



Research article

The value of online networks of practice: the role of embeddedness and media use

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Abstract

This article addresses the question how networks of practice (NoPs) can create value (operationalized as their contribution to individual members' performance) for organizations through knowledge integration and management. The discussion focuses on two sets of variables influencing member performance: the embeddedness of the network and the use of different media. Three dimensions of embeddedness are distinguished: (1) *embeddedness in practice*: the extent to which the knowledge shared in the network is integrated in members' (local) practices; (2) *structural embeddedness*: the extent to which network members are connected to each other and know who knows what; and (3) *relational embeddedness*: the extent to which the network is characterized by strong social ties. In terms of communication media, information and communication technology (ICT)-enabled and face-to-face interaction are distinguished. A survey study among 206 members of different NoPs reveals that all three forms of embeddedness are important antecedents of NoP member performance (explaining 43% of the variance in performance) and that these forms are interrelated. Furthermore, ICT use positively influences embeddedness in practice, whereas face-to-face communication contributes to the structural and relational embeddedness of an NoP. This contributes to knowledge management and ICT literature in general and NoP theory in particular.

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Introduction

In our globalizing economy, organizations are increasingly confronted with the need to integrate knowledge from both internal and external sources, often geographically dispersed, in order to create and appropriate value (Kogut and Zander, 1993; Foss and Pedersen, 2004). From a practice-based perspective on knowledge, insights have developed on 'networks of practice' (NoPs) as vehicles capable to integrate such dispersed knowledge (Brown and Duguid, 2001; Tagliaventi and Mattarelli, 2006). An NoP is a knowledge network of individuals who share the same practice, yet are geographically dispersed (Brown and Duguid, 1991, 2001; Vaast, 2004; Ormrod *et al.*, 2007). NoPs are inherently emergent, self-organizing structures that thrive on the interaction of people who act within a particular shared context, or a practice (Brown and Duguid, 1991, 2001). NoPs often serve as boundary spanners by

connecting people who share a common practice, but work in different professional groups (Tagliaventi and Mattarelli, 2006) or different organizations (Brown and Duguid, 2001; Whelan, 2007), and are geographically dispersed (Vaast, 2004). NoPs are suggested as means to enable the integration of dispersed knowledge (both within and outside of organizations) without extracting it from practice (Tagliaventi and Mattarelli, 2006). In spite of their inherently emergent nature, such networks are often explicitly implemented by organizations in order to integrate dispersed knowledge.

However, it is unclear *how* NoPs can serve this role as a means to create value for organizations. This article contributes to the literature by clarifying the value that such networks can have, as well as the mechanisms that underlie value creation in NoPs. At the most concrete level, value is

created by improving the performance of employees who are members of these networks. In this study, value is defined as the contribution of a network to the efficiency and quality of members' work in terms of the integration of knowledge. NoPs provide members with increased access to relevant knowledge, as a large number of knowledge sources (both human and codified) are easily available. The increased availability of knowledge, and people to exchange this knowledge with, is likely to improve the quality of knowledge as well (Wasko and Faraj, 2005). Consequently, NoPs are likely to contribute to members' performance in terms of the quality and efficiency of their work. Combined, the improved individual performance of employees at the micro-level will contribute to organizational level value, in terms of knowledge integration (Foss and Pedersen, 2004). The question we address in this article is what factors determine the extent to which NoPs contribute to members' performance. Based on the literature on NoPs, we identify two sets of factors that are likely to play a role here.

First, our central assumption is that the more a member is – and their knowledge and activities are – part of, or 'embedded in' an NoP, the more this network will contribute to their performance (Agterberg *et al.*, in press; Van den Hooff *et al.*, 2007). Since a shared practice is the primary motivation for participation in an NoP (Cook and Brown, 1999; Gherardi, 2000; Wasko and Faraj, 2005), we assume that the extent to which the knowledge and activities in an NoP are embedded in the members' practices will positively influence the network's contribution to members' performance. Next, based on the literature on social networks (Granovetter, 1985; Gulati, 1998) and social capital (Nahapiet and Ghoshal, 1998; Huysman and Wulf, 2006), we assume that the extent to which network members are embedded in the social structure of the network and in the relationships within that structure will also positively influence the network's contribution to their performance.

Second, we focus on the means of communication used by NoP members as an influence on the network's contribution to their performance. Since members of NoPs are almost by definition geographically dispersed, interaction within NoPs largely depends on the use of information and communication technologies or ICTs, which is why they are often referred to as 'online' or 'electronic' NoPs (Wasko and Faraj, 2005). These technologies facilitate the overcoming of boundaries of time and place that characterize geographically dispersed knowledge sharing, and enable network members to share knowledge quickly, globally and with large numbers of individuals (Wasko and Faraj, 2005), thus contributing to their performance (and consequently, to the network's value). Our assumption, however, is that this contribution to member performance is more indirect than direct, in the sense that the increased ease of accessing knowledge and reaching valuable contacts positively impacts members' social embeddedness in the network and the embeddedness of network activities in their practices. Although ICT-intensive NoPs are referred to as 'online networks of practice' (Wasko and Faraj, 2005; Whelan, 2007), communication in such networks typically does not exclusively take place via ICT but also via face-to-face interaction. We assume that this face-to-face communication will also have a role in establishing

embeddedness. In general, the influence of the use of different modes of communication on the value of NoPs is a relatively uncharted area, to which this article aims to contribute.

The article is structured as follows. First, we present our theoretical arguments and hypotheses regarding both sets of factors, leading to an integrated theoretical model. This model is tested with a survey among 206 members of different online NoPs using the same software functionality for knowledge exchange. The results of this study point out that both online and face-to-face communication play a role in enhancing an NoP's embeddedness in terms of practice and social dynamics, and that the embeddedness of an NoP is a rather strong determinant of members' performance – and thus, the network's value.

Theory and hypotheses

Value of NoPs

As defined above, an NoP is a knowledge network of geographically dispersed individuals sharing the same practice. Although NoPs are described as inherently emergent and self-organizing, in practice they are often implemented as a means to an end, as structures that specifically aim at integrating dispersed knowledge. Still, regardless of their origin, the internal dynamics in these networks that determine their actual contribution to this aim are emergent and bottom-up in nature (Agterberg *et al.*, in press). NoPs can be both intra-organizational and inter-organizational, as practices do not necessarily coincide with organizational borders. The online NoP that is central to Wasko and Faraj's (2005) study, for instance, is a typical example of an inter-organizational network as it connects legal professionals from different organizations. Van den Hooff *et al.* (2007), however, focus on an intra-organizational network, connecting members of one development aid organization who are dispersed all across the globe. Our study focuses on online NoPs that are not bound by organizational borders; networks that connect professionals with a shared practice from different organizations. In these networks, members create, share, store and retrieve knowledge that can help them improve their performance.

Generally, the primary value of such NoPs lies in the facilitation of integrating geographically dispersed knowledge. We aim at disentangling this 'function' of an NoP through studying the performance of network members, which is essential for organizations to derive value from an NoP. From the perspective of the members of an NoP, their performance can best be defined in terms of improvement in the efficiency and quality of their work. In this study, value of an NoP is defined as the extent to which the NoP contributes to organizations via members' work performance in terms of efficiency and quality.

Embeddedness and value of NoPs

Van den Hooff *et al.* (2007) distinguish two forms of embeddedness of an NoP which are assumed to influence their value: embeddedness in practice and social embeddedness. In this article, we further elaborate these forms of embeddedness and their relationship to member

performance. The concept of social embeddedness is further divided into structural and relational embeddedness in this article (Gulati, 1998; Agterberg *et al.*, in press).

The American Heritage Dictionary defines 'to embed' as 'causing something to be an integral part of a surrounding whole.' We distinguish the three forms of embeddedness, where the first one refers to embeddedness of knowledge in a certain environment, and the latter two to embeddedness of network members in the network (Agterberg *et al.*, in press):

1. *Embeddedness in practice*: the extent to which the knowledge shared in the network is integrated in the distributed, local practices of network members.
2. *Structural embeddedness*: the extent to which network members are connected to each other and know who knows what (Granovetter, 1985).
3. *Relational embeddedness*: the extent to which the network is characterized by strong social ties, as a mechanism for gaining fine-grained information (Granovetter, 1985).

Below, we will discuss how each of these forms of embeddedness may be related to NoP member performance, based on the discussion in Van den Hooff *et al.* (2007).

Embeddedness in practice

In order for an NoP to have a positive impact on members' performance, the activities in the network need to be part of the daily activities of these members. The more network members can integrate the knowledge that is created and shared in the network into their daily work, the more the quality and efficiency of their work will benefit. In line with the practice-based perspective on knowledge (Cook and Brown, 1999; Gherardi, 2000; Hislop, 2002), we refer to this contextual nature of networks as 'embeddedness in practice.' The actual value of NoPs lies in their ability to join people with shared practices and work interests. From this follows that the contribution of these networks to members' performance will be positively related to the extent to which the knowledge being created and shared in the NoP is directly related to and integrated in those practices and work interests. This leads to the following hypothesis:

Hypothesis 1: Embeddedness of the activities in an NoP in members' daily practices positively influences the performance of network members.

Structural embeddedness

In what Cook and Brown (1999) call the 'epistemology of practice,' knowledge is seen as socially constructed and embedded in the social context. Consequently, the characteristics of this social context are crucial; how employees are connected to one another in networks of social relations primarily determines to what extent and in what way they can draw upon and contribute knowledge (Hansen *et al.*, 2005; Smith *et al.*, 2005).

Based on the literature on social and organizational networks, the concept of social embeddedness concerns the extent to which a network is characterized by stable

relationships, created and routinized over time, in repeated and rich exchanges based on mutual interests, understanding and trust (Gulati, 1998). Building on the work of Granovetter (1985), Gulati (1998) distinguishes two different perspectives on social embeddedness: relational embeddedness and structural embeddedness. Both forms of social embeddedness can be assumed to positively influence NoP members' performance.

Structural embeddedness stresses the structural positions that members have in a network (e.g., their centrality, weak and strong ties), the connections they have with others and the extent to which they know what these others know (and need to know) (Agterberg *et al.*, in press). This is related to Nahapiet and Ghoshal's (1998) concept of *structural social capital*. Thus, structural embeddedness can be assumed to positively influence member performance through providing access to people with relevant knowledge or relevant needs and questions (Wasko and Faraj, 2005):

Hypothesis 2: The level of structural embeddedness of an NoP positively influences the performance of network members.

Relational embeddedness

Relational embeddedness stresses the role of direct cohesive ties as a mechanism for gaining important information and knowledge, ties that also lead to shared understandings and emulation of behavior. This is similar to Nahapiet and Ghoshal's (1998) *relational* dimension of social capital, which stimulates knowledge combination and exchange by providing a common interest and an atmosphere of mutual trust and appreciation and a 'common know-how' which facilitates understanding of each others' knowledge. This common interest and common know-how will facilitate the accessibility of knowledge and members' willingness to share knowledge, positively influencing the efficiency and quality of their work. This leads to the following hypothesis:

Hypothesis 3: The level of relational embeddedness of an NoP positively influences the performance of network members.

Interrelatedness of different forms of embeddedness

There is reason to assume that the three forms of embeddedness are interrelated as well. First of all, based on the work by Tsai and Ghoshal (1998) and Van den Hooff and Huysman (2009), both forms of social embeddedness are likely to be related. In this argument, structural embeddedness is the starting point – the presence of social interaction ties positively influences mutual trust and obligations and shaping a common interest (relational embeddedness). This leads to the following hypothesis:

Hypothesis 4: The level of structural embeddedness of an NoP positively influences the level of relational embeddedness of that network.

Moreover, social embeddedness (both structural and relational) can also be assumed to be related to embeddedness in practice. Given that knowledge usually has a large tacit dimension, is dispersed and contextually bound, the

interaction needed to share knowledge is usually intensive (Hislop, 2005). In other words, the learners will need to become 'insiders' of the social community in order to acquire its particular viewpoint (Lam, 1997; Brown and Duguid, 1991). We believe that social embeddedness and embeddedness in practice are interrelated, because using and developing knowledge in practice, or learning by doing (Hislop, 2005) will simultaneously involve social interaction and vice versa. Gherardi (2000) refers to this mutual influence as 'discursive practice.' We assume that this relationship starts with embeddedness in practice: sharing a practice creates an environment in which connections are established and knowledge of each other's knowledge is necessary (structural embeddedness), and it also establishes a shared interest which is the basis for trust and mutual identification (relational embeddedness). Therefore, we hypothesize:

Hypothesis 5: The level of embeddedness in practice of an NoP positively influences the level of (a) structural embeddedness and (b) relational embeddedness of the network.

Media use and embeddedness

As argued in the introduction to this article, NoPs are by definition geographically dispersed, and consequently, are characterized by rather intensive use of ICTs (which is why they are referred to as online NoPs). Still, NoP members often do also meet face-to-face, infrequently as this may be. In other words, a range of different media is used for communication within NoPs, which raises the question how the use of different communication media is related to the different forms of embeddedness of an NoP. In this section, we will discuss theories providing insight into the relationship between the use of ICT and face-to-face communication on the one hand, and embeddedness of networks on the other.

Based on insights from traditional media choice theories such as Media Richness Theory (Daft and Lengel, 1984, 1986), an impressive body of research addresses the question what the consequences are when certain media are used for certain tasks in certain organizational and social contexts. With regard to such effects, the lack of 'social cues' (such as tone of voice, facial expressions, gestures) in communication via ICT is often expected to negatively influence the social richness of this communication (Short *et al.*, 1976; Daft and Lengel, 1984, 1986; Trevino *et al.*, 1990). As a consequence, such communication is often assumed to lead to less identification with communication partners compared to a face-to-face setting, and consequently to less attention to common goals, practices and interests (Kiesler *et al.*, 1984; Sproull and Kiesler, 1986). Following this line of reasoning, for social embeddedness and embeddedness in practice to occur, face-to-face interaction is crucial. Direct interaction creates trust, social identification, and commitment to the group (Handy, 1995; Jarvenpaa and Leidner, 1999; Roberts, 2000; Bos *et al.*, 2002; Burgoon *et al.*, 2003) – elements related to social embeddedness. As for embeddedness in practice, this is created by directly sharing practices, that is, by collaborating (Cook and Brown, 1999; Hislop, 2002). Such

collaboration is better served by direct interactions in which problems are defined and clarified in mutual sense making, and in which coordinated efforts lead to solutions. Based on such insights, we would expect that social embeddedness and embeddedness in practice will primarily be increased by 'rich' communication, that is, face-to-face communication:

Hypothesis 6: The use of face-to-face communication in an NoP positively influences the level of (a) embeddedness in practice, (b) structural embeddedness and (c) relational embeddedness of the network.

Empirical results, however, often contradict the somewhat naïve assumptions of these 'reduced social cues' approaches (Walther, 1992; Walther and Burgoon, 1992; Postmes *et al.*, 1998; Carlson and Zmud, 1999). Consequently, insights from such approaches have long been surpassed by what Van den Hooff *et al.* (2005) call 'situational theories' of media use. According to these theories, the fact that ICTs help overcome constraints in terms of time and distance is often much more important than their 'appropriateness' for certain tasks, and the perception of this appropriateness changes with experience (Orlikowski, 1992; Markus, 1994; Carlson and Zmud, 1999). This is in line with Granovetter's (1973) argument about the strength of weak ties, which also emphasizes that connecting people across distance through weak ties can be more valuable than more cohesive, strong ties, which are characterized by richer communication.

ICT applications can be related to the different forms of embeddedness distinguished above. For instance, storage and retrieval in databases can improve embeddedness in practice by providing a shared knowledge base, an archive of the common understanding of the subject at hand. On the other hand, an expertise finding application (such as a 'who is who' or personal yellow pages) can increase the structural embeddedness in the network, by facilitating contact between members and insight into where which knowledge is located. Applications facilitating actual interaction (such as discussion forums) can increase the exchange of knowledge about the common practice, also increasing embeddedness in practice. Finally, theories such as those developed by Walther (1996) and Postmes *et al.* (1998) argue that computer-mediated interactions can even lead to communication with a richer level of social relationships than found in face-to-face conditions, and to more instead of less group feeling (or relational embeddedness). Since most present day social networking applications integrate each of these functions, we hypothesize that ICT can positively influence each of the forms of embeddedness:

Hypothesis 7: The use of ICT in an NoP positively influences the level of (a) embeddedness in practice, (b) structural embeddedness and (c) relational embeddedness of the network.

All in all, these hypotheses lead to the theoretical model that is presented in Figure 1. This model was the basis for a survey study among various NoPs using the 'NetTool' (pseudonym) software functionality for knowledge sharing.

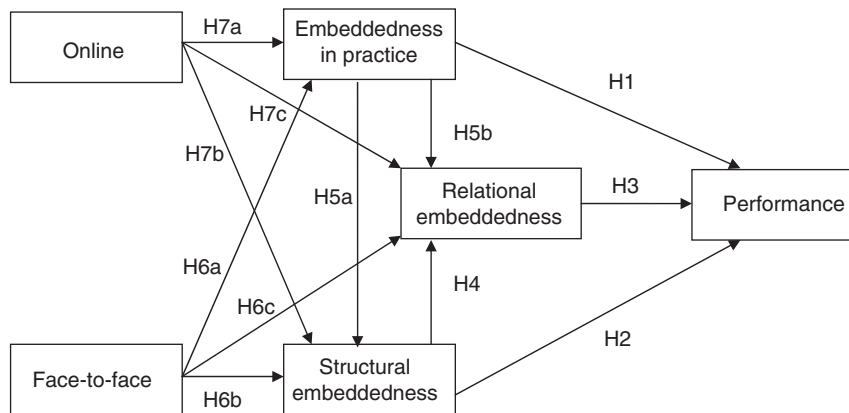


Figure 1 Theoretical model.

In the next section, the methodological specifics of this study will be discussed.

Study site and methods

The empirical study was conducted in collaboration with a company that provides social software in the form of a web environment for collaboration and knowledge sharing. In this article we will refer to this environment as NetTool. Various organizations (both governmental and commercial) use NetTool to facilitate online NoPs. Most of these networks have physical meetings as well.

In this study, use of ICT equals use of NetTool. NetTool offers its members various functionalities within an integrated collaboration environment: members can upload and retrieve documents (storage and retrieval), there is a shared 'who is who' of network members (expertise finding) and online discussions can be initiated and conducted on every relevant topic (interaction). Thus, Nettool is an integrated social networking environment that is offered to all network members.

Sample and procedure

A request to participate in an online survey was sent out to all members of various networks, based on their NetTool use. A total of 206 respondents from these networks responded to our request and started to fill in the survey. Ultimately, 152 respondents completed the survey. Respondents were members of various different networks. By way of example, four of the networks from which the largest number of respondents were derived, are discussed below.

The first network joins representatives from various organizations in a southern Dutch province. The network facilitates project management and knowledge sharing among different kinds of organizations in this region, with members from various levels and positions within these organizations – yet sharing a common practice. Although they are in the same region, they are geographically dispersed and share knowledge across organizational borders. Discussions are maintained on subjects related to regional government, such as spatial planning, economic development, public safety and bio-diversity, with numbers of participants ranging from 5 to 50 people. The general

purpose is to learn from others, coordinate activities, manage projects and prevent re-inventing the wheel.

A second network consists of people sharing practices of calamity prevention and fire fighting in the Netherlands. Employees from different organizations involved in this (primarily from fire brigades, but also policy makers) exchange knowledge about specific topics all across the country. The topics include crisis management, information management during calamities, risk control, and training and practicing. Participants learn from each others' experiences and debate ways to handle exceptional situations and improve their daily work by working with new materials and new working methods. The sub-networks within this larger NoP consist of 10–50 people who meet face-to-face every three months.

A third network brings together experiences and knowledge in the field of public procurement. This NoP offers a forum for governmental employees all over the Netherlands who are responsible for public procurement. They are geographically dispersed and from various organizations, but do share the daily practice of procurement. Via a large number of forums they learn from each other's expertise and experiences on a day-to-day basis. Topics range from national policy issues (such as the free distribution of school books) to operational tips on how to conduct negotiations with suppliers. The larger network consists of 2700 members who meet face-to-face at some events.

Finally, a fourth network represents a governmental organization that advises and assists justice and police organizations on information exchange. Representatives from these organizations and external experts share knowledge and experiences related to best and worst practices concerning this issue, and also use the network to interact with clients. Participants represent various organizations and are geographically dispersed. Membership of the different forums within this network varies from 5 to 50 members, and participants meet each other face-to-face on a regular basis.

Measures

In the survey, all variables – unless otherwise reported – were measured using 1–5-point (strongly disagree–strongly agree) Likert-type scales. The scales for performance and

Table 1 Results of confirmatory factor analysis

Scale (items)	Stand. factor loading	CR	AVE
<i>Performance</i>		0.887	0.613
More contacts that can help me with daily work.	0.721		
Can solve problems more efficiently.	0.814		
Quality of knowledge I use in work improved.	0.866		
Can obtain new relevant knowledge.	0.756		
Speed with which tasks completed has increased.	0.748		
<i>Embeddedness in practice</i>		0.817	0.690
Activities in network related to daily work.	0.812		
Subjects of discussion relevant for daily work.	0.849		
<i>Structural embeddedness</i>		0.877	0.589
Know who has relevant knowledge in network.	0.758		
Network members know what knowledge I have.	0.771		
Frequent contact network members with relevant knowledge.	0.768		
Network members know what knowledge I need.	0.752		
Know what knowledge can be relevant for network members.	0.787		
<i>Relational embeddedness</i>		0.857	0.750
I feel connected to this network.	0.805		
I see the network as a group I belong to.	0.923		

For each composite scale, this table lists the items of which it consists, the standardized factor loadings, Composite Reliability (CR) and the Average Variance Extracted (AVE).

structural and relational embeddedness were based on Van den Hooff *et al.* (2007) and Van den Hooff and Huysman (2009). The scale for embeddedness in practice was newly designed, but incorporated the single item used by Van den Hooff *et al.* (2007) to measure this variable. The wording of the items for each scale is shown in Table 1. In line with previous studies about media use (Rice and Shook, 1990; Van den Hooff *et al.*, 2007), use of face-to-face and ICT was measured by asking what percentage of the time members spent communicating in the network, they used either via face-to-face contact or the NetTool software functionality.

Confirmatory factor analysis (CFA) was used to assess the psychometric properties of the composite measures (all variables except use of online and use of face-to-face). AMOS 5.0 with maximum likelihood estimation was used to assess the measurement model. The measurement model in which the composite scales (latent variables) were related to the items outlined in Table 1 produced a satisfactory fit: the ratio of chi-square to degrees of freedom scored 1.78, which indicates a good fit of the model to the data (critical value is 2.0). Furthermore, the Goodness of Fit Index (GFI) and Adjusted Goodness of Fit Index (AGFI) reached satisfactory levels at 0.90 and 0.85, respectively, the Tucker-Lewis Index (TLI) scored sufficiently close to 1 at 0.94 and the Root Mean Square Error of Approximation (RMSEA) scored 0.07, indicating a reasonable error of approximation. As such, the results confirmed the dimensionality of the solution, and suggested convergent and discriminant validity. We further studied the validity and assessed the reliability of the measures by computation of Composite Reliabilities (CR) and Average Variance Extracted (AVE) scores, shown in Table 1.

Table 1 shows the composite scales, the items measuring these scales, the factor loadings of these items derived from the CFA, and the CR and AVE values. These results show support for both the reliability and the validity of the measures: all factor loadings exceed 0.7, the CR values are all above 0.7 as well (indicating sufficient reliability) and the AVE values all exceed 0.5, indicating a sufficient degree of convergent and discriminant validity of these scales. The convergent validity of the measures was confirmed by the factor loadings (CFA), CR and AVE values. Discriminant validity was further confirmed by comparing the within-construct item factor loadings to across-construct item loadings. Since all within-construct item loadings were high (exceeding 0.7), and clearly higher than the cross-loadings, discriminant validity could be assumed. Finally, scores were compared with the squared correlations among the constructs. All AVEs exceeded the values of the squared correlations among the constructs in the corresponding rows and columns (see Table 2). As such, discriminant validity was confirmed.

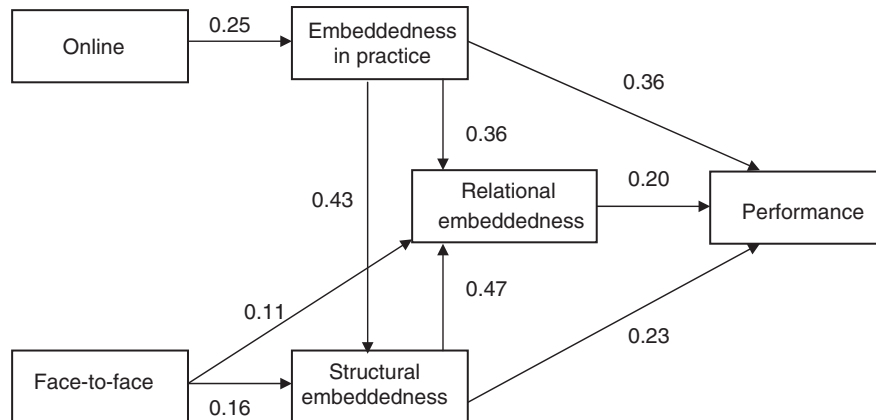
Results

In order to determine the influence of the variables discussed above on the performance, structural equation modeling (SEM) was applied, using AMOS 5.0, which provides SEM and analysis of covariance structures, or causal modeling. Where the measurement model (which was discussed above) concerns the validity and reliability of the measurements used, a structural model concerns the causal relations between these measurements. SEM basically entails the testing of a set of regression equations

Table 2 Squared correlations and Average Variance Extracted for measures

	1	2	3	4
1 Performance	0.613			
2 Embeddedness in practice	0.325	0.690		
3 Structural embeddedness	0.260	0.176	0.589	
4 Relational embeddedness	0.270	0.281	0.372	0.750

Table shows squared Pearson correlation coefficients between variables. AVEs for composite scales are shown on diagonals (in bold).

**Figure 2** Tested model.

Fit statistics: chi-square = 8.1 (df = 5, $P = 0.15$), AGFI = 0.93, TLI = 0.96, RMSEA = 0.06.

Numbers near arrows denote standardized parameters for relationship strength, ranging from -1.0 to 1.0.

simultaneously, providing both parametric statistics for each equation and indices that indicate the fit of the model to the original data. Models can thus be adjusted in terms of adding or deleting relationships. The strength and significance of the different hypothesized relationships were therefore tested using AMOS 5.0.

The model produced mixed results for model fit: chi-square analysis was not significant (5.5, df = 2, $P = 0.06$), and the ratio of the chi-square to the degrees of freedom was 2.8. Since the chi-square value is sensitive to sample size and non-normality, the ratio of chi-square to degrees of freedom is preferred as a fit statistic (Browne and Cudeck, 1993). Although different critical values are considered valid for this statistic, values below 3.0 are generally assumed to indicate a sufficient fit, and values below 2.0 a close fit. Whereas the chi-square statistic thus indicated a sufficient fit, some of the relative fit statistics indicated that the model's fit was barely sufficient: AGFI was below the critical value of 0.90 at 0.88, the TLI should be close to 1 and it scored 0.90, and finally, the RMSEA was 0.11, whereas a value of 0.05 would indicate a close fit, and a value of 0.08 or lower still indicated a reasonable error of approximation. Further inspection of the results revealed that the model also contained a number of relationships that were not significant at the 0.05 level:

- Use of face-to-face communication was not found to influence embeddedness in practice, rejecting hypothesis 6a;

- Use of ICT was not found to influence either structural or relational embeddedness, rejecting hypotheses 7b and 7c.

We decided that these non-significant relationships must be removed from the model, leading to the model that is presented in Figure 2.

This tested model had a satisfactory fit: the chi-square value (8.1, df = 5) was not significant ($P = 0.15$), and the ratio of chi-square to df was 1.6. AGFI scored 0.93 and TLI scored 0.96, both indicating a sufficient fit. The RMSEA value of 0.06 fell just short of a close fit (0.05), but it was well within the range of a satisfactory error of approximation (0.08). All relationships in this model were significant at $P < 0.05$. Finally, the model explained 43% of the variance in performance.

The results shown in Figure 2 provide support for most of our hypotheses. First of all, network members' performance is determined by embeddedness in practice, structural embeddedness and relational embeddedness of the network, providing support for hypotheses 1, 2 and 3. Next, we also find support for our assumptions concerning the interrelatedness of these forms of embeddedness: structural embeddedness positively influences relational embeddedness, in line with hypothesis 4, and the level of embeddedness in practice influences both structural and relational embeddedness of the network, providing support for hypotheses 5a and 5b. As for media use, we find that face-to-face communication positively influences the level of structural and relational embeddedness, supporting hypotheses 6b and 6c, and finally, the use of ICT was

found to positively influence the level of embeddedness in practice, providing support for hypothesis 7a.

Discussion

Our study demonstrates that embeddedness in practice, structural embeddedness and relational embeddedness are important determinants of the value of NoPs in terms of member performance. In other words, for NoPs to contribute to network members' performance, the knowledge being created and exchanged in the network must be integrated into network members' daily work, members must be well connected with each other and have insight into who knows what, and there must be a positive social climate in the network, characterized by trust, reciprocity and social identification. This means that conceptualizing such networks as tools that can be implemented to stimulate knowledge sharing is not realistic: such an instrumental approach overlooks the importance of embeddedness – both in practice, and in terms of social relations. Embeddedness is something that almost by definition emerges in a bottom-up fashion, out of shared experiences, practices and a shared social context. Regardless of the origin of the network (which may very well be instigated in a top-down fashion), the actual dynamics between network members determine the level of embeddedness (in practice, structural and relational) and thus, the network's contribution to member performance. As NoPs are often implemented as 'means to an end', in a more or less top-down fashion, this can create an interesting tension to the top-down organizational goals underlying the implementation of these networks on the one hand, and the emergent nature of these dynamics on the other. Identifying three forms of embeddedness as antecedents of network member performance (and thus, network value) is thus an important contribution to the literature. The value of NoPs is not something that is determined by the quantity of participation as such, but by the *content* exchanged in the network (embeddedness in practice) as well as the *connections* between network members.

Next, our results also show that embeddedness is positively influenced by communication via both ICT and face-to-face meetings. Where ICT is primarily conducive in terms of *content* (providing the information that is relevant for members' practices, creating their common 'know how' concerning this practice), the richer communication in face-to-face settings is primarily conducive to the *connections* in the network. Even though the reduced social cues approaches that were discussed in our theoretical framework are often considered to be out of fashion, we do find some support that the 'leaner' communication via ICT has a positive contribution to task-oriented communication concerning members' practices, and the 'richer' communication via face-to-face contributes to the social dimensions of this communication. Since the different forms of embeddedness were also found to be interrelated, however, this is not as simple as it seems: by increasing embeddedness in practice, ICT can also enhance the structural and relational embeddedness of an NoP.

In general, this difference in influence of online communication and face-to-face communication can be related to recent theoretical developments in the area of the

use of communication media. Media Synchronicity Theory, or MST (Dennis and Valacich, 1999; Dennis *et al.*, 2008), conceptualizes any communication task as consisting of two primary processes: conveyance, or the 'transmission of a diversity of new information – as much new, relevant information as needed – to enable the receiver to create and revise a mental model of the situation' (Dennis *et al.*, 2008: 580), and convergence, or 'the discussion of preprocessed information about each individual's interpretation of a situation, not the information itself' (Dennis *et al.*, 2008: 580). The central point of MST is that convergence processes benefit from synchronicity (a shared pattern of coordinated synchronous behavior with a common focus), whereas conveyance processes do not. Media have different capabilities for meeting these needs for synchronicity, and thus different capabilities for effectively supporting both convergence and conveyance.

Our findings clearly relate to this: face-to-face communication is a medium that scores highly on synchronicity and thus offers support for convergence processes – a shared understanding emerges from such processes. This shared understanding is reflected in the social embeddedness of the network, the feeling of group cohesiveness, of being related to others. Online communication, on the other hand, scores much lower on synchronicity and thus offers more support for conveyance (information processing) than for convergence. This is reflected by the fact that online communication in our findings creates embeddedness in practice (having to do with the *content* being transmitted), whereas face-to-face creates structural and relational embeddedness (having to do with the *connections* between network members). In general, our findings connect with the idea that online communication supports a focus on task-related information, whereas face-to-face communication is primarily related to relational goals (Kayany *et al.*, 1996; Walther, 1997; Münzer and Holmer, 2009). Our contribution to this literature lies in identifying the relationship between media and goals within the setting of an online NoP, and relating these to the value that NoPs have in terms of member performance.

In conclusion, managing NoPs is about managing content and connections. Supporting knowledge sharing in such networks is about wisely balancing the use of different media: online communication to support the creation and exchange of content (and enhance embeddedness in practice), face-to-face communication to support the creation and maintenance of connections (and enhance structural and relational embeddedness). Where literature on NoPs tends to perceive the 'online' part of these networks (in particular discussion forums) as the most important means to support knowledge sharing (e.g. Vaast, 2004; Hustad and Teigland, 2005; Wasko and Faraj, 2005), our findings indicate that providing the opportunity for face-to-face interaction within an online NoP is crucial (for structural and relational embeddedness). However, such interaction will almost by definition be relatively infrequent, which means that the frequent interaction that is necessary for establishing embeddedness in practice will mostly take place by online interaction. This implies that supporting NoPs is about wisely managing which communication media are applied, in which stage of the process of learning within the network. Clearly, more research is

needed to analyze the dynamic aspects of using media to support this social learning process through which one gradually becomes a full member of an NoP.

Limitations and further research

There are two important limitations to this research that must be taken into account when drawing conclusions: the fact that respondents from different networks were all taken together in the sample, and the fact that no distinction was made between the different functions that ICT can have.

First of all, respondents in the sample came from different networks. By aggregating the responses of the members of these various networks, the diversity of the activities (content, level of participation, functionalities used, etc.) has not been taken into account in these analyses. The aim was to conduct a general analysis of the factors affecting NoP value, regardless of specific characteristics of the networks, so in that sense integrating the responses was justified. Unfortunately, a lot of possibly relevant information is lost in this process. Future research would benefit from going more in depth into different networks, and accounting for the specific dynamics within those networks, in order to gain a more detailed understanding of what determines their value.

Second, ICT was treated as kind of a 'black box' in this research, based on the main argument that often social networking tools integrate various functions. The only thing that was measured was the proportion of time people spent communicating via NetTool, but not what specific functionalities they did or did not use. This could be relevant, though, since a network in which members primarily store and retrieve information might well have a different value from a network in which the emphasis is primarily on using social interactive functionalities such as discussion fora. As the theoretical reasoning leading to hypotheses 7a through 7c does imply that different functionalities have different consequences for embeddedness, future research should make the distinction between different functionalities in ICT. We would suggest distinguishing at least storage/retrieval, expertise finding, and social interaction as functionalities in further research, as these may well have different effects on the different dimensions of embeddedness. On the other hand, the whole concept of tools like NetTool is that they are *integrative* and offer a complete environment for online collaboration. The value of such tools largely stems from the ability they offer users to integrate and combine different functionalities as they please, so a counter-argument could be that analyzing each functionality separately would lead to an artificial separation of things that in the users' perception may well be one and the same online tool. Still, making a distinction between the different functionalities may be a very valuable approach in future research.

Conclusion

This study helps to understand the contribution of online NoPs in managing knowledge sharing within distributed organization. It shows that the value of networks mainly resides in being embedded in practice and in social relations. Consequently, the study can be considered a warning for the growing tendency to perceive knowledge

networks as tools that can be implemented independently from their relation with the local practice and social context. Moreover, the study shows that the media used by members of such NoPs influence this degree of social embeddedness and embeddedness in practice. Organizations relying on such networks need to consider a combination of various communication media rather than relying solely on one medium, such as electronic networks.

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