Knowledge Sharing in Knowledge Communities

Bart van den Hooff[1], Wim Elving[1], Jan Michiel Meeuwsen[2] & Claudette Dumoulin[1]

[1]University of Amsterdam, Amsterdam School of Communications Research, The Netherlands

[2] TNO Work & Employment, The Netherlands

vandenhooff@pscw.uva.nl, elving@pscw.uva.nl, J.Meeuwsen@arbeid.tno.nl, cmdumoulin@hotmail.com

Abstract. This paper investigates the contribution of ICT to knowledge sharing in communities of practice. A theoretical model is built that identifies the possible influence of ICT on the extent to which knowledge is shared within a community, as well as a number of variables that determine the extent to which this contribution is realized. This theoretical model was tested within two ICT-facilitated communities for professionals in the area of working conditions. The results of these case studies show that ICT's most important contribution to knowledge sharing in communities consists of the realization of a shared information base (communality) and facilitating communication independent of time and place (connectivity). The results also show that trust among members of a community, and their identification with the community, are important influences on knowledge sharing. Task interdependence and the community's information culture are also identified as important influences.

Introduction

In theory and research concerning knowledge management and knowledge sharing, increasing attention is being paid to a 'community-based' approach (Scarbrough & Swan, 2001), in which shared practices among members of such a community are the basis for knowledge sharing, and not their formal organizational roles. As Brown & Duguid (2001) argue, shared practices are the basis for a "common know-how". This common know-how is a common frame of reference, which explains why knowledge can flow relatively easily among members of a community that is based on shared

practices. As Scarbrough and Swan (2001) put it: "(...) knowledge-sharing is facilitated by the norms of reciprocity, and the levels of trust generated among the community" (p. 12). Communities are especially identified as effective environments for the sharing of implicit knowledge (Brown & Duguid, 1991; 2001; Davenport & Prusak, 1998; Huysman & Van Baalen, 2001; Wenger, 1998).

In today's knowledge-intensive economy, such knowledge (both implicit and explicit) is becoming an increasingly important resource. The sharing of knowledge between individuals with similar or dissimilar practices, in and between organizations is considered to be a crucial process (O'Dell & Grayson, 1998; Osterloh & Frey, 2000). The role of technology, especially of information and communication technology (ICT) in supporting such processes is the subject of many debates (Roberts, 2000; Huysman & De Wit, 2002; Huysman & Van Baalen, 2001; Scarbrough & Swan, 2001; Zack, 1999). Communities are often defined in ICT terms – as "virtual communities" or "virtual teams". ICT is often seen as a valuable means in bridging gaps of space and time between members of such communities, who often originate from different organizations and different locations. On the other hand, the risk of automatically defining communities in such terms creates the risk of an 'ICT pitfall' (Huysman & De Wit, 2002; Weggeman, 2000): too strong a focus on the technology could lead to neglecting the organizational, social and psychological elements of communities and knowledge sharing. For an accurate view of what the added value of ICT can be for knowledge sharing in communities, it is important to consider the role of ICT together with other influences, such as identification and trust within communities (Roberts, 2000; Scarbrough & Swan, 2001).

In this paper, we focus on this contribution that ICT can make to knowledge sharing in communities. Knowing that the use and effects of ICT in such processes is itself part of a broader range of influences on knowledge sharing, the question that is central to this paper is:

What is the contribution of ICT to knowledge sharing within communities, and which factors determine the extent to which this contribution is realized?

In order to answer this question, we first discuss relevant theories concerning this subject, which lead to an integrated theoretical model of the contribution of ICT to knowledge sharing. This model was tested in two case studies, which were conducted within two knowledge communities for professionals in the area of working conditions. Based on these case studies, we present an empirical model in which the contribution of ICT to knowledge sharing within communities, and the factors determining this contribution, are summarized.

Theory: knowledge sharing and ICT

Factors affecting knowledge sharing

Knowledge sharing is the process where individuals mutually exchange their (implicit and explicit) knowledge and jointly create new knowledge. The extent to which this

process actually takes place is influenced by a number of factors, which Hinds & Pfeffer (2003) label *cognitive* and *motivational* limitations towards knowledge sharing. Cognitive limitations are related to the way that experts store and process information. As level of expertise increases, the level of abstraction in representing that expertise increases as well. In other words, it is often hard for experts to put their knowledge into words that are understandable to non-experts. They overestimate non-experts' information processing capability and basic knowledge level, and underestimate the time non-experts need to complete and understand certain tasks.

Where cognitive limitations are related to an individual's *ability* to share knowledge, motivational limitations are related to their *willingness* to share knowledge. Different incentives and disincentives for this willingness are distinguished by Hinds & Pfeffer, such as team level rewards, internal competition, status differences, degree of formalization and the individual's relationship to the organization.

With regard to this latter influence on people's willingness to share, Hinds & Pfeffer point towards trust as an important variable. The extent to which coworkers are trusted to reciprocate favors (i.e., provide their knowledge in return) and the organization is trusted not to use provided knowledge against an individual, determines this individual's willingness to actively share knowledge with others inside this organization. Orlikowski (1993) for instance, describes how in a very competitive environment, distrust in others inhibited the sharing of information. Pan and Scarbrough (1998) observe how a "climate of continuity and trust" is a crucial (and hard to realize) condition for knowledge sharing. Roberts (2000), in an investigation of how ICT contributes to knowledge sharing, points out the importance of trust – especially as a prerequisite for the transfer of implicit knowledge.

Another influence on the willingness to share identified by Hinds and Pfeffer is the extent to which individuals identify with the team or group of which they are a part. The stronger they identify with this group, the more they will be willing to share knowledge within this group. Stronger identification with the group may, however, also lead to a reduced willingness to share knowledge outside of the group. Social identification is an important condition for cooperation (Wiesenfeld, Raghuram & Garud, 1999), and may lead to a more collectivistic climate within a group, which in turn promotes cooperation (Wagner, 1995), leads to more effective knowledge processes (Gladstein, 1984), more communication in the group (Moorman & Blakely, 1995) and better group performance (Eby & Dobbins, 1997).

So, both the ability to share knowledge and the willingness to share knowledge are identified as important influences on knowledge sharing. Mutual trust and identification with the community are identified as important characteristics of community members influencing knowledge sharing. In conclusion, this discussion leads to the following hypotheses:

H1. An individual's ability to share knowledge positively influences the extent to which they actually share knowledge.

H2. An individual's willingness to share knowledge positively influences the extent to which they actually share knowledge.

H3. The extent to which an individual trusts the other members of a community positively influences their willingness to share knowledge within that community.

H4. The extent to which an individual identifies with the other members of a community positively influences their willingness to share knowledge within that community.

ICT and knowledge sharing

By sharing their knowledge, members of a community contribute to the shared intellectual capital of the community – which can be conceived as a "public" or "collective" good (Nahapiet & Ghoshal, 1998), since it possesses two key characteristics of such goods (Monge et al, 1998): (1) *Impossibility of exclusion*: members of the collective (i.e., the community) can not be excluded from using the good even if they do not contribute to it; and (2) *Jointness of supply*: one person's use of the good does not diminish the level of good for other users. The value of the shared intellectual capital is not influenced by the fact that other members of the community use it.

For such a public good to be realized, a sufficient number of members of a community must contribute to the shared intellectual capital (i.e., share their knowledge). According to Fulk et al (1996), ICT contributes to such collective action through the realization of two public goods:

1. *Communality*, the collective storing and sharing of information to which all members of the collective have access, and.
2. *Connectivity*, the ability to reach other members of the collective.

Connectivity is the ability for members of a social system to contact each other directly. Easy and frequent contact with other members of a community can be considered to be an important contribution of ICT to knowledge sharing: connectivity positively influences both the ability and the willingness of members of a community to share knowledge. Communality, on the other hand, exists where organizational members have access to a commonly held body of information. This is also expected to be positively related to knowledge sharing: the more the shared intellectual capital is accessible to members of a community, the more these will be willing to contribute their own knowledge to it. Since accessing the shared intellectual capital will also increase one's awareness of others' capabilities and interests, communality can also be expected to positively influence the ability to share knowledge. This leads to the following hypotheses:

H5. The use of ICT within a community leads to a shared information base (communality) within that community.

H6. The use of ICT within a community leads to more contact (connectivity) among members of that community.

H7. Communality positively influences both (a) the ability to share knowledge and (b) the willingness to share knowledge.

H8. Connectivity positively influences both (a) the ability to share knowledge and (b) the willingness to share knowledge.

With regard to the influence of ICT use on identification with the community, the lack of 'social cues' (such as tone of voice, facial expressions, gestures and the like) in communication via ICT is often expected to negatively influence the social richness of this communication (Short, Williams & Christie, 1976; Daft & Lengel, 1984; 1986; Trevino, Daft & Lengel, 1990). Thus, the lack of social cues could be expected to lead to less identification with those with whom communication takes place than in a face-to-face setting.

Empirical results, however, contradict this (Walther, 1992; Walther & Burgoon, 1992; Postmes, Spears & Lea, 1998). In a search to explain such results, Walther (1996) argues that computer-mediated communication can lead to *hyperpersonal* interactions – indeed, communication with a richer level of social relationships than found in face-to-face conditions. His conclusion is that specific characteristics of ICT (such as reduced social cues and asynchronous communication) can even lead to socially 'richer' communication, to stronger identification with the group and thus to more collective behavior.

A related perspective is the Social Identification model of Deindividuation Effects, also known as the SIDE model (Reicher, Spears & Postmes, 1995; Spears & Lea, 1992). SIDE proposes that social cues can facilitate the individuation of communication partners – in other words, forming impressions of them as idiosyncratic individuals. In computer-mediated conditions, where social cues are relatively scarce, *group* characteristics are likely to be attributed to individuals – i.e., their *social identity* is likely to become more salient than their individual identity. Thus, provided that the relevant social group and its attributes are known, the lack of social cues in ICT can "accentuate the unity of the group and cause persons to be perceived as group members rather than as idiosyncratic individuals" (Tanis & Postmes, in press: 8). So, SIDE theory argues the use of ICT positively influences identification with a community. Since the shared practice of a community is in itself a ground for identification (Brown & Duguid, 2001; Scarbrough & Swan, 2001) and forms a typical "common identity" with which members can identify (Postmes & Spears, 2000), we expect a positive contribution of ICT to identification with the community:

H9. The use of ICT within a community positively influences the identification of community members with that community.

The use of ICT in a community also has consequences for the degree of trust among the members of such a community. The 'traditional view' here is that communication that is mediated by ICT is insufficiently rich or social to establish real trust. Handy (1995) argues that without face-to-face interactions, trust cannot emerge. Nohria and Eccles (1992) consider face-to-face interactions to be crucial to both building and maintaining trust. As Roberts (2000) argues, trust is more complex than mere communication, and requires a common social and cultural framework. For this

to emerge, Roberts argues, face-to-face communication is crucial – as Handy (1995: 46) puts it: "trust needs touch".

A number of studies produce a somewhat different view of the influence of ICT on trust in groups. As Jarvenpaa and Leidner (1999) argue, virtual teams that exclusively interact through ICT can very well develop trust, albeit a task-related, "swift" kind of trust instead of truly interpersonal or socially based trust. Bos et al. (2002) compared four modes of communication and found that face-to-face was indeed the mode of communication that generated the most trust among communication participants, closely followed by video and audio conferencing. Purely text-based communication (chat) generated significantly less trust. Burgoon et al. (2003) found that participants who communicated exclusively through ICT were able to establish trust and mutuality without meeting face-to-face. Boisot (1998) claims that electronic communication enables co-presence without co-location, which would enable a person to build "a more "trusting" relationship with a transaction partner located on a neighboring continent than with one located in a neighboring room" (p. 225).

Shared practice is not only a ground for identification (as mentioned before), but also one for trust. Or, as Brown (n.d.) puts it on the "Storytelling" website:

> "(...) when you share a practice, when you have evolved a practice together in a community of practice, you have learnt to read each other, and basically because of that shared practice, there is a kind of trust that is built up, such that basically knowledge circulates amazingly well within a community of practice."

Our position here is that ICT helps members of a community to overcome barriers of space and time, and thus to communicate more efficiently and intensively with each other than when they had to meet in person all the time – enabling them to further evolve this trust.

H10. The use of ICT within a community positively influences the degree of trust among members of a community.

Factors affecting the use of ICT for knowledge sharing

Jarvenpaa and Staples (2000) provide insight into the factors which influence individual's choices for ICT's to support knowledge sharing. First of all, on an individual level they identify *task interdependence* as a relevant factor here: individuals whose work is interdependent of others will be motivated to use such collaborative technologies more. Another influence on the individual level is related to individuals' attitudes towards the technology: *computer comfort.* Following Davis' (1989) Technology Acceptance Model, such an attitude can be expected to have a significant influence on an individual's choice whether to use ICT for knowledge sharing. A related attitude concerns the *content* found in ICT: an individual's *attitude towards computer-based information* (specifically concerning quality and accessibility) is also expected to determine their use of such technologies.

Another influence identified by Jarvenpaa and Staples concerns the organizational (or, in this case, community) level. The *information culture* in such an organization (or community) is expected to be of influence on ICT use: following Davenport

(1997), it is expected that an open and organic information culture within such a community positively influences the use of ICT in that community. Such a culture is characterized by open exchanges, an external orientation and focused on empowerment of individuals. Jarvenpaa and Staples also mention *propensity to share* and *ownership of information* as influences on the use of ICT for knowledge sharing, but such variables have already been integrated in our discussion on motivational factors – or willingness to share.

All in all, the following hypotheses concerning influences on ICT use for knowledge sharing in communities are derived from this:

H11. Task interdependence positively influences the extent to which a member of a community uses ICT to share knowledge with other members.

H12. Computer comfort positively influences the extent to which a member of a community uses ICT to share knowledge with other members.

H13. A positive attitude towards computer-based information positively influences the extent to which a member of a community uses ICT to share knowledge with other members.

H14. An open and organic information culture within a community positively influences the extent to which members of that community use ICT to share knowledge among each other.

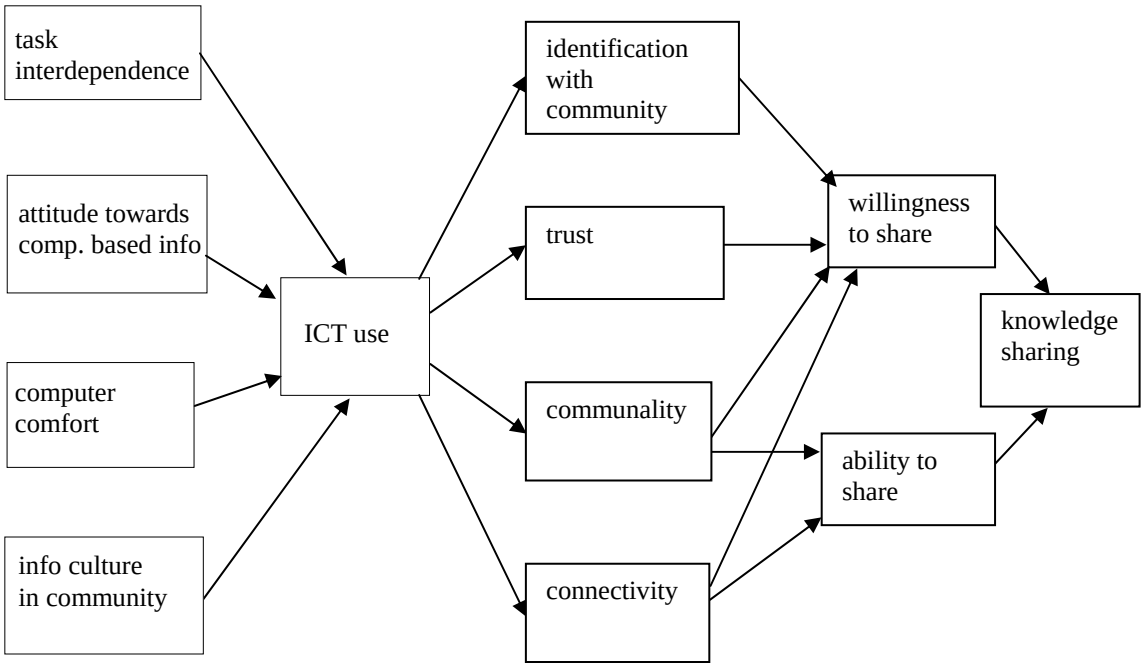


Figure 1. Theoretical model

Theoretical model

So, the theoretical discussion in this section has yielded 14 hypotheses concerning the contribution of ICT to knowledge sharing in communities, and the conditions under which this contribution can be realized. In figure 1, these hypotheses are represented in an integral theoretical model that forms the basis for the case studies discussed in the following sections.

Study sites and methods

The theoretical model presented in the previous section was tested in two case studies. Both case studies consisted of ICT-facilitated professional communities of practice concerning working conditions. Both communities were aimed at professionals in the area of working conditions – advisors, consultants, doctors, etcetera – and were facilitated by the Dutch research and consultancy organization TNO Work and Employment.

The first community is called “Arboconet” and is a community in which professionals from different branches of trade gather to exchange information. This community has its origins in a couple of face-to-face meetings organized by TNO Work and Employment. The ICT environment studied here was designed on the basis of the members’ request to enable them to exchange information in other ways than only face-to-face.

The second community is “Arbozw” and is originally a “knowledge center” established by a branch organization for health care and welfare. It is primarily oriented towards professionals in the health care sector. Contrary to Arboconet, its origins are not in face-to-face meetings, but in the ICT environment that was explicitly established to facilitate the sharing of knowledge among such professionals.

Both ICT environments have comparable functionalities, which can be separated into functionalities for storage and retrieval of (static) information and functionalities for the exchange of information (dynamic). For instance, storage and retrieval functionalities are: news pages, journal articles, a calendar with relevant events, legislation, best practices, links to libraries and databases and frequently asked questions. Exchange functionalities found in both environments are discussion fora and discussion archives, opinion polls and various possibilities to react to others’ contributions.

In both communities, members were approached with the request to fill in a questionnaire with some 80 statements. The questionnaire was administered both electronically (through the ICT environments) and on paper. A total of 257 questionnaires were returned: 107 from Arbozw (about 20% response) and 150 from Arboconet (about 15% response).

The relevant variables from the hypotheses were measured using a number of different scales. The scales used for knowledge sharing and the factors influencing knowledge sharing are presented in table 1.

scale items	M	SD	Cronb. alpha
knowledge sharing	20,99	4,65	.8744
whenever I've learned something new, I tell the other members of this community about it I tell the other members of this community what I know, when they ask me about it I tell the other members of this community about my skills, when they ask me about it When they've learned something new, other members of this community tell me about it I ask other members of this community what they know when I need particular knowledge the other members of this community tell me what they know, when I ask them about it the other members of this community tell me about their skills, when I ask them about it			
willingness to share	16,14	2,11	.64
I'm afraid to lose influence when sharing knowledge (recoded) I keep important matters to myself (recoded) I think I function better when I share what I know I think it's important that professionals are interested in each other's knowledge			
ability to share	10,51	2,55	.65
I find it hard to put what I know into words I find it hard to understand others' knowledge on working conditions I am unable to share my knowledge It is often impossible for my to make my knowledge on working conditions concrete for others			
identification with community	12,30	3,02	.66
I feel a bond with the other members of this community I feel solidarity with the other members of this community I identify myself with the other members of this community I really feel I'm part of the group within this community			
trust	20,00	13,07	.76
other members of this community help me when I have a problem concerning working conditions I can rely on the other members of this community to support me in my work I can count on the other members of this community to do what they say I have faith in the skills of the other members of this community			

Table 1. Scales and items: knowledge sharing and factors

All items in these scales used five point Likert scales as answering categories. The means have been computed on the basis of the sum total of these scores. The scales for knowledge sharing, ability and willingness to share have been used in previous research (Van den Hooff, Vijvers & De Ridder, 2003; Van den Hooff & De Ridder, 2003). The scale for identification is derived from Doosje, Ellemers and Spears (1995), and the items measuring trust are based on Wrightsman (1999).

The scales for ICT use and the factors influencing this ICT use are presented in table 2. The scales for ICT use are based on the functionalities found in both ICT environments, and factor analyses showed that separate scales should be constructed for the storage and retrieval functionalities (Cronbach's alpha = .83) on the one hand,

and the exchange functionalities on the other (Cronbach's alpha = .85). The scales for task interdependence, computer comfort, attitude towards computer-based information and information culture were derived from Jarvenpaa & Staples (2000). The scales for communality and connectivity were constructed specifically for this study. Again, all items were scored on five point Likert scales, except the ones measuring information culture, which were scored on a seven point scale.

scale items	M	SD	Cronb. alpha
task interdependence	8,87	2,41	.72
in my work, I often cooperate with people from other organizations my work requires me to share information with people from other organizations the results of my work are dependent of people in other organizations			
computer (dis)comfort	14,17	2,45	.82
I am uncertain using computers, since I might make incorrectable errors I fear that using a computer I will lose information by pressing a wrong button computers make work more interesting (recoded) I am uncomfortable using a computer working with computers is fun (recoded)			
attitude towards computer based information	21,07	3,73	.95
thanks to ICT, I can find more up to date information ICT provides better access to new information ICT saves time when searching for information ICT makes it easier to obtain certain information ICT makes new information available for my organization			
information culture in community	13,57	2,05	.77
organization is open or closed with regard to new information facts or rumors and intuition primary source of information mutual trust or distrust towards sharing information			
communality	12,33	2,89	.78
this community helps me obtain relevant information on working conditions faster I help other members of this community to obtain information that is useful to them I contribute actively to the information available within this community within this community, we work together towards creating a shared information base			
connectivity	13,51	3,28	.91
thanks to this community, I can communicate faster with other professionals in this area through this site, I can exchange information with people from outside my organization faster through this site, it has become easier to come into contact with other members of this comm. I use this site to overcome distances between me and other professionals in this area			

Table 2. Scales and items: ICT use and factors

As the statistics in tables 1 and 2 show, all scales used in this study were homogeneous with Cronbach's alphas exceeding .60. Factor analyses showed that all

scales were unidimensional as well, except for the one measuring ICT use, which was divided into storage & retrieval and exchange.

Results

The data from both cases were integrated into one dataset that provided the basis for the empirical testing of the theoretical model. A first test of the hypotheses in the theoretical model in figure 1 was conducted by performing linear regression analyses (stepwise) for each of the dependent variables in the theoretical model. In these analyses, the distinction between ICT use for storage and retrieval on the one hand, and for information exchange on the other, was incorporated. The results of these analyses are summarized in figure 2. For each of the dependent variables, the proportion of variance explained (R2) is given above the variable in question. So we can conclude, for instance, that 53% of the variance in knowledge sharing is explained by identification, trust, communality and connectivity. The figures near the arrows are the betas for each of the relationships found.

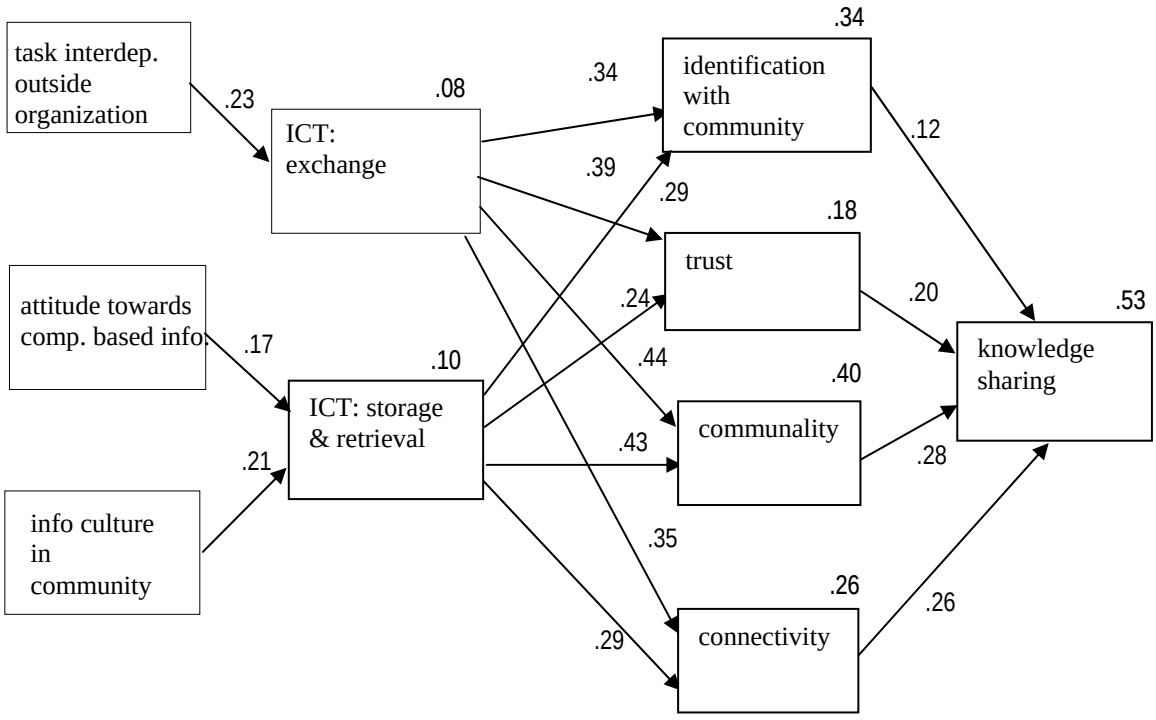


Figure 2. Regression model

Although this model is at a number of points quite similar to the theoretical model in figure 1, there is one remarkable difference: willingness and ability to share were not found to predict knowledge sharing behavior – knowledge sharing is directly influenced by identification, trust, communality and connectivity, and not mediated by ability and willingness to share. This is in partial contradiction to hypotheses H1 through H4 as well as H7 and H8. Still, the assumption that identification, trust,

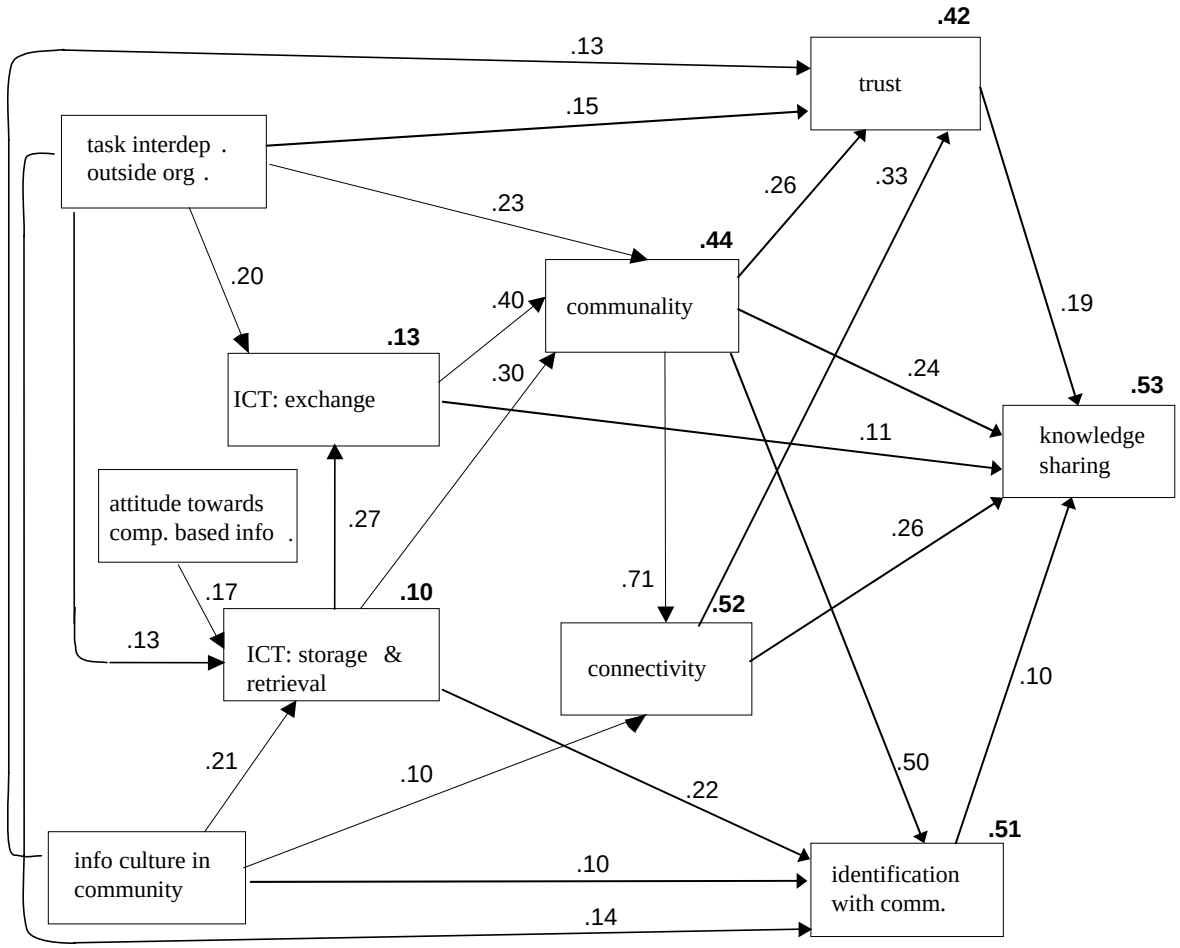
communality and connectivity are positive influences on knowledge sharing is supported by these results. These influences are not mediated by willingness and ability to share, however.

Hypotheses H5 and H6 receive support from these analyses, as well as H9 and H10: the use of ICT positively influences the creation of communality and connectivity, as well as identification and trust within the community. This holds for both dimensions of ICT use: storage & retrieval as well as exchange.

As for H11 through H14, only H12 is rejected on the basis of these results: computer comfort was not found to be a predictor for ICT use. Here, the distinction between both dimensions of ICT use is important: task interdependence is found to positively influence the use of exchange functionalities (providing support for H11), where attitude towards information in computers and an open and organic information culture in the community are found to positively influence the use of storage and retrieval functionalities. This latter result provides support for hypotheses H13 and H14.

All in all, the analyses provide considerable support for the theoretical framework presented before. The representation of the results in figure 2 is, however, not entirely methodologically sound – the model as a whole was not tested, just the various relationships of which it consists. In order to get a more complete insight into the model and relationships, a structural equation model analysis was performed using AMOS (Arbuckle & Wothke, 1999), a software package which supports data analysis techniques known as structural modeling, analysis of covariance structures, or causal modeling. Structural equation modeling basically enables the testing of a set of regression equations simultaneously, providing both parameter statistics for each equation and indices which indicate the “fit” of the model to the original data. Based on the data discussed in the previous sections, the structural equation model that optimally fits these data and has the strongest explanatory power is the one presented in figure 3.

In the model in figure 3, seven endogenous (or ‘downstream’) variables are distinguished. Also, three exogenous (or ‘upstream’) variables are defined. The standardized regression coefficient for each relationship is indicated by the number near the arrow symbolizing the relationship. For each endogenous variable, the proportion of variance explained by these regression equations (R square) is indicated as well.



chi square = 27.996 (df = 19). p = .084. TLI = .997. RMSEA = .04 3

Figure 3. Structural equation model

For the model as a whole, three statistics are found to be relevant. Although AMOS produces a very large number of different statistics, the University of Texas (n.d.) mentions that these three statistics are the commonly reported fit statistics:

1. The chi square value. This value indicates the absolute fit of the model to the data, and is the result of the testing of the null hypothesis that the model does indeed fit the data. For the model in figure 3, the chi-square test of overall model fit is 27.996 with 19 degrees of freedom, returning a probability value of .084 that a chi-square value this large would be obtained by chance if the null hypothesis that the model fits the data is true. In other words, this statistic indicates that the model fits the data.
2. Tucker-Lewis Index (TLI): The Tucker-Lewis Index (TLI) is an example of a relative fit statistic (not sensitive to sample size and non-normality), and compares the absolute fit of the specified model to the absolute fit of the most restrictive model possible, in which all relationships between the observed variables are assumed to be zero. The greater the discrepancy between the

overall fit of the two models, the larger the values of these descriptive statistics. TLI values close to 1 indicate a very good fit (Arbuckle & Wothke, 1999), and for the model in figure 3, this value is .997. So, this is further evidence for a good fit of this model to the data.

3. RMSEA: the Root Mean Square Error of Approximation, based on a comparison of the values in the specified model to population means and covariance structures. There are several rules of thumb concerning this statistic, such as the one by Browne and Cudeck who claim that an RMSEA of .05 or less would indicate a close fit of the model in relation to the degrees of freedom (Arbuckle & Wothke, 1999). Since the model in figure 3 has an RMSEA of .048, this statistic provides further evidence of a good fit of the model.

On the basis of both regression coefficients and fit indices, a number of conclusions can be drawn from this model with regard to the contribution of ICT to knowledge sharing. First of all, the model confirms that willingness and ability to share are not, contrary to what we expected, predictors of knowledge sharing. The model also confirms the importance of trust, identification, communality and connectivity in explaining knowledge sharing in communities, and it shows that the relationships are somewhat more complex than the model in figure 2 would indicate.

Communality appears to be an important effect of ICT use. A shared information base forms the basis for a community: it positively influences both trust and identification in the community. Communality is also found to directly influence knowledge sharing in a community. Finally, it also positively influences connectivity: apparently, the existence of a shared information base facilitates contacting other members of the community. Such an information base can be seen as an important part of a communities common knowledge, its common frame of reference even. Such a common base also provides an individual member of the community with information on who the other members are, what they do and what they know – which can indeed be an important facilitator of contacting the “right” people.

Connectivity, in turn, primarily facilitates knowledge sharing. Once it is easier to contact the other members of the community, more knowledge is also shared with these other members. The fact that ICT enhances the ability of community members to come into contact with other members also positively influences trust among these members. This confirms our theoretical argument that ICT’s contribution to such trust lies in facilitating easier and more frequent contact (independent of time and place) among members of a community.

The contribution of ICT to knowledge sharing, this model shows, further lies in creating communality, which (as described before) can be seen as the basis for a community. The relationship between both dimensions of ICT use is comparable to the relationship between their effects: where communality creates the conditions for connectivity, the use of ICT for storage and retrieval promotes the use of ICT for exchanging information. The contribution of ICT is also found in directly facilitating knowledge sharing (through exchange functionalities) and in enhancing identification (through storage and retrieval – that common frame of reference again).

Finally, the factors hypothesized to influence ICT use, are found to influence more than that. An open and organic information culture not only explains ICT use, but also connectivity, trust and identification. Task interdependence on the other hand, not only explains ICT use, but also communality, trust and identification. So, such characteristics of communities and their members are important explanations for the degree of knowledge sharing that takes place within such communities.

On the whole, these results indicate that ICT can indeed have a positive contribution to knowledge sharing. As mentioned in the theoretical section, face-to-face interaction is often considered to be an important addition here – members of communities who also interact face-to-face are likely to develop higher levels of trust, identification and (consequently) share more knowledge than those who don't. Since both communities studied here have quite different origins (Arboconet originated from face-to-face interactions, whereas Arbozw did not), it is interesting to see to what degree they score differently on a number of key variables. A t-test was performed for this purpose, and the results of this analysis are presented in table 3.

	M		T-value	Sign.
	arboconet	arbozw		
knowledge sharing	20.2	22.1	-3.1	.001
willingness to share	16.1	16.2	-0.7	.502
ability to share	10.9	10.1	2.7	.008
trust	12.6	13.6	-3.7	.000
identification	11.8	13.0	-3.3	.001
ICT use (storage & retrieval)	10.0	10.9	-2.3	.025
ICT use (exchange)	4.1	8.0	-9.4	.000

Table 3. Means and differences for both communities

Contrary to our expectations, Arboconet (with a face-to-face origin) did *not* score higher on trust, identification and knowledge sharing. Surprisingly, Arbozw (with an ICT origin) scored significantly higher on each of these variables. The only variable where Arboconet *did* score higher was the ability to share knowledge. Apparently, the fact that the members of this community already knew each other from face-to-face meetings makes it easier for them to estimate others' levels of knowledge and to put their knowledge into words that are understandable to these others. For all the other variables, however, we see that either there is no difference (willingness to share), or that Arbozw scores higher.

Conclusion

The conclusion we can draw from the findings presented before is that ICT can indeed have a positive contribution to knowledge sharing in communities, but that this

contribution is part of a complex set of influences and relationships. The use of ICT by community members directly facilitates easier exchanges (independent of time and place) between them, and it helps create two public goods (communality and connectivity) that further promote knowledge sharing. ICT use also plays a role because it influences mutual trust and identification between community members.

So, ICT plays a role (and a not unimportant one when we look at the strengths of the relationships found), but this influence should be considered in interaction with a range of other factors. Not only trust and identification between community members are important here, but also an open and organic information culture, as well as the extent to which the tasks of community members are interrelated.

Discussion

The results of our case studies provide support for the theoretical arguments made before. An important conclusion is that communality is a central contribution of ICT to knowledge sharing in communities. Not only does a shared information base directly contribute to knowledge sharing, but it also positively influences trust and identification in the community. We would argue that this shared information base is the explicit manifestation of the shared practice that is so central to communities: this is where the common knowledge, experiences and frames of reference are found.

The fact that, primarily through this communality, ICT positively influences trust and identification, offers support for the theoretical arguments made with regard to those variables. The central premise of SIDE theory, that ICT use can enhance social identification is certainly not contradicted by these results. The arguments made with regard to trust also hold. The importance of being able to overcome barriers of time and space are crucial here – creating and maintaining trust may well be best served by intensive face-to-face communication, but the fact that ICT facilitates frequent communication between community members who are geographically dispersed may be more important than the relative “richness” of such media. So, the contribution of ICT here lies primarily in allowing community members to communicate frequently and intensively, irrespective of the time and place where they want to do so. For truly interpersonal trust (instead of “swift”, task-related trust), it would however seem important to use ICT not as a total substitute for face-to-face communication, but as an addition to it.

It would seem that the comparison between the two communities would contradict this supposed importance of face-to-face interactions next to ICT interactions: the community originally based on face-to-face meetings scored lower on trust, identification and knowledge sharing than the one with an ICT origin. There are two alternative explanations for this, however. The first, and most important one, is that the healthcare community (Arbozw) has an explicit focus – all members work in the health care sector, and thus have a broad range of shared practices. For the other community, this is much less the case: although the members all have some sort of coordinating function regarding working conditions, the diversity in backgrounds is much larger. Members of this second community come from all kinds of different branches of trade, so there shared practice is much more amorphous and diverse. This

explanation further supports the importance of such shared practices. A second explanation is the fact that the ICT environment for the health care community has been existence longer than the other one – Arbozw is more than a year 'older' than Arboconet, so the experience that the members of the first community already have in communicating through ICT may also be an explanation for this finding.

On the whole, we can conclude that most variables distinguished in the theoretical section of this paper do indeed influence knowledge sharing in communities, but that the relationships are more complex than assumed at first. For instance, the factors assumed to influence ICT use are partly factors that do much more than that: task interdependence and information culture are important predictors of trust and identification within a community. The distinction between different dimensions of ICT use (storage & retrieval versus exchange) also proved to be an important addition.

With regard to future research, it would be interesting to further explore the main dependent variable in our research: knowledge sharing. In this study, we focused on the *extent* to which members of a community share knowledge. In the introduction of this paper, however, we mentioned that communities are specifically seen as environments for the sharing of *implicit* knowledge. It would therefore be very interesting to explore the *kind* of knowledge being shared in communities instead of only the *amount* of knowledge. Other dimensions of knowledge sharing should also be incorporated into such further qualifications of this concept: the relevance of the knowledge being shared, the breadth and depth of it, and the ease with which the process takes place.

The arguments made before also indicate that a more explicit comparison of knowledge sharing in communities in face-to-face and ICT conditions would be an interesting avenue of research. Both as additions and as substitutes, both modes of knowledge sharing should be explicitly linked to crucial variables such as identification, trust and knowledge sharing. It would also be useful to distinguish between different kinds of ICT applications – not only shared databases and electronic discussions, but also video or audio conferencing, CSCW et cetera.

The differences found between the two communities in terms of trust, identification and knowledge sharing also warrant some further study of the importance of time: a longitudinal study into how communities form and develop, and how knowledge sharing within such communities develops over time. Specific attention should also be paid to the different roles of face-to-face and ICT-based communication – is face-to-face communication primarily of interest in the phase where the community is created for instance, and is ICT communication more important as communities have existed for a longer duration? These differences, and the explanations given for them, also give a further indication (together with the results discussed before) that shared practices are a central subject of research when studying communities.

Finally, a number of practical implications come to the fore as well. First of all, when creating or maintaining a community of practice, it is important to establish trust and see to it that there is a common identity for members to adhere to. In line with this, the fact that members share a certain practice should also be emphasized. Finally, an optimal balance should be found between face-to-face communication on

the one hand, and ICT on the other. As this study indicates, such actions would create favorable conditions for knowledge sharing within a community.

References

Arbuckle, J.L. & Wothke, W. (1994). *Amos 4.0 User's Guide*. Chicago: SmallWaters Corporation.

Bos, N., Olson, J., Gergle, D., Olson, G. & Wright, Z. (2002). Effects of four computer-mediated communication channels on trust development. *Proceedings of Conference on Human Factors in Computing Systems (CHI) 2002 (Minneapolis MN, April 2002*. New York: ACM Press, 135-140.

Brown, J.S. (n.d.). Storytelling: Scientist's Perspective. In: Brown, J.S, Denning, S., Groh, K. & Prusak, L. (eds.). *Storytelling: Passport to the 21st century*. Downloaded March, 2003 from http://www.creatingthe21stcentury.org/JSB14-k-sticky-leaky.html

Brown, J.S. & Duguid, P. (1991). Organizational learning and communities-of-practice: toward a unified view of working, learning and innovation. *Organization Science* 2:1, 40-57.

Brown, J.S. & Duguid, P. (2001). Knowledge and Organization: A Social-Practice Perspective. *Organization Science* 12:2, 198 – 213

Burgoon, J.K., Stoner, G.M., Bonito, J.A., & Dunbar, N.E. (2003). Trust and Deception in Mediated Communication. *Proceedings of the Hawaii International Conference on Systems Science*. Kona, HI: HICSS.

Daft, R.L. & Lengel, R.H. (1984). Information richness: a new approach to managerial behavior and organizational design. In L.L. Cummings & B.M. Staw (eds.), *Research in organizational behavior* 6, 191-233. Homewood, IL: JAI Press 1984.

Daft, R.L. & Lengel, R.H. (1986). Organizational information requirements, media richness and structural design. *Management Science* 32, 554-569

Davenport, T. (1997). *Information Ecology*. Oxford: Oxford University Press.

Davenport, T. H. & Prusak, L. (1998). *Working Knowledge; How organizations manage what they know*. Boston: Harvard Business School Press.

Davis, F.D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*. 13: 3, 319-340

Doosje, B., Ellemers, N., & Spears, R. (1995). Perceived intragroup variability as a function of group status and identification. *Journal of Experimental Social Psychology*, 31, 410-436.

Eby, L.T. & Dobbins, G.H. (1997). Collectivistic orientation in teams: an individual and group-level analysis. *Journal of Organizational Behavior* 18, 275-295.

Fulk, J., Flanagin, A.J., Kalman, M.E., Monge, P.R. and Ryan, T. (1996), Connective and Communal Public Goods in Interactive Communication Systems, *Communication Theor*y, 6, 60–87.

Gladstein, D.L. (1984). Groups in context: a model of task group effectiveness. *Administrative Science Quarterly* 29, 499-517.

Handy, C. (1995). Trust and the virtual organization. *Harvard Business Review*. 73:3, 40-50.

Hinds, P., & Pfeffer, J. (2003). Why organizations don't "know what they know": Cognitive and motivational factors affecting the transfer of expertise. In M. Ackerman, V. Pipek & V. Wulf (Eds.), *Beyond knowledge management: Sharing expertise*. Cambridge, MA: MIT Press.

Huysman, M. & Van Baalen, P. (2001). Knowledge sharing, communities and social capital. In: Huysman, M. & Van Baalen, P. (eds.). *Trends in Communication; Special issue on Communities of Practice.* Amsterdam: Boom, 7-20.

Huysman, M.H. & D. de Wit (2002). *Knowledge Sharing in Practice.* Dordrecht: Kluwer Academics.

Jarvenpaa, S.L. & Leidner, D.E. (1999). Communication and trust in global virtual teams. *Organization Science* 10:6, 791-815.

Jarvenpaa, S.L. & Staples, D.S. (2001). Exploring Perceptions of Organizational Ownership of Information and Expertise. *Journal of Management Information Systems* 18:1, 151–183.

Monge, P.R., Fulk, J., Kalman, M.E., Flanagin, A.J., Parnassa, C. & Rumsey, S. (1998). Production of Collective Action in Alliance-Based Interorganizational Communication and Information Systems. *Organization Science* 9:3, pp. 411 – 433.

Moorman, R.H. & Blakely, G.L. (1995). Individualism-collectivism as an individual difference predictor of organizational citizenship behavior. *Journal of Organizational Behavior* 16, 127-142.

Nahapiet, J. & Ghoshal, S. (1998). Social capital, intellectual capital, and the organizational advantage. *Academy of Management Review* 40:2, 242-266.

Nohria, N. & Eccles, R.G. (1992). Face-to-face: Making network organizations work. In: Nohria, N. & Eccles, R.G. (1992). *Network and Organizations.* Boston, MA: Harvard Business School Press, 288-308.

O'Dell, C. & Grayson, C.J. (1998). If only we knew what we know: Identification and transfer of internal best practices. *California Management Review* 40:3, 154 – 174.

Orlikowski, W. J. (1993). Learning from notes: Organizational issues in groupware implementation. *The Information Society* 9:3, 237-250.

Osterloh, M., & Frey, B. S. (2000). Motivation, knowledge transfer, and organizational forms. *Organization Science,* 11:5, 538-550.

Pan, S.L. & Scarbrough, H. A socio-technical view of knowledge-sharing at Buckman Laboratories. *Journal of Knowledge Management* 2:1 55-66.

Postmes, T. T., Spears, R. & Lea, M. (1998). Breaching or Building Social Boundaries? SIDE-effects of Computer-Mediated Communication. *Communication Research* 25, 689-715.

Postmes, T. & Spears, R. (2000). Redefining the Cognitive Definition of the Group: Deindividuation effects in common bond vs. common identity groups. In: Postmes, T., Spears, R., Lea, M. & Reicher, S. (eds.) *SIDE Issues Center Stage: Recent Developments in Studies of De-individuation in Groups.* Amsterdam: Royal Netherlands Academy of Arts and Sciences

Roberts, J. (2000). From know-how to show-how? Questioning the role of information and communicatoin technologies in knowledge transfer. *Technology Analysis & Strategic Management* 12:4, 429-443.

Scarbrough, H. & Swan, J. (2001). Knowledge communities and innovation. In: Huysman, M. & Van Baalen, P. (eds.). *Trends in Communication; Special issue on Communities of Practice.* Amsterdam: Boom, 7-20.

Short, J., Williams, E. & Christie, B. (1976). *The Social Psychology of Telecommunications.* London: John Wiley.

Tanis, M. & Postmes, T. (in press). Social Cues and Impression Formation in CMC. To appear in *Journal of Communication*

Trevino, L.K., Daft, R.L. & Lengel, R.H. (1990). Understanding manager's media choices: A symbolic interactionist perspective. In: J. Fulk & C.W. Steinfield (eds.) *Organizations and communication technology,* 71-94. Newbury Park, CA: Sage

University of Texas (n.d.). *Structural Equation Modeling using AMOS: An Introduction.* Downloaded february 2002 from http://www.utexas.edu/cc/stat/tutorials/amos/index.html.

Van den Hooff, B., Vijvers, J. & De Ridder, J. (2003). Knowing what to manage: foundations and applications of a knowledge management scan. *European Management Journal*.

Van den Hooff, B. & De Ridder, J. (2003). The context of knowledge sharing. *Paper to be presented at the Annual Conference of the International Communication Association,* San Diego, CA, May 2003.

Wagner, J. (1995). Studies of individualism-collectivism: effects on cooperation in groups. *Academy of Management Journal* 1, 152-172.

Walther, J.B. (1992). Interpersonal Effects in Computer-Mediated Communication: A relational perspective. *Communication Research* 19, 52-90.

Walther, J.B. & Burgoon, J.K. (1992). Relational Communication in Computer-Mediated Interaction. *Human Communication Research* 21, 460-487.

Walther, J.B. (1996). Computer-Mediated Communication; Impersonal, Interpersonal and Hyperpersonal Interaction. *Communication Research* 23:1, 3 –43.

Weggeman, M. (2000). *Kennismanagement: de praktijk [Knowledge Management: Practice]*. Schiedam: Scriptum Management.

Wenger, E. (1998). *Communities of Practice; The social fabric of a learning organization.* New York: Cambridge University Press.

Wiesenfeld, B.M., Raghuram, S. & Garud, R. (1999). Communication patterns as determinants of organizational identification in a virtual organization. *Organization Science* 10, 777-790.

Wrightsman, L. S. (1991). Interpersonal trust and attitudes toward human nature. In J. P. Robinson, P. R. Shaver & L. S. Wrightsman (Eds.) *Measures of personality and social psychological attitudes: Vol. 1: Measures of social psychological attitudes*, 373-412. San Diego, CA: Academic Press.

Zack, M.H. (1999). Managing codified knowledge. *Sloan Management Review* summer 1999.