moral appraisal is the possibility to give presentations on a subject an engineer is proud of; this can be a project, new technologies or the like.

Also having the R&D department doing presentation on their developments will have positive impact on the motivations of the engineers, since they emphasised that they still do not know what this department is working on or has been working on. When such presentations are held, the engineers can create critical mass when presenting new technologies or the like.
In line with that is to invite engineers, who perform outstanding in knowledge sharing, to give a presentation on their expertise area at management conferences.

Education should also be related to a "knowledge matrix" in which the fields of knowledge that the organisation needs, now and in the future, are recorded. If some of those fields are not filled in with individual or group knowledge then there should be acted upon this knowledge gap and people should be triggered to do education in that knowledge field.

Moreover the most important issue that was presented is that of the lack of time, so the allocation of time is necessary to have the engineers documenting their knowledge, project evaluations are an example of this.

# 7 Gap analysis

The last phase in the design cycle that is discussed in this research has been fulfilled. A preliminary design has been presented. In the following paragraphs, a scenario to implement knowledge management will be presented. In this last phase of the research the current and the desired situation are described, and moreover the differences between them. The research question to which an answer will be found in this chapter is as follows:

What should be done to overcome the differences between the current and the desired situation?

- What are the problems and the origin of the problems that form the gap between the current and the desired situation?
- What are the areas of improvement regarding the knowledge management cycle?

## 7.1 Differences current and desired situation

As already discussed in the previous chapters, the KHC and the engineers find it hard to document their daily findings simply because of lack of priority and time. The biggest issue resulting from this is that knowledge cannot easily find its way to other engineers; it cannot be transferred easily. When a comparison is made between the current situation and the desired situation, based on the maturity model introduced in §2.4, one may see a four level gap, as can be seen in Table 19.

| *Knowledge phase* | *Maturity stage* | *Current situation (level 1: initial)* | *Desired situation (level 5: optimised)* |
|---|---|---|---|
| *Knowledge capture* | Nature of knowledge (mode of conversion) | Little codified (socialisation) | Codified (externalisation) |
| | Opportunities | Ad-hoc documenting | Protocols for structural knowledge capturing |
| | | No clear structure where to save documents | Roles and responsibilities are clear within knowledge groups |
| | | A couple of people take time to save lessons learned into a database | |
| | | Knowledge is rarely refreshed or searched | |
| | | Initiate yellow pages | |
| | (de)Motivations | Little trust | High amount of trust |
| | | Little priority to capture knowledge | Knowledge is constantly updated |
| *Knowledge sharing* | Nature of knowledge (mode of conversion) | Mostly tacit (socialisation) | Codified supported with tacit (internalisation, combination, socialisation) |
| | Opportunities | Knowledge is little used | Frequent presentations on working papers and technologies are given |
| | | Lacking facilities to share | IT is maximally furnished for the needs of the KHC |
| | Motivations | Difficulties to locate expertise and information | Knowledge is broadly available and it is easy to locate |
| | | Facilities are hard to use | A shared lingo and guidelines lead to effective knowledge sharing |
| *Knowledge acquisition* | Nature of knowledge (mode of conversion) | Tacit (internalisation) | Tacit (internalisation) |
| | Opportunities | People only use knowledge for personal purposes | People frequently discuss problems with experts |
| | | Little or no education | Frequent education based on knowledge matrix (which is structurally updated according the company strategy) |
| | Motivations | People acknowledge the importance of knowledge, but cannot find time to do it | Moral motivation by pressure of community |
| | | | Experts are assigned on basis of publications, experience, and sharing behaviour |

*Table 19* *gap analysis, based on maturity model*

To help the engineers to share their knowledge as easily as possible, a leading strategy must be chosen as advised by Hansen *et al.* (1999). For the KHC and the regional engineers the most fitting one would be the codification strategy supported with the personalisation strategy, this is the most logical strategy because of the fact that time zones have to be crossed. In the current situation, it is very difficult to control the quality and frequency of knowledge sharing.

Due to language issues and, as mentioned earlier in this paragraph, different time zones it is very difficult for the engineers to share knowledge and information. If the KHC is to improve the capturing of knowledge they will need to change from ad-hoc knowledge sharing to structurally updating and sharing knowledge. Concerning the sharing, it is a very extensive change: facilities, mindsets, and workflows will need to change. Improving their knowledge acquisition they will first have to define which knowledge areas are important for future organisational purposes so education can be aligned with these strategic goals.
The leading strategy will be the codification strategy subsequently the support strategy for the KHC will be the personalisation strategy (Hansen *et al.* 1999). This means however that if codifying knowledge were priority, socialisation (Nonaka and Takeuchi, 1995) must not be forgotten.

## 7.2 Implementation scenario

Introducing the IT solution to facilitate knowledge sharing will be the easy part, since there are dozens of suppliers for such programs. The problem, however, will be to make sure the knowledge management initiative will find critical mass and will be used. Presenting the IT solution fully at once will only force resistance. Therefore, all negative aspects or sharing disablers need to be eliminated and the solution will need to be implemented in phases.

The implementation of a knowledge management solution fully depends on critical mass; if the engineers want to spend time on the matter it can succeed otherwise the initiative will have a hard time coming through. Therefore a phased implementation will be the most important, that way people can learn to work in favour of knowledge management gradually.

The implementation scenario for knowledge management will be based on the maturity model as discussed in §2.4.

*Transition from maturity level 0-1:* this transition is to be seen as the starting point for the management to be able to find out the best knowledge management strategy. The goal of the strategy will of course be *level 5* in the maturity model. Before implementing the strategy, the following actions must be taken:

- advocate the importance of knowledge management through the organisation, in this case the KHC and the regional offices;
- disseminate the needs for knowledge management, and to;
- perform knowledge management benchmarks (currently initiated).

The engineers have stressed their demotivations to share knowledge; to be able to motivate the engineers their sharing disablers must be taken away. In Table 20 an overview can be found of solutions to knowledge sharing demotivators, given by the engineers in §4.3.

| *Demotivator* | *Solution* |
|---|---|
| Lack of ease of publishing | Giving training on the use of the solution, and sharing knowledge in general |
| No time for knowledge management, lack of priority<br>No wish to spend time on writing reports<br>Writing in after hours | Include the sharing of knowledge in the employees' job responsibilities so it can be included in daily routine |
| Competitive information | Secure the system so that this competitive information cannot easily leak out. (Try not to limit people in publishing knowledge, this can result in negative reactions)<br>Review group can discuss the content and apply censorship if needed |
| Language barrier | Courses in English language |
| Negativity, not invented here syndrome (NIH)<br>Loss of face<br>Lack of understanding by receiver<br>Misuse<br>Non use<br>Lack of responsibility<br>Not sharing in return<br>Trust | Moral appraisal<br>Trainings and reviews;<br>Divide publications into subjects of interest<br>Push notifications about publications and the limited application of the information/knowledge<br>By including sharing in appraisal sharing gets a obligation<br>Emphasise the social ties of the engineers |

*Table 20 possible solutions to engineers' demotivators*

The next step is to continue with an implementation scenario according to the maturity model presented in §2.4.

*Transition from maturity level 1-2*: as discussed in §4.4, the KHC is currently situated in the first maturity level. This phase is the hardest part because the first codification and standardisation protocols have to be set up. So the focus in this phase is more on the *types of knowledge* supported by *opportunities*, and *motivations*. Moreover, when this phase has been completed there will be little change in the nature of the captured knowledge. In addition, this phase is characterised by management motivation towards the engineers.

*Types of knowledge*
Since the engineers still are writing only for their selves, the primary improvement must be in capturing knowledge, which in this phase shall be the project related information. The engineers need to become producers (Markus, 2001) of knowledge but also must consume knowledge produced by others. When documenting project specific information, the engineers will have a steadier foundation on which new projects can be based. In line with that, company wide standards have to be set up, since they are not fully present at the moment, and must be agreed upon by every department, stronger rules must be set up in the use of these standards. In the view of technical designs, boundaries of the system must be set up but this is a logical result of standardisation.

The sharing of knowledge will need to undergo changes towards a more codified basis, but individual tacit knowledge will still have the upper hand. Basically, there will be changes from pure *socialisation* towards *internalisation*, *combination*, and *socialisation* (Nonaka & Takeuchi, 1995). The captured project, technology, and standardisation knowledge will form the basis for this.

Acquisition of knowledge is an act of *internalisation* (Nonaka & Takeuchi, 1995) that concerns tacit knowledge; basically the nature of this knowledge will not change during the five maturity phases but only the

amount and frequency of the knowledge acquisition in general will change.

*Opportunities*
Necessary for capturing knowledge is the availability and, more importantly, the skills to work with word-processing tools, since that the engineers indicated that there still is little experience with the current systems. Moreover, the allocation of time is necessary to enable the engineers to codify their knowledge. Then yellow pages / personal profile pages must be implemented, for which every engineer is responsible in keeping it up to date. Pilots are initiated to start with codifying troubleshooting issues and solutions, so to research the most effective way of sharing this kind of knowledge. Also, the project evaluations must be planned so that the engineers (and other departments) have the opportunity to discuss the pros and the cons of finished projects. These evaluations of course have to be captured in project summaries that are to be made public to the rest of the KHC, so other engineers can reuse them.

The acquisition of knowledge in this phase will not be fully initiated as such. Researching the knowledge gaps in the organisation is the biggest task at hand, since there is not completely clear what knowledge is present at the KHC and especially at the regional engineers. The knowledge gaps are researched based on the strategic goals of Norit Enschede, identifying which knowledge is necessary to survive or grow in certain markets. When large gaps are recognised, education or acquisition of new employees must be used to fill in these gaps, so actively offering education 'vacancies' will give the engineers more opportunities to acquire new knowledge. This also can be input for the development of new knowledge domains.

*Motivations*
When implementing knowledge management, it must be kept in mind that during the implementation positive motivations are to be emphasised. This is realized by making sure that engineers receive training to get acquainted with the system (Bondarouk et al., 2008). Moreover, the engineers' work must be planned with the IT. To enable the engineers in capturing their project related knowledge it is important to set up standard layouts that only require to be filled out. In addition the management must oblige project evaluations so that the engineers, in the first place are triggered to think about lessons learned *during* projects and in the second place use the IT solutions provided to document the evaluations. Other motivations to share knowledge are that the principals assess the usability of documents; in this way an acceptable quality is guaranteed.

Concluding, the facilities that are introduced in this phase are:
- yellow pages / profile pages;
- troubleshooting forum;
- allocation of time to codify, share, and acquire knowledge;
- initiating knowledge gap analysis;
- standardised project summary documents;
- principals function as reviewers;
- starting with trainings on the use of IT solutions.

Motivations that are introduced in this phase are:

- assigning of roles to all engineers;
- management motivations concerning project evaluations;
- allocation of time to codify knowledge;
- management motivation for education.

*Transition from maturity level 2-3*: this phase is the transformation from being able to repeat certain actions to defining why certain actions and more importantly reactions happen. When this transformation has been completed the engineers are able to exactly state what happens, why it happens, and how it can be improved. During this transformation in maturity the motivation shifts from pure management motivation towards group motivation.

*Types of knowledge*
The only transformation that occurs in the types of knowledge is the structural improvement of the quality and sharing of codified knowledge.

*Opportunities*
During this transformation the opportunities that must facilitate the capturing of knowledge are in the first place one central system to capture and hand in documents, which also was stressed by the interview respondents as a large issue in sharing information. Second, the management and principal engineers need to assign knowledge groups that are responsible for a specific knowledge domain and record knowledge and information according to one protocol. These groups also assess the usability of the documents that are handed in. Third the engineers are allocated time to write working papers of projects, technologies, etc…since time and priority was one of the largest issues addressed by the respondents.

Sharing of knowledge is also facilitated by the central system. Lessons learned originating from projects are shared freely, but the engineers still need to search for information so to 'pull' documents from the IT solution, condition is the use of a strong search engine.

Since the current situation still is somewhat chaotic, standard protocols need to be set up to retrieve knowledge and information, this will solve the bouncing around of phone calls at the KHC department. Education is aligned to the knowledge matrix. Last opportunity to retrieve knowledge and information is through the troubleshooting database.

*Motivations*
The motivations need to come from peers and is based on the knowledge groups' responsibility to publish. The knowledge group also rates the documents on usability and creates an appraisal in publishing knowledge and information, see chapter 6. But still, the management has to push the engineers to search for knowledge on the IT solution and the expert database. The engineers also find reward and motivation in easier finding, defining, and solve historical problems that reoccur.

Concluding, the facilities that are introduced in this phase are:
- setting up knowledge groups that are responsible for documenting according one capturing protocol;
- linking the current systems towards a central knowledge repository (i.e. Salesflow information gets updated when technical documents undergo changes);

- opportunities to write working papers to be read and used by other engineers.

Motivations that are introduced in this phase are:
- knowledge groups are set up, top-down;
- management motivation for searching knowledge;
- allocation of time to write working papers;
- targets of knowledge management are clear for the engineers.

*Transition from maturity level 3-4*: this is the transformation from defined towards managed, where the transformation stands for the change of management motivation towards self and group motivation. The engineers motivate one another in sharing, because of the 'expert-rating' that is introduced in the system. The engineers who do not share enough knowledge or information are seen as knowledge hoarders and will be morally motivated by the group and addressed by the manager either in the yearly performance appraisal or in daily routine (Wasko and Faraj, 2005). As mentioned in the previous transition phase, the types of knowledge do not change as such; therefore this concept will not be discussed in this and in following phases.

*Opportunities*
The most important change in the capturing opportunities is that every individual is responsible for his publication; the knowledge groups' function will be layered down to the individual engineer and will need to document according to pre-defined protocols. However, the reviewing committee will have the last saying in whether the document is or is not publish. In addition, the individual is still responsible for his personal profile / yellow page. Moreover, the engineers are to structurally create working papers.

Engineers with assigned roles for making knowledge available will facilitate the sharing of knowledge, they will become the knowledge intermediary (Markus, 2001). Besides that, a knowledge officer must be appointed who can facilitate the overall organisation around the knowledge sharing. This knowledge officer also will need to disseminate knowledge and information (create awareness (Roosendaal, 2001)) through the organisation; push technologies may help facilitate this dissemination. Creating awareness will happen through digestive alerts, which contain possible interesting knowledge or information for the individual engineers. Besides the previous, set meetings meant specifically for sharing knowledge are held, these meetings may be discussions about working papers, projects or the like.

Acquisition of knowledge is structurally done through the IT solution, because every engineer knows where to find specific information. If it is not on the system, experts can be located through the yellow pages. When documents are retrieved and used, the 'consumer' (Markus, 2001) must rate the document for usability, that way an expert rating is set up.

*Motivations*
Because of the individual responsibility for capturing, sharing, and updating knowledge engineers can be individually rated for sharing their share. Performance appraisals are structurally held to discuss the amount and quality of sharing knowledge. The last motivation is that just-in-time knowledge is available.

Concluding, the facilities that are introduced in this phase are:

- appointment of knowledge intermediaries;
- knowledge groups become review groups;
- every individual is responsible for keeping their codified knowledge up-to-date;
- working papers are structurally created.

Motivations that are introduced in this phase are:

- (review)group motivation (group pressure) for capturing, sharing, and acquiring knowledge;
- increased efficacy and efficiency in daily work;
- expert rating;
- assignment of a knowledge officer who facilitates the organisation of knowledge management;
- frequent appraisal of knowledge activities.

*Transition from maturity level 4-5:* this change is towards the optimisation level, where knowledge is constantly updated and used, and roles and responsibilities are clear through the organisation. This phase does not require much implementation but merely maturation of the previous phase. The responsibility that the management (combined with the HR department) still has is the offering of education based on the knowledge matrix.

*Opportunities*
Capturing knowledge occurs structurally according to strict protocols by engineers who all know their roles and responsibilities. Sharing knowledge occurs frequently through the TTM, meetings in general, and presentation on i.e. working papers and during meetings. Moreover this transition is a crystallisation of all previous phases towards an optimum situation. There are no new tools introduced in this phase.

*Motivations*
Because of structurally updating knowledge, the usability reviewing committee, and individual rating, engineers trust each other on the content that they capture. Besides that the engineers are motivated by community pressure, and automatic assignment of experts based on publications, experience and sharing behaviour.

As can be seen, all these phases can be implemented but will have a long lead-time before it is profitable. Moreover, it is important to include feedback loops in the implementation to assess the current situation before entering the next maturity stage. Condition for entering the next phase will be that critical mass must be reached in both producers and in consumers, as discussed in §2.4. In Figure 28 the implementation scenario has been illustrated.

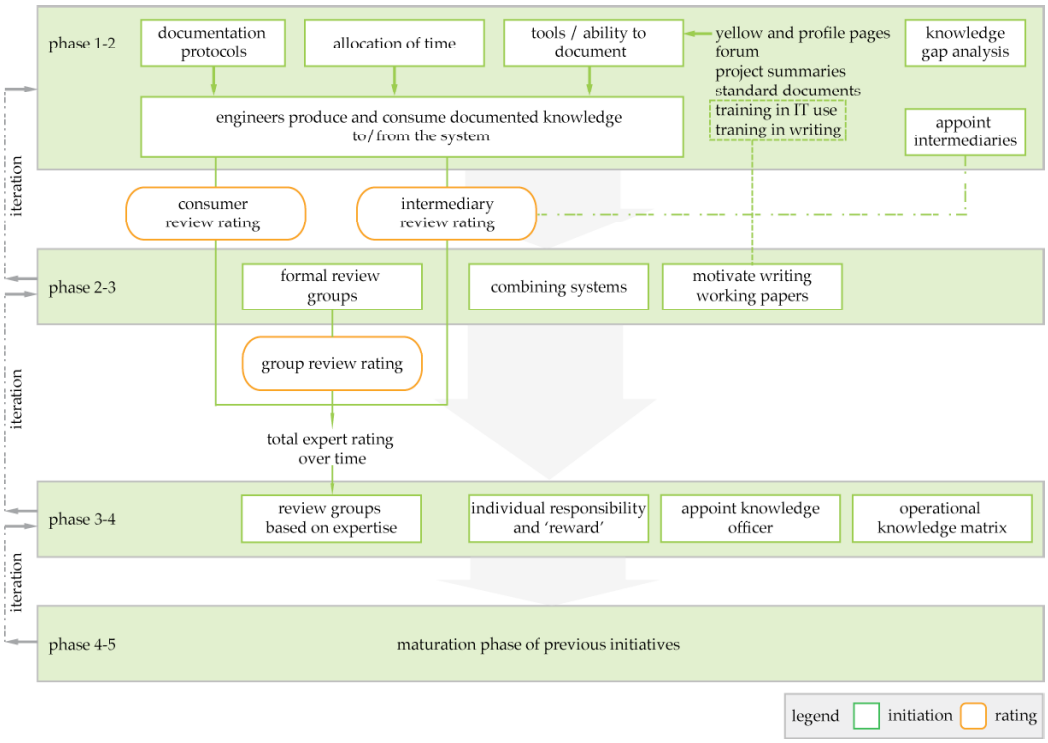



*Figure 28 initiation of need per phase in order to implement knowledge management*

## 7.3 Conclusion

The implementation of knowledge management is subject to a change management process that can lead to fierce resistance among the individuals that are affected with it. However the most occurring barriers for sharing knowledge that have been discussed by the engineers in §4, have been tried to tackle with the implementation and support of a specific knowledge management strategy for the KHC, namely the codification strategy supported with the personalisation strategy (Hansen *et al.*, 1999).

Basically the implementation of 'new' opportunities to share, only occurs in the first three phases; the first phase is the basis for the IT part of the solution, the second phase will match the workflow to the IT solution by making use of motivations through management obligations, and the third phase tries to harmonise the IT and the workflow by adding new features to the IT solution and assigning new tasks to the engineers. Beyond the third phase there are little new implementations other than assigning roles and responsibilities to the engineers.

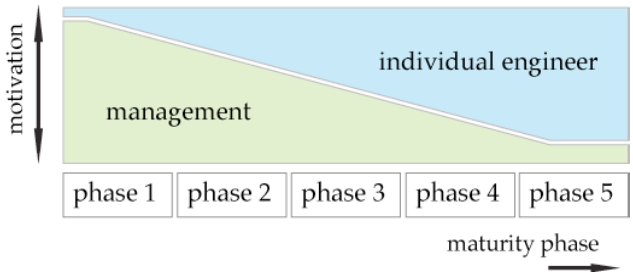



*Figure 29 decrease of management motivation, increase of individual motivation*

The motivations for sharing knowledge in the first phases come from the management, obligations to codify knowledge from a project point of view combined with training on documenting, and working with the IT solution. Further along the maturity stages, the motivations become less management driven but more individually driven by the engineers but also knowledge groups. Figure 29 shows the increase of individual motivations and decreasing management motivation.

Finally the maturity model presented in §2.4 has been extended with the results from the interviews and also with that of the gap analysis. The complete maturity model is enclosed in attachment §a.1.

# 8 Conclusions and recommendations

The goal of this research was to give a functional description of a software solution for sharing knowledge and an implementation plan how to trigger consumers and producers to share their knowledge at Norit Enschede's Know-How Centre (KHC) and regional offices. Therefore, the research objective was stated as designing a functional description of a software solution and the accompanying motivations for sharing knowledge, in order to homogenise the Know-How Centre's group knowledge.

From literature research several concepts and models have been found concerning knowledge systems, implementation barriers in information technology, and how to motivate people to use knowledge systems. These have been used to set up a framework to analyse the collected data. The data collection has been done by means of a panel discussion and several interviews, with both engineers at the KHC and engineers from regional offices. The panel discussion, addressing several subjects in information and knowledge management, was held during the Technology Transfer Meeting, where 33 engineers (both KHC and regional engineers) participated in the discussion. After the panel discussion, 14 engineers where interviewed and where asked to individually answer questions concerning information needs, problems encountered when information and knowledge is shared during daily work, barriers in sharing knowledge in general, etc. A total of five other companies have been interviewed to find the current state of the use of knowledge systems within international oriented technical companies with their headquarters in the east of The Netherlands. As mentioned earlier, this data has been analysed by means of the theoretical framework set up from the literature research. In the next paragraph an answer will be presented on the research objective.

## 8.1 Conclusions

The KHC at Norit Process Technology has a long way to go when it comes to effectively sharing knowledge. Several aspects of knowledge management are insufficient at the moment; that is why the research assignment concerned investigating and identifying those aspects and designing a solution to share knowledge, both in information technology (IT) and the motivational human resource (HR) area.

A lot of ad-hoc documenting is done and structural codifying of knowledge is not performed. Besides the sharing of knowledge is not sufficiently managed, if knowledge is shared this also happens on an ad-hoc basis, where problems are the relay of knowledge sharing. The capturing of knowledge can be stated as insufficient. During projects, there are little moments to evaluate the projects. Lessons learned are therefore not documented resulting in losing efficiency and solutions to encountered problems, thus knowledge loss. Problems seem to return and are solved more then once. Moreover the engineers mostly write only to support their individual memory, which means that documenting happens as a by-product of the daily work. Besides, if documents are written for others, there is not clear where to save this captured knowledge.

The knowledge that is shared has a strong tacit emphasis and knowledge remains in a small part of the group. Because of the fact that not much is codified, the engineers have to rely on each other's individual memory. Because this knowledge stays in the individual, locating expertise is difficult. Moreover, knowledge acquisition is low because of the fact that there is no overview on which knowledge is present and where knowledge gaps are located. Some information and knowledge is codified, however not structurally. When in search for information or knowledge, one must first find its way through a jungle of documents or a list of the engineers to get to the right item or person. Then, there is the human factor in sharing knowledge; 'he' needs to be motivated, or in other words is subject of demotivation when encountering problems. The most demotivation is found in two areas, firstly the lacking facilities (both IT and HR) to share knowledge and secondly social capital. The KHC engineers do not see barriers in sharing knowledge with other engineers face-to-face because of a strong relation between one another. However, the regional engineers are reluctant to share knowledge because of too little structural capital, they are afraid that their shared knowledge will be misused or not used. Another factor that could be a cause of not sharing knowledge is the low relational capital the regional engineers have with other engineers, because they mostly operate on their own in their region.

The interviewed companies encountered several problems when implementing knowledge management. What can be learned from these companies is that support of top management is crucial, but also the planning of the daily work of the people that are to share knowledge with the facilities. In addition, one may say that knowledge management is still not widely applied in the manufacturing industry.

The sharing solution must be one central portal on which all engineers can logon and can find everything they need, when it is not located on that system they may contact the experts that are listed in the various knowledge areas. This central portal is preferably web-based with a thorough search engine. The various content that will be hosted on the system concerns individual profile pages, technical bulletins, project summaries, lessons learned, etc… besides that a forum needs to be set up so that the engineers can post questions or problems concerning i.e. a certain technology. Besides that an expert rating system is needed, so that engineers who perform outstanding in sharing relevant knowledge can be rewarded by status within the group. When people are rewarded status, condemnation by the community may occur where the community puts pressure on the fact that someone is not publishing any knowledge. Other possibilities to reward people, is to let them write working papers, which they may present at frequent presentation rounds. The authors of the best-rated working papers can then be invited to management conferences at which they can present their work.

When implementing a knowledge system, a gap must be bridged. To overcome this gap between the current and the desired situation it is most important to keep in mind that a bulk implementation of the solution will result in severe resistance among the engineers. Therefore a phased implementation must lower the barriers for the end users. A possible scenario is the following:

- Phase transition 0-1 *concerns creating awareness among the engineers, so they are aware of the necessity of knowledge management and also about what they can gain from it.*
- Phase transition 1-2 *consists of introducing the various means for knowledge capturing, sharing, and acquisition. IT related but also setting up standardisation protocols for capturing knowledge.*
- *In* phase transition 2-3, *the engineers will be able to define what happens, why certain actions happen and more importantly what to do to improve the situation.*
- *In* phase transition 3-4, *the transformation from* defining *what happens to* managing *what happens.*
- *In* phase transition 4-5, *the optimisation level is reached and crystallisation of previous initiatives*

The implementation of knowledge management is thus subject to a change management process that can lead to severe resistance among the individuals who are affected, therefore the management must take the first steps to motivate the people involved.

The scientific relevancy of this research was to give insights in how to implement a knowledge management solution. Introducing the maturity model and applying it to the concept of knowledge management, and the introduction of the implementation scenario this has been fulfilled. Both from literature and practice, it was found that companies in the manufacturing industry still find it hard to perform knowledge management and subsequently knowledge systems. Companies or researchers can use the implementation scenario as a starting point for implementing knowledge management.

Finally, trying to increase knowledge sharing can only occur if knowledge remains in the company. That is why retention of knowledge workers is one of the most important tasks of a HR department. As a knowledge manager said in a research by Currie and Kerrin (2003): *"no matter how good a knowledge repository is, it can never replace the loss of an employee."*

## 8.2 Recommendations for the KHC

It is of utmost importance to advocate the importance of knowledge management throughout the organisation. Clearly communicate the reasons and goals why knowledge sharing is so important, and clearly state the rewards that can be gained. With this it is important to also assign roles to the people involved with clear description of their responsibilities. When this has been done there can be started with the implementation of (obliged) project evaluations, so that lessons learned are codified. This will reduce making mistakes multiple times. Moreover it is important to assess which knowledge is present, therefore it is advised to initiate a knowledge gap analysis where the organisation aligns the strategy with the knowledge necessary. If the knowledge is not present in the organisation, a knowledge gap is discovered and actions to acquire this knowledge can be initiated; this all results in a knowledge matrix.

Norit must offer *training*, *appraisal* and *compensation* to facilitate this. Training is focussed on the use of the IT and how to write documentation for others. Appraisal happens by means of the expert rating system but also by frequent appraisal reviews by the manager or principal engineers. Compensation is mostly facilitated by moral incentives (status within the group). Other

compensations are: structural education, expert ratings, working papers, presentations, etc…

The engineers will need to have facilities to create, publish, and retrieve documents. This is done through a phased implementation of a web based IT solution, such as the current Technology Website, so that different time zones will not be an issue. The system will need to contain the following functionalities:

- *Yellow pages*: finding expertise through search engine or browsing the yellow pages;
- *Standard documents:* a download page for technical bulletins, standard drawings, etc… which is accessible by everyone based on a rights structure;
- *Project summaries:* a structured representation of projects, so that is clear what the project entails, which technologies were used, who was involved, and most importantly the lessons learned;
- *Forum:* where the engineers can state their questions, problems, and solutions divided by technology, i.e. troubleshooting;
- *Workspace:* a content management back-end where every engineer can manage his or her profile, publications, version history, etc…
- *Overall search engine:* the ability to find documents or expertise;
- *Expert rating system:* this system concerns both open and closed rating. The closed rating happens by the reviewer *before* publication and the open rating happens *after* publication. The consumer can rate the publication on its usefulness and so, adds to the overall rating of the individual's documents.

Not only the above-mentioned functionalities are necessary for the exchange of knowledge and information, but also the reciprocal connection between the knowledge management solution and the file server and also between the knowledge management solution and Salesflow is necessary. A central repository so to speak, to make sure all departments are using the same standard documents. In addition, frequent presentations are to be introduced so that the engineers will have a motivation to write working papers. This is also very important for the engineers to develop a stronger relationship with each other and thus a stronger connection to the collective. Therefore strong recommendations go out towards organising Technology Transfer Meetings frequently.

If Norit Enschede wants to implement knowledge management, the implementation scenario presented in this research, can be used as a guideline to implement knowledge management. It is the case for the KHC to develop the knowledge sharing system and initiate the first transition.

## 8.3 Recommendations for further research

The primary and most important recommendations for the KHC are already discussed in previous paragraph, however there will always be additional points of improvement in order to develop well-organised knowledge sharing. Therefore the following pointers are interesting for further research at Norit Enschede:

- *Research the financial gains when knowledge sharing is implemented.*
  The current research focuses on the how and what, so the following study would be to research the financial gains, and with that starting to program and implement the system.

- *Research the tensions between departments to try to eliminate them in order to improve interdepartmental knowledge sharing.*
  The different departments are still separate islands, which is not a desirable situation for sharing knowledge. In the future the knowledge sharing initiative will need to exceed the limits of the KHC and also become organisation wide available, as discussed in the implementation scenario is that the frequent presentations at which different departments can present their current developments is a good start to create reciprocal respect.

- *Research the impact of a non-disclosure agreement towards knowledge management.*
  Norit has a strong policy for keeping knowledge indoors, meaning that only a few people know how certain processes take place. This is not a bad thing, but as came forward from one of the interviews is that knowing what is happening within the organisation, especially technical developments, is currently not communicated much. Besides, one of the interview respondents stated the following:
  *"…for me a barrier could be that we all had to sign a non-disclosure agreement. Why should I invest my knowledge into Norit, if when I intend to leave, I'm confronted with such penalties? It has to cut both ways."*

- *The relation between new to hire field engineers, NCS and the KHC regarding knowledge sharing.*
  As a result of some organisational changes, field engineers are to be hired whose job it is to commission plants. These field engineers are taking over some tasks of the KHC engineers. It is important that those engineers two will contribute their share of information about the operations of plants, troubleshooting, etc… Besides that, the NCS (Norit Components and Services) department is becoming more important in the future, if they have a good relation and knowledge flows towards the KHC, then Norit in general has a better change of improving plants and consequently products.

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# 10 Attachments

## a.1 Complete capability maturity model

| *Knowledge phase* | *Maturity stage* | *Current situation (level 1: initial)* | *(level 2: repeatable)* | *(level 3: defined)* | *(level 4: managed)* | *Desired situation (level 5: optimised)* |
|---|---|---|---|---|---|---|
| *Nature of knowledge* | *Knowledge capture* | Little codified | | Codified (externalistion) | | |
| | *Knowledge sharing* | Mostly tacit (socialisation) | Mostly tacit, supported by codified (socialisation, internalisation, combination) | Tacit and codified (socialisation, internalisation, combination) | Codified supported by tacit (internalisation, combination, socialisation) | Codified supported with tacit (internalisation, combination, socialisation) |
| | *Knowledge acquisition* | | | Tacit (internalisation) | | |
| *Opportunities* | *Knowledge capture* | Ad-hoc documenting | Troubleshooting problems and solutions are saved into a database | A knowledge group takes responsibility for knowledge and records according one protocol (set up by principals and management) | Every individual is responsible for updating his knowledge | Protocols for structural knowledge capturing |
| | | No clear structure where to save documents | Lessons learned from project evaluations are saved after finishing projects | Working papers are written for others | Working papers are structurally generated | Roles and responsibilities are clear within knowledge groups |
| | | A couple of people take time to save lessons learned into a database | Allocate facilities and time to codify knowledge | The engineers are able to easily work with IT means | Review groups assess useability of knowledge publications | |
| | | Knowledge is rarely refreshed or searched | yellow pages are present | Lessons learned are saved for use by others | | |
| | | | Principal engineers act as reviewers | | | |

| *Knowledge phase* | *Maturity stage* | *Current situation (level 1: initial)* | *(level 2: repeatable)* | *(level 3: defined)* | *(level 4: managed)* | *Desired situation (level 5: optimised)* |
|---|---|---|---|---|---|---|
| | *Knowledge sharing* | Knowledge is little used | Reuse of project evaluations on demand | Little distillation (push, creating awareness) | Intermediaries take part in systematically making knowledge available | Frequent presentations on working papers and technologies are given |
| | | Lacking facilities to share | Yellow pages are updated frequently | Standard protocols for sharing and retrieving knowledge are set up | Disseminating knowledge through IT by one individual | IT is maximally furnished for the needs of the KHC |
| | *Knowledge acquisition* | People only use knowledge for personal purposes | Knowledge is accessible but hard to find | Finding knowledge is through one central protocol | Just in time knowledge is present and easily accessible | People frequently discuss problems with experts |
| | | Little or no education | Researching knowledge gaps, increase education | Align education and knowledge gaps in a knowledge matrix | Knowledge sharing occurs through set meetings between groups | Frequent education based on knowledge matrix (which is structurally updated according the company strategy) |
| | | | | Troubleshooting databases are used to solve problems | | |
| *(de)Motivations* | *Knowledge capture* | Little trust | Obliged project evaluations | Capturing knowledge is motivated by peers | Moral motivation to capture by pressure of community | High amount of trust |

| *Knowledge phase* | *Maturity stage* | *Current situation (level 1: initial)* | *(level 2: repeatable)* | *(level 3: defined)* | *(level 4: managed)* | *Desired situation (level 5: optimised)* |
|---|---|---|---|---|---|---|
| | | Little priority to capture knowledge | Allocate time to codify knowledge | | | Knowledge is constantly updated |
| | *Knowledge sharing* | Difficulties to locate expertise and information | Sharing knowledge happens because of management motivation | The targets of the management are recognisable for people outside the management | Knowledge becomes easier to access | Knowledge is broadly available and it is easy to locate |
| | | Facilities are hard to use | | Searching for knowledge is encouraged by the management | Review groups structurally motivate peers to publish documents | A shared lingo and guidelines lead to effective knowledge sharing |
| | *Knowledge acquisition* | People acknowledge the importance of knowledge, but cannot find time to do it | Education happens because of management motivation | (knowledge)Groups are set up top-down | Personal incentive as a result of increased efficiency and efficacy of working routine | Moral motivation by pressure of community |
| | | | | | Knowledge officer present to support functional management | Experts are assigned on basis of publications, experience, and sharing behaviour |