

How Does ICT Support Knowledge Sharing?

Case-study of Knowledge Sharing and the Role of ICT in a Government Agency

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## Abstract

Although in modern societies knowledge is considered to be important for organizational development and ICT is assumed to support knowledge sharing, in practice organizations often encounter problems regarding knowledge sharing. In a number of studies it has been pointed out theoretically what role ICT potentially *could* play in processes of knowledge sharing. In a case-study we examined the role of ICT in processes of knowledge sharing in a team concerned with the project 'Mapping Safety in the Netherlands'. From diaries of and interviews with project teammembers we inferred processes of knowledge sharing, types of knowledge sharing and use of ICT and other communication channels. The results show that many processes of knowledge sharing occur between and within knowledge levels.

Knowledge is donated as well as acquired and exchanged. ICT is not often used in processes of knowledge sharing. Face-to-face contact seems to be the most important communication channel for sharing knowledge. ICT is complementary to face-to-face contact.

## How Does ICT Support Knowledge Sharing?

### Case-study of Knowledge Sharing and the Role of ICT in a Government Agency

This study examines processes of knowledge sharing and the role of information and communication technology (ICT) in a governmental agency. The increased use of ICT in various contexts is assumed to have an impact on society. Empirical studies show that internet has accentuated a change towards a networked society that had already been underway (Wellman & Haythornthwaite, 2002). De Haan & Huysmans (2002) argue that ICT may be regarded as a catalyst in a process of cultural change. At the same time, the technological development of ICT is influenced by society itself as individuals and groups use ICT in non-prescribed manners (e.g., Orlikowski, 2000; Verbeek, 2000). This mutual shaping of ICT and society is the focus of the research program 'ICT and Society' of the Netherlands Organization for Scientific Research (NWO, 2000). One of the foci in this program, in which the authors participate, is organizational use of ICT. Organizations are increasingly implementing ICT, which leads to an increased use among organizational members (e.g., Rice & Gattiker, 2001). A main reason for ICT implementation in organizations is knowledge sharing. In modern economies knowledge is considered to be a factor of outstanding strategic importance for organizational development and the assumption is that ICT is supportive of processes of knowledge sharing (e.g., Huysman & De Wit, 2000; Malhotra, 1996; Nonaka & Takeuchi, 1995; Senge, 1992).

Processes of knowledge sharing are influenced by the presence and use of ICT in organizations, and vice versa. Little is known, however, about the mutual shaping of both knowledge sharing and ICT. The emergent perspective on ICT and knowledge-sharing suggests that stimulation of processes of knowledge-sharing through ICT use is a result of complex social interactions between the institutional framework and the actions of individuals (e.g., Büchel, 2001). In a number of studies it has been pointed out what role ICT potentially *could* have in processes of knowledge sharing (Büchel, 2001; Huysman & De Wit, 2000). Nevertheless only a few empirical studies on this subject have been conducted (Huysman & De Wit, 2000). So, in the present study we explore empirically processes of knowledge sharing and the role of ICT in a governmental agency.

We begin with a section on the central concepts in this study. In the next section the methods used in this study will be discussed in more detail. Subsequently, the results of the case-study will be presented. In this study we distinguish three main elements, which are related to each other, namely processes of knowledge sharing, types of knowledge sharing and

the use of ICT and other communication channels. These elements will be discussed in separate sections. In the first section we elaborate on processes of knowledge sharing present in this case. In the following section types of knowledge sharing will be discussed and related to processes of knowledge sharing. In the latter section we deal with ICT-use and the use of other communication channels and relate this to processes of knowledge sharing and types of knowledge sharing. In the final section the findings of this case will be discussed and reflected upon.

### Central concepts

In this paper we employ Davenport & Prusak's (1998) definition of knowledge. They defined knowledge as:

a fluid mix of framed experience, 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 mind of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices and norms. (Davenport & Prusak, 1998, p. 5)

On the basis of Nonaka & Takeuchi (1995) we add to this definition that knowledge is essentially related to human action. From the definition of Davenport & Prusak (1998) it appears that knowledge is personal. However Berger & Luckmann (1966) argue that people interacting in a certain historical and social context share information from which they construct social knowledge as a reality, which in turn influences their judgement, behaviour, and attitude. In this way persons can have (partially) the same frameworks of knowledge and interpret new experiences and information in roughly the same way. Consequently, we assume knowledge can be collectively shared at several levels of knowledge in an organization as well.

The basic tenet of our theoretical notions of knowledge sharing resides in the idea that knowledge in organizations manifests itself at the individual, group and organizational level (e.g., Berger & Luckmann, 1966; Huysman & De Wit, 2000). Between these levels specific processes of knowledge sharing are apparent. As a result of processes of knowledge sharing, knowledge becomes increasingly common and collective within groups and within the entire organization. The ideal of knowledge sharing is that individual knowledge will become group knowledge and organizational knowledge over time. These processes can be defined as the externalization of knowledge. The other way around, processes in which organizational

knowledge becomes group and individual knowledge, can be seen as the internalization of knowledge.

ICT and other communication channels could have three functionalities which are assumed to lead to knowledge sharing (e.g., Choo, Detlor & Turnbull, 2000). These functionalities are communication, information storage and retrieval, and collaboration (Choo et al.). Communication takes place when conversations and negotiations occur. Information storage and retrieval occurs when communication channels serve as an organizational memory which allows for storage of knowledge for future purposes. Finally collaboration occurs when communication channels support the awareness of others in the organization and their availability for cooperative action (Choo et al.).

ICT enables an integration of these three functionalities. When the three functionalities are facilitated collectively by means of ICT, a shared information work space is realized. We expect that a shared information work space supports the integration of communication, and accumulation of knowledge.

## Methods

### *Research Design*

As only a few studies on this subject have been conducted, we employed a case-study approach (Wester & Peters, 2004) in order to illustrate processes of knowledge sharing and the role of ICT in these processes. Since knowledge sharing in organizations concerns 'everything' in organizations, it is difficult to examine knowledge sharing in general. Therefore, in this study we examined knowledge sharing of teams concerned with a particular 'event'. An 'event' is an important activity or occasion in the organization in which a considerable part of the management and employees is involved. Furthermore the event should be part of the primary processes, and everyday knowledge of the event is shared within and between several knowledge levels.

In this case, an event occurring in a specific organization, observations were made of elements of the organization and other units related to the case in order to explore aspects of knowledge sharing on the basis of theoretical insights and to obtain insights in the social processes between persons within the case (e.g. Wester & Peters, 2004). The analysis was focussed on describing processes and relations within this case. In the continuation of this project other cases will be described and generalizations will be made through comparisons between the cases. Accordingly the design of the entire project can be considered as a comparative case-study approach.

The event in this study is the project: 'Mapping Safety in the Netherlands (MSN)'. This project is carried out by a project team and is aimed at mapping the flood risks of dikes in the Netherlands. The team's task is to develop a new methodology in order to estimate flood risks. To calculate the flood risks the project team obtains data about dikes from a water board. Engineer agencies execute calculations with these data. The results of these calculations enable the project team to determine flood risks. The project team reports to its superiors at the Ministry. The most important methods were diaries and interviews.

In the exploratory phase of this study we distinguished four levels of knowledge, the individual, subgroup, group and organizational level. The individual level is represented by individual members of the project team, the subgroup level by working units within the project team and the group level by the project team as a whole. The group level outside the organization is represented by water boards and engineer agencies. The organizational level is represented by the Ministry of Transport, Public Works and Water Management including the project team and several groups involved in the project. In this study we concentrated on the processes of knowledge sharing between these levels and within the individual and subgroup level.

### *Instruments*

#### *Diaries*

Participants were asked to fill in a diary to obtain insight into processes of knowledge sharing and the role of ICT. In these diaries we focussed on the communication acts concerning main activities of project teammembers. In this way we were able to obtain insight into the daily routines with regard to the three main elements: processes of knowledge sharing, types of knowledge sharing, and the use of ICT and other communication channels. The items and categories of the diaries were based on the information from the exploratory phase of this study. The diary consisted of four dissimilar lists: an email list, telephone list, meeting list and a list for remaining activities. In these lists members filled in the topic of the communication act, the main activity and persons involved in the communication act. In the list for remaining activities members registered other channels used for communication too. All twelve members of the project team were asked to register their communication acts in on two representative workdays in a period of two weeks in October 2004.

#### *Follow-up interviews and observations*

For additional information and clarification we carried out follow-up interviews with four members of the project team in the role both of informant and participant. In these interviews

we elaborated on the three elements of processes of knowledge sharing. Since the registered topic in the diaries was not clear to us, in some cases we were not able to determine these elements. In these cases we asked for clarification and asked for the chains of activities the communication act is part of. Moreover, in the interviews we derived functionalities of ICT and other communication channels by asking the reasons and aims of using a particular communication channel and by asking the ways in which a communication channel is used. Some functionalities of meetings emerged by observations. Moreover, we took a closer look at the communication context of the registered communication channels.

## *Analysis*

### *Diaries*

The activities registered in the diaries were ordered per main activity per person in a text-file. Accordingly, processes of knowledge sharing and types of knowledge sharing were mainly inferred by combining the topic of the communication act with the persons involved in the communication act registered in the diaries. Use of ICT and other communication channels was mainly inferred by combining the use of communication channels with the persons involved in the communication act registered in the diaries. Functionalities of communication channels for knowledge sharing were also inferred mainly in this way. From this analysis profiles per person of communication acts per main activity and even some chains of communication acts were drawn. However some communication acts per person remained unclear. In the additional interviews (and observations) we elaborated on this.

### *Follow-up interviews and observations*

The interviews were recorded and transcribed in text-files. From these transcriptions we derived additional information about the three elements of processes of knowledge sharing, types of knowledge sharing and use and functionalities of ICT and other communication channels per main activity. In this way we found additional communication acts.

Accordingly the communication acts of all persons involved in this study from the diaries and as well from the follow-up interviews were ordered per type of knowledge sharing in an excel-file. This accumulated into an overall picture of the case on various processes of knowledge sharing and the role of ICT. From these files tables of processes of knowledge sharing per direction of knowledge sharing were made (see supplement). In these tables we show per process which types of knowledge sharing occur, and which channels and functionalities are used.

## Processes of Knowledge Sharing

The results show that many processes of knowledge sharing between and within levels of knowledge occur. For instance a member tells in a meeting in a subgroup of the MSN-group about his experiences with gathering data from water boards or a member sends an e-mail to a person of the Ministry with information about the progression of the project. Table 1 presents schematically all processes of knowledge sharing between and within levels of knowledge in this case-study.

Table 1

### *Observed Processes of Knowledge Sharing*

Knowledge levels	TO	Ind MSN	Subgr MSN	Group MSN	Org	Group water board	Group engineer agency
FROM							
Ind MSN		X	X	X			
Subgr MSN		X	X	X			
Group MSN		X	X	N/A	X	X	X
Org		X		X	N/A		
Group catchment area				X		X	
Group engineer agency				X			

In general Table 1 shows that in this study knowledge is diffused from lower to higher levels and from higher to lower levels of knowledge by processes of knowledge sharing in the organization. Moreover, processes of knowledge sharing occur also within the individual and subgroup level as well as between the MSN-group and the external groups. Accordingly processes of knowledge sharing take place in four directions, respectively externalization, internalization, within knowledge levels and between the MSN-group and external groups.

When we have a look at Table 1 in more detail, it appears that processes of knowledge sharing from the individual level and from the subgroup level to the organizational level (externalization) do not occur and processes from the organizational level to the subgroup level (internalization) do not occur either. A possible explanation for this could be that it is important for teammembers that the group as a whole is involved in processes with the

organizational level. Moreover, it appears that processes of knowledge sharing with externals only take place with the level of the MSN-group.

Interviews showed that processes within the individual level and from the individual to the subgroup level occur more frequently than other processes. It seems that knowledge sharing within subgroups is emphasized. Furthermore, the interviews show that processes of knowledge sharing from the organizational to the individual level hardly ever take place. To a lesser extent, this is the same for processes from the group to the individual level.

In summary, in this section we have shown that many processes of knowledge sharing occur in four directions, especially within subgroups. Only a few processes do not occur. However, it became not clear in which forms these processes of knowledge sharing occur. In the next section we will examine this in more detail.

### Types of Knowledge Sharing

While examining the communication acts registered in the diaries, we found that 17 types of knowledge sharing with different intentions could be distinguished. In Table 2 these types of knowledge sharing are presented and explained. All of these 17 types of knowledge sharing appeared to be aimed at a) donating, b) acquiring, or c) exchanging knowledge and therefore could be divided into three categories. The categories a and b are related to each other. For instance, as a MSN-member sends an e-mail to another member, this e-mail is registered as spreading information and receiving information. Category c can be seen as a chain of interaction between donating and acquiring knowledge. Characteristic for category a) donating knowledge and b) acquiring knowledge is that no interaction takes place and the initiative for knowledge sharing comes from one side. Category c, exchange of knowledge, is characterized by persons reacting to each other in interaction. Besides, the input comes from several persons. In Table 2 the types of knowledge are presented and classified per category.

Table 2

#### *Observed Types of Knowledge Sharing (per Category)*

Type of knowledge sharing	Explanation and illustration
Making information available	E: Making information accessible in such a way that others can look up and consult this information (pull) I: MSN-member makes a memo available for the MSN-group by shared drive.
Spreading information	E: Sending information to others (push) I: MSN-member spreads a memo about the evaluation of engineer agencies to the MSN-group by e-mail.
Giving advise	E: Giving advise to others about how they could act.

	I: MSN-member advises another member which position he must take towards engineer agencies in negotiations in face-to-face conversations.	Donating knowledge
Giving an answer	E: Giving a reaction on a question. I: MSN-member answers a question from an engineer agency about calculation methods by ways of giving information.	
Making mention of things	E: Reporting about activities to persons/parties not involved in these activities. I: MSN-member sends a document by e-mail to its superiors at the Ministry about the progression of the MSN-project	Acquiring knowledge
Writing down information and appointments, taking minutes	E: Writing down thoughts of people, discussed matters, and/or, appointments. I: MSN-member writes actionlist as a result of a meeting	
Inquiring information	E: Active search for information (pull). I: MSN-member consults document on shared drive.	
Acquiring information	E: Information you get offered (push). I: MSN-member receives magazine for personnel of the Ministry	
Acquiring mentions	E: Receiving reports about activities of people directly involved in those activities. I: A subgroup receives mentions about the gained experiences of a MSN-member with regard to the process and continuation of the calculations of an engineer agency in an internal meeting.	
Acquiring advise	E: Taking advise of others about how to act. I: MSN-member receives advise from the subgroup about the solution of a problem..	
Receiving an answer	E: Receiving a reaction on a question. I: MSN-member receives data about dikerings of a catchment area.	
Asking a question	E: Addressing yourself to someone with the intention to be informed by him. I: MSN-member asks a catchment ares for additional data about a dikering.	
Receiving a question	E: Receiving a 'sign' of someone who wants to be informed by you. I:MSN-member receives a question about a calculation method of an engineer agency by e-mail.	
Exchanging information	E: Several persons furnishing input to a conversation and reacting to each other in interaction. I: MSN-members exchange information in a meeting about their expertises with regard to calculationmethods.	
Fine tuning	E: Persons have attention for each others activities and organize these activities to each other. I: MSN-members are fine tuning their approaches towards engineer agencies.	
Brainstorm	E: members of a group come up spontaneously with ideas and react on each other. I: MSN-members are brainstorming about the ways the final report can gets shape.	
Evaluation/reflection	E: In interaction in a group, reconsidering and discussing the things that had happened, judging this and taking the consequences. I: MSN-members are discussing their experiences with calculations carried out by engineer agencies up till now in a meeting.	

The results show that three categories of types of knowledge sharing could be distinguished. It appeared that the type of knowledge 'Writing down information and appointments, taking minutes' does not occur in processes of knowledge sharing. In general, the three categories of knowledge sharing play a role in many processes of knowledge sharing in all of the four

directions (externalization, internalization, within levels of knowledge and between the MSN-group and externals). Types of knowledge sharing in category a and b appeared to take place just as much in the four directions. However, types of knowledge sharing in category c, exchanging knowledge, appeared to occur more often in processes of externalization and within levels of knowledge than in processes of internalization and between the MSN-group and externals. Table 3 presents a summary of the findings with regard to the categories of knowledge sharing related to processes of knowledge sharing in general. A ‘+’ means that a category occurs much in a particular directions. A ‘+/-’ means that a category occurs less often in a particular direction. In the supplement those results are presented in detail.

Table 3

*Categories of Knowledge Sharing related to Processes of Knowledge Sharing per Direction.*

Directions	Categories		
	Donating knowledge	Acquiring knowledge	Exchanging knowledge
Externalization	+	+	+
Internalization	+	+	+/-
Within levels of knowledge	+	+	+
Between the MSN-group and external groups	+	+	+/-

There are some exceptions (see supplement) to the general picture, explained above. We have not found types of knowledge sharing of category c occurring in processes from the individual to the group level (externalization). A possible explanation for this could be that in this project members are working in subgroups and not in a group as a whole. Besides, we found many types of knowledge sharing of category c in processes from the organizational to the group level (internalization). Perhaps this could be because these processes take place in a context where it is important to fine tune the organizational and group interests for an optimal functioning of the project group.

From this section we can conclude that 17 types of knowledge sharing divided in three categories take place. Category a and b occur just as much in all directions. Category c takes place more in externalization and within levels of knowledge than in internalization and between the MSN-group and externals. In the next section we will discuss the use of ICT and other communication channels related to processes of knowledge sharing and types of knowledge sharing.

### Use of ICT and Other Communication Channels

The results showed that when we have a look at the use of communication channels in general, face-to-face contact plays an important role in most of the processes of knowledge sharing. Besides, e-mail is used to support face-to-face contact. Written documents and to a lesser extent telephone have been used scarcely. Furthermore, in a few processes of knowledge sharing (from the individual to the group level and vice versa) only ICT has been used, namely e-mail, the shared drive, the electronic diary, and the shared e-mailarchive.

When we have a look at the differences in use of communication channels between the four directions it turns out that face-to-face contact has a less prominent role in processes between the MSN-group and externals and to a lesser extent internalization. ICT and the telephone are more important channels in these processes in comparison with the processes in the other directions. So there are only a few main differences between the several directions. Table 4 presents a summary of the findings with regard to the used channels of communication related to processes of knowledge sharing per direction in general. A ‘+++’ means that a channels is often used, a ‘+/-’ means that a category is less often used and a ‘--’ means that a channels is used scarcely in a particular direction. In the supplement these results are presented in detail.

Table 4

*Used Channels of Communication related to Processes of Knowledge Sharing per Direction.*

Directions	Channels			
	Face-to-face	Telephone	Written	ICT
Externalization	+++	-	--	+/-
Internalization	++	-	--	+/-
Within levels	+++	--	-	+/-
Between MSN-group and externals	++	+	-	+

When we have a look at the use of communication channels per category, it appears that types of knowledge sharing in category a and b, donating knowledge and acquiring knowledge, occur by all of the four communication channels. This is remarkable, since literature (e.g. Trevino, Daft & Lengel, 1990) shows that face-to-face is not the most suitable channel for donating and acquiring knowledge. Types of knowledge sharing in category c, exchanging knowledge, occur mainly through face-to-face contact and to a lesser extent by the telephone.

In a few cases, the exchange of knowledge takes place by e-mail. When we have a look at the differences between the four directions it turns out that more types of knowledge sharing in category c, exchange of knowledge, are shared through face-to-face contact in externalization and to a lesser extent within groups. Besides, e-mail and telephone is used more for category c, exchange of knowledge, in processes of knowledge sharing where there is a physical distance between persons (for instance between members of the MSN-group and externals and between members of the organization and MSN-group). Table 5 presents a summary of the findings with regard to the categories of knowledge sharing related to processes of knowledge sharing per direction in general. A ‘++’ means that a channels is often used, a ‘+/-’ means that a category is less often used and a ‘--’ means that a channels is used scarcely for a particular category. In the supplement those results are presented in detail.

Table 5

*Used Channels of Communication related to Categories of Knowledge Sharing*

Categories	Channels			
	Face-to-face	Telephone	Written	ICT
Donating knowledge	+	-	-	+
Acquiring knowledge	+	-	-	+
Exchanging knowledge	++	+/-	--	-

When we examined for which functionalities of knowledge sharing communication channels are used in this study, it turned out that mainly the functionalities of communication and to a lesser extent collaboration occur. The functionality information storage and retrieval appears to takes place scarcely. A possible explanation for this could be that project teammembers feel no need to store information for others. Inasmuch as the group is small, they are well informed and can ask each other in face-to-face contact. We found that the functionality of communication mainly occurs through face-to-face contact. When there is a physical distance between persons, the telephone is used for communication too. Persons interact in face-to-face contact and the telephone. E-mail and written documents are also used for communication. However, in this study persons hardly ever interact through e-mail and written documents, but instead they donate or acquire information. The functionality of information storage and retrieval takes place by shared drive. However, information on the shared drive is often difficult to find. Collaboration occurs mainly through face-to-face

contact. Furthermore, collaboration is supported by e-mail, electronic diaries, shared e-mailarchive, the virtual space and written documents. Table 6 presents a summary of the findings with regard to the functionalities of knowledge sharing related to the use of communication channels in general. A ‘++’ means that a channels is often used, a ‘+/-’ means that a category is less often used and a ‘--’ means that a channels is used scarcely for a particular functionality. In the supplement these results are presented in detail.

Table 6

*Functionalities of Knowledge Sharing related to Use of Communication Channels*

Functionalities	Channels			
	Face-to-face	Telephone	Written	ICT
Communication	++	+	-	+/-
Information storage and retrieval	--	--	--	+/-
Collaboration	++	--	-	+/-

It appeared from the interviews that the functionalities of ICT-applications are not integrated in use. So ICT does not offer a shared information work space in this case-study.

In summary, we can conclude from this section that ICT does not contribute that much to processes of knowledge sharing in all directions. Face-to-face contact has a prominent role and ICT is complementary to face-to-face contact. Donating and acquiring knowledge occur mostly by ways of face-to-face contact and ICT. The exchange of knowledge occurs for the most part by face-to-face contact. This face-to-face contact and ICT contact is mainly used for the functionalities of communication and to a lesser extent of collaboration. The functionalities of ICT-applications are not used in an integrated manner.

*Discussion*

In this paper we examined processes of knowledge sharing and the role of ICT in the project team ‘Mapping Safety in the Netherlands’ (MSN) in a governmental agency. We found that many processes of knowledge sharing occur in four directions, namely externalization, internalization, within groups and between the MSN-group and externals. Only a few processes do not take place.

These processes of knowledge sharing occur by ways of 16 types of knowledge sharing, which can be divided in three categories: donating knowledge, acquiring knowledge and exchanging knowledge. Donating and acquiring knowledge take place just as much in all

directions. Exchanging knowledge occurs more in externalization and within levels of knowledge than in internalization and between the MSN-group and externals.

The processes of knowledge sharing, mentioned above, take mainly place by face-to-face contact in all directions, especially in externalization and within levels. ICT does not have a prominent role and supports face-to-face contact. In face-to-face contact types of knowledge sharing of all of the three categories occur for the functionalities of communication and collaboration. Through ICT mainly types of knowledge of the categories donating and acquiring knowledge occur for the functionalities of communication, collaboration and information storage and retrieval. Between the MSN-group and externals, ICT and telephone contacts have a more important role in comparison with the other directions.

Some additional remarks about the results of this case-study are to be made. In this study we were concerned with the main parties involved in the project. More parties are, however, involved in the project, for example, individuals or departments within the organization or external experts. The organizational level, the group level of water boards and the group level of engineer agencies in this study consist of several parties. For order and clarity these parties are taken together in one level in this paper. However, there are some differences with regard to knowledge sharing between these parties.

From the results of this study we obtained insights into processes of knowledge sharing and the role of ICT in organizations. In spite of this, a number of issues emerged which need further attention in the continuation of this project in order to obtain a more complete picture of processes of knowledge sharing, in the field of conceptualization as well as in the field of empirical evidence. Some of these issues with regard to knowledge sharing and ICT are:

- what differences there are between knowledge sharing and information sharing. In this study we examined communication acts. From the results, it seems that information can be considered as a message and information sharing occurs when messages are exchanged. Knowledge could be considered as interpreted information and therefore knowledge sharing occurs at a more abstract level.
- in what ways persons deal with knowledge sharing in problematic situations such as developing a new methodology and non-problematic situations such as acquiring from water boards data with regard to dikes. From the results it appeared that in the former persons are involved in processes of knowledge sharing in which they are conscious of their knowledge sharing practices and have no everyday routine yet. In these processes

new knowledge is created and the frameworks of knowledge of persons may change. We believe in these cases conversions of knowledge may take place (e.g. Nonaka & Takeuchi, 1995).

- whether persons in processes of knowledge sharing are concerned with the content of knowledge or with the location where to find knowledge (meta-knowledge). The results show that besides the content of knowledge, for instance the results with regard to dikes, metaknowledge, such as where to find those results, is also important in processes of knowledge sharing.
- which relations there are between types of knowledge sharing. The results gave insights in which types of knowledge sharing occur, but not in which types of knowledge sharing could be related to each other and to what extent chains of knowledge sharing occur.

In the continuation of this project we will investigate these aspects in more detail in new cases and compare the results of those cases with this case.

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Supplement

Table 7  
Processes of knowledge sharing at externalization

Process of knowledge sharing	Type of knowledge	Channel	Functionality
	1° category: Donating knowledge	2° category: Acquiring knowledge	3° category: Exchanging knowledge
Ind lev. MSN -> subgr lev. MSN	Spreading information, make mention of things, giving advise	Receiving information, acquire mentions, acquire advise, receiving a question, asking a question	Exchanging information, fine tuning, brainstorm, evaluation/reflection
	<i>Spreading information, giving advise</i>	<i>Receiving information, acquiring advise, receiving a question, asking a question</i>	<i>E-mail</i>
Subgr lev. MSN -> group lev. MSN	Spreading information, make mention of things <i>Spreading information</i> <i>Making information available</i>	Receiving information, acquire mentions <i>Receiving information</i>	Fine tuning
			<i>E-mail</i>
			<i>Shared drive</i>
			<i>Storage and retrieval</i>
Group lev. MSN -> org lev.	Spreading information, make mention of things	Receiving information, acquire mentions, acquire advise, receiving a question, asking questions	Exchanging information, fine tuning, brainstorm, evaluation/reflection
	Spreading information, giving advise, make mention of things	Receiving information, acquire mentions, receiving a question, asking a question	Exchanging information, fine tuning, brainstorm, evaluation/reflection
	<i>Spreading information, make mention of things</i>	<i>Receiving information, acquire mentions, receiving a question, asking a question</i>	<i>Exchanging information, fine tuning</i>
Ind lev. MSN -> group lev. MSN	<i>Spreading information, make mention of things</i> <i>Writing down information and appointments, taking minutes</i> <i>Making information available</i> <i>Making information available</i>	<i>Receiving information, acquire mentions</i>	<i>E-mail</i>
			<i>Elec diary</i>
			<i>Shared e-mailarchive</i>
			<i>Shared drive</i>
			<i>Storage and retrieval</i>

Table 8

*Processes of knowledge sharing at externalization*

Process of knowledge sharing	Type of knowledge			Channel	Functionality
	1 <sup>e</sup> category: Donating knowledge	2 <sup>e</sup> category: Acquiring knowledge	3 <sup>e</sup> category: Exchanging knowledge		
Org lev. -> group lev. MSN	Spreading information, answering a question, giving advise	Receiving information, receiving an answer, giving advise	Exchanging information, fine tuning, brainstorm, evaluation/reflection	Face-to-face	Communication/collaboration
	Spreading information, answering a question, giving advise	Acquiring information, receiving an answers, acquiring advise	Exchanging information, fine tuning, brainstorm, evaluation/reflection	Telephone	Communication
	<i>Spreading information answering questions</i>	<i>Receiving information, receiving an answer</i>	<i>Exchanging information, fine tuning, evaluation/reflection</i>	<i>E-mail</i>	<i>Communication</i>
Group lev. MSN -> subgr lev. MSN	Spreading information, make mention of things	Acquiring information, receiving mentions	Fine tuning	Face-to-face	Communication/collaboration
Subgr lev. MSN -> ind lev. MSN	Spreading information, giving advise, answering a question	Acquiring information, receiving answers acquire advise	Exchanging information	Face-to-face	Communication/collaboration
	<i>Spreading information</i>	<i>Acquiring information</i>		<i>E-mail</i>	<i>Communication</i>
Group lev. MSN -> ind lev. MSN	<i>Spreading information, make mention of things</i>	<i>Acquiring information, receiving mentions</i>		<i>E-mail</i>	<i>Communication</i>
		<i>Inquiring information</i>		<i>Elec. diary</i>	<i>Collaboration</i>
		<i>Inquiring information</i>		<i>Shared e-mailarchive</i>	<i>Collaboration</i>
		<i>Inquiring information</i>		<i>Shared drive</i>	<i>Storage and retrieval</i>
	<i>Spreading information</i>	<i>Acquiring information</i>		<i>E-mail</i>	<i>Communication</i>
Org lev. -> ind lev. MSN	Spreading information	Acquiring information	Exchanging information	Face-to-face	Communication
	<i>Spreading information</i>	<i>Acquiring information</i>		<i>E-mail</i>	<i>Communication</i>
	Spreading information	Acquiring information		Written	Communication

Table 9

*Processes of knowledge sharing within levels of knowledge*

Process of knowledge sharing	Type of knowledge			Channel	Functionality
	1 <sup>e</sup> category: Donating knowledge	2 <sup>e</sup> category: Acquiring knowledge	3 <sup>e</sup> category: Exchanging knowledge		

Ind lev. MSN -> ind lev. MSN	Spreading information, make mention of things, giving advise, answering a question	Acquire information, inquire information, acquire advise, receiving an answer, acquiring mentions receiving a question, asking a question	Exchanging information, fine tuning, brainstorm, evaluation/ reflection	Face-to-face	Communication/ collaboration
	Spreading information <i>Spreading information, giving advise, answering a question</i>	Acquire information <i>Acquire information, acquiring advise, receiving an answer</i>		Written <i>E-mail</i>	Communication/ collaboration <i>Communication</i>
Subgr lev. MSN -> subgr lev. MSN			Fine tuning	Face-to-face	Communication/ collaboration

Table 10

*Processes of knowledge sharing between the MSN-group and externals*

Process of knowledge sharing	Type of knowledge			Channel	Functionality
	1° category: Donating knowledge	2° category: Acquiring knowledge	3° category: Exchanging knowledge		
Group lev. MSN -> group lev. Water board	Spreading information, make mention of things, answering a question	Acquiring information, acquiring a mention, receiving an answer, receiving a question, asking a question	Fine tuning, brainstorm, evaluation/reflection	Face-to-face	Communication/ collaboration
	Answering a question	Receiving an answer, receiving a question, asking a question		Telephone	Communication
	<i>Spreading information</i>	<i>Acquiring information, receiving a question, asking a question</i>	<i>Fine tuning</i>	<i>E-mail</i>	<i>Communication</i>
Group lev. MSN -> group lev. Engineer agency	Spreading information, make mention of things, answering a question	Acquiring information, acquiring a mention, receiving an answer	Exchanging information, fine tuning, brainstorm, evaluation/reflection	Face-to-face	Communication/ collaboration
	Answering a question	Receiving an answer, receiving a question, asking a question	Fine tuning	Telephone	Communication
	Spreading information	Acquiring information		Written	Communication/ collaboration
	<i>Spreading information, answering a question</i> <i>Making information available</i>	<i>Acquiring information, receiving an answer</i> <i>Inquire information</i>		<i>E-mail</i>	<i>Communication</i>
Group lev. Water board -> group lev. MSN			Fine tuning, brainstorm, evaluation/reflection	Face-to-face	Communication/ collaboration?
	Answering a question	Receiving an answer, receiving a question, asking a question		Telephone	Communication

	Spreading information	Acquiring information		Written	Communication/ collaboration
	<i>Answering a question, spreading information?</i>	<i>Receiving an answer, acquiring information</i>	<i>Fine tuning</i>	<i>E-mail</i>	<i>Communication</i>
Group lev. engineer agency -> group lev. MSN	Spreading information, make mention of things	Acquire information, acquiring a mention, asking a question, receiving a question	Fine tuning, brainstorm, evaluation/reflection	Face-to-face	Communication/ collaboration
	Answering a question, make mention of things	Receiving an answer, acquiring a mention, receiving a question, asking a question	Fine tuning	Telephone	Communication/ collaboration
	<i>Spreading information</i>	<i>Acquire information, receiving a question, asking a question</i>		<i>E-mail</i>	<i>Communication</i>
	<i>Making information available</i>	<i>Inquire knowledge</i>		<i>Virtual space</i>	<i>Collaboration</i>