Knowledge sharing in inter-unit cooperative episodes: The impact of organizational structure dimensions

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ABSTRACT

We study how classic organizational structure dimensions should be altered to be more adapted to organizational knowledge sharing. In particular, we look at the dimensions: coordination, centralization, formalization, and specialization; and assess their impact on inter-unit knowledge sharing. These classic organizational structure dimensions are underpinning the differentiation–integration balance, which has been the major task structure (Lam, 1997, 2000), informal versus formal coordination (Tsai, 2002), incentive structures (Osterloh & Frey, 2000), or technology (Birkinshaw, Nobel, & Ridderstrale, 2002); while existing literature that provides insight into the relationship between organizational structure and knowledge sharing much further through a focus on the structural dimensions only, and knowledge sharing within inter-unit cooperative episodes. In doing so, we analyze how each of the classic organizational structure dimensions relates to the concepts of knowledge sharing by building on the classic organization theory literature and more recent advances on knowledge sharing. Knowledge is here viewed as: “a product of human reflection and experience, located in an individual or a collective, or embedded in a routine or process” (De Long & Fahey, 2000:114). Knowledge sharing is then defined as: “the process through which one unit is affected by the experience of another” (Argote & Ingram, 2000:151).

A large body of literature on organizational aspects and knowledge sharing already exists (Grover & Davenport, 2001). However, existing literature that provides insight into the relationship between organizational structure choices and knowledge sharing is fragmented. Authors discussing the concept of knowledge sharing have focused on one particular aspect of organization structure: the role of networking (Hansen, 2000; Scarbrough, 1995), the impact of task structure (Lam, 1997, 2000), informal versus formal coordination (Tsai, 2002), incentive structures (Osterloh & Frey, 2000), or technology (Birkinshaw, Nobel, & Ridderstrale, 2002); while authors discussing organizational structure dimensions have not explicitly clarified the relationship between structure and knowledge sharing (such as Daft & Lengel, 1986; Tushman & Nadler, 1978). Furthermore, the field of organization theory is also highly fragmented, hindering an integrated view on organization structure and knowledge sharing.

The paper continues with explaining the relevance of each of the dimensions for understanding processes of knowledge sharing.

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1. Introduction

Studying effective inter-unit knowledge sharing in organizations requires insight into how organizational structure influences and shapes the cooperative episodes in which knowledge sharing takes place. To obtain this insight, we revisit four of the most important classic organizational structure dimensions, namely coordination, centralization, formalization, and specialization; and assess their impact on inter-unit knowledge sharing. These classic organizational structure dimensions are underpinning the differentiation–integration balance, which has been the major focus in the classic organization theory literature (Lawrence & Lorsch, 1969; Miller & Drogue, 1986; Mintzberg, 1979). Coordination, centralization, and formalization are tuning and integrating units’ tasks and behaviour, while specialization is causing differentiation among units. Although very classic, these dimensions are still frequently used in organizational design research (Cunningham & Rivera, 2001; Tsai, 2002). Three of these dimensions have also been used in a recent study of Chen and Huang (2007); the only study that revisited several of the classic organization structure dimensions to explain knowledge sharing. They have studied the relationship between organizational structure and knowledge management mediated by social interaction. Our study continues on these authors’ work by exploring the link between organizational structure and knowledge sharing much further through a focus on the structural dimensions only, and knowledge sharing within inter-unit cooperative episodes. In doing so, we analyze how each of the classic organizational structure dimensions relates to the concepts of knowledge sharing by building on the classic organization theory literature and more recent advances on knowledge sharing. Knowledge is here viewed as: “a product of human reflection and experience, located in an individual or a collective, or embedded in a routine or process” (De Long & Fahey, 2000:114). Knowledge sharing is then defined as: “the process through which one unit is affected by the experience of another” (Argote & Ingram, 2000:151).
The next part describes our research strategy, the method of data collection, and the results. Sections 5 and 6 bring this paper to an end.

2. Organization structure and knowledge sharing

2.1. Coordination choices

Coordination takes a special place in our discussion. Coordination choices are central to organization structure (Van De Ven, Delbecq, & Koenig, 1976). Mintzberg (1979: 2), e.g. illustrates this by saying: "The structure of an organisation can be defined simply as the sum total of the ways in which it divides its labour into distinct tasks and then achieves coordination among them." We define coordination as the process of informing each as to the planned behaviours of the others (Simon, 1945). This occurs through the use of firm-specific coordination mechanisms (Martinez & Jarillo, 1989).

The impact of coordination on knowledge sharing depends on the kind of coordination mechanisms used, and this is closely related to the other structure dimensions (centralization, formalization and specialization). In particular, we will explain the following two overall propositions that capture the relationships between the organization structure dimensions and knowledge sharing. First, the extent to which coordination is formalized and oriented towards centralized decision-making makes this coordination less fit for inter-unit knowledge sharing (see also Chen & Huang, 2007). Second, the effectiveness of coordination mechanisms for knowledge sharing depends on the level of specialization in the organization and in particular, the levels of knowledge complexity, interdependency and unit differences. Organizations successful in knowledge sharing are able to choose the right combination of coordination mechanisms, including a combination of centralized and decentralized coordination (Nonaka, Von Krogh, & Voelpel, 2006), depending on the specific levels of interdependency, unit differences, and knowledge complexity in the cooperative episodes between units.

2.2. Centralization and formalization in coordination

Centralization refers to the extent to which decision-making power is concentrated at the top management level in the organization (Hage & Aiken, 1967). Formalization indicates the extent to which the rights and duties of the members of the organization are determined and the extent to which these are written down in rules, procedures and instructions (Schminke, Ambrose, & Cropaanzano, 2000). Both are considered to be negatively related to knowledge sharing. Coordination mechanisms based on centralization and formalization are less appropriate for knowledge sharing than mechanisms that are based on decentralization and low formalization (Chen & Huang, 2007). Centralized and formal coordination are found in the form of formal hierarchical coordination (centralized and formal) and formal systems (formal and mostly centralized) such as plans, procedures, standards and goals. These kinds of coordination formally determine which and how much information and knowledge should be exchanged (Egelhoff, 1991; Galbraith, 1973; Ndumolu, 1996). They determine for instance the knowledge flow in the different steps of a sequentially organized production process. Such coordination is considered to have a low cost but has limited possibilities for enhancing knowledge sharing in a flexible way (Grant, 1996; Lam, 2000). Furthermore, decisions about the sharing of specialized knowledge can only be effective if the centralized decision-maker knows which knowledge is held individually (Bogenrieder & Nooteboom, 2004). Decision-making power on knowledge issues is best delegated to the owner of the relevant knowledge (Jensen & Meckling, 1992). Centralization, and especially hierarchy also have a negative effect on knowledge sharing between units in organizations because of the control embedded in centralized systems (Chen & Huang, 2007; Kramer, 1999; Tsai, 2002). Top-down directives can reinforce an environment of fear, distrust and internal competition, reducing collaboration and integrative actions (Senge, 1997). Formalization has similar disadvantages to centralization for knowledge sharing. It creates an environment of control and reduces flexibility in knowledge sharing. Formalization is thus ineffective to reach integration from a knowledge sharing point of view (Chen & Huang, 2007; Van den Bosch, Volberda, & de Boer, 1999).

Decentralised, i.e. horizontal-coordination consisting of teams, mutual adjustment, networking, and integration roles (less formal and decentralized) allows flexible coordination during task execution and can deal with ad hoc communication and information needs (Galbraith, 1973). Teams and similar kinds of horizontal coordination allow high levels of integration (Lawrence & Lorsch, 1967). Liaisons and coordinators can even play the role of knowledge brokers. Nonaka et al. (2006) use the concept of knowledge activists to explain how knowledge crosses unit boundaries. Teams can be composed whenever a need for knowledge sharing arises (Ayas & Zeniuk, 2001; Grant, 1996; Van den Bosch et al., 1999). Communities of practice for instance, are examples of teams or project groups reaching high levels of knowledge sharing (Ayas & Zeniuk, 2001; McDermott, 1999). For even more urgent and less intensive sharing, mutual adjustment can solve the communication and knowledge-sharing problem. Hence, horizontal coordination will result in more communication and knowledge sharing among units (Cabrera & Cabrera, 2002; Ghoshal, Korine, & Szulanski, 1994).

Informal coordination (informal and decentralized) was not topical in the classic organization structure literature but received thorough attention in the network literature, which also stressed the relationship with knowledge sharing. Informal coordination, i.e. any form of personal contact between people and units in the organization that is not intended or imposed by management (Mintzberg, 1989; Van De Ven et al., 1976), can have a major impact on knowledge sharing, and can even have knowledge sharing as its raison d’être. Informal interactions between units constitute an important means for integrating diffused expert knowledge in organizations and to cross internal and external organizational boundaries (Widén-Wulff & Gimnan, 2004). This informal coordination is based on trust and voluntary cooperation, creating a high willingness for cooperation and knowledge sharing based on non-reciprocal pro-social behaviour (Bogenrieder & Nooteboom, 2004; Chen & Huang, 2007; Constant, Kiesler, & Sproull, 1994; Jarvenpaa & Staples, 2001). However, some authors have also pointed at the drawbacks of informal coordination for knowledge sharing, especially when informal networking is a source of power (Willem & Scarbrough, 2006). Nonetheless, the informal character of informal coordination has a positive effect on knowledge sharing.

Summarising the above leads to support for the proposition that decentralized and informal coordination is preferred. However, it is unclear whether indeed less centralization and less formalization are generally preferred; whether a contingency view should be taken in line with the classic structure literature, or whether an optimal level of centralization and formalization in coordination exists. Our study takes a step in answering this question by investigating the following two propositions.

**Proposition 1a.** The more decentralized coordination, the more knowledge will be shared between the units.

**Proposition 1b.** The more informal coordination, the more knowledge will be shared between the units.
2.3. Specialization and coordination

Specialization is the extent to which the organizational tasks are divided into subtasks, and people are allocated to execute only one of these subtasks (Mintzberg, 1989). Specialization causes the development of specific knowledge uniquely held by an individual or group (Grant, 1996). Organizations are thus dispersed knowledge systems and have the organizational task to utilize this dispersed knowledge (Tsoukas, 1996). Knowledge management literature has paid thorough attention to the impact of specialized knowledge on knowledge sharing. In doing so, several closely related concepts are developed, such as tacit (Johannessen, Olaisen, & Olsen, 2001; Johannessen & Olsen, 2003; Polanyi, 1997), non-codified (Zander & Kogut, 1995), embedded (Nidumolu, Subramani, & Aldrich, 2001), sticky (Szulanski, 2000), and dependent (Birkinshaw et al., 2002; Hansen, 1999) knowledge. These concepts all refer to the context-related character of knowledge and the difficulty to share dispersed and specialized knowledge between individuals or groups. We follow Hansen (1999) who integrates the knowledge characteristics, tacitness and dependency into the complexity dimension of knowledge. Knowledge complexity, resulting from organizational specialization, is then the extent to which knowledge is tacit and dependent upon knowledge of a larger system (Johannessen et al., 2001).

The relationship among knowledge complexity, coordination and knowledge sharing becomes clear through revisiting another classic organizational characteristic, technology. Birkinshaw et al. (2002) explain that knowledge can be considered as a contingency element in organizational structure choices, with an impact and role comparable to technology. Technology and knowledge are closely related concepts. Technology refers to the technical system that includes the collective instruments used to do the work in organizations (Mintzberg, 1979: 250) or actions that an individual performs upon an object to make some changes to the object (Perrow, 1967). There exists a parallel between the concept of knowledge complexity and the technology dimensions 'complexity' and 'dependency.' The more complex the technology in terms of low analysability, and thus the more complex the knowledge required for this technology, the more difficult to integrate units and the more there is a need for complex integration mechanisms (Daft & Lengel, 1986; Galbraith, 1973). Such complex integration mechanisms are inter-unit horizontal and informal coordination (Gargiulo & Benassi, 2000; Grandori, 1997a; Hansen, 1999; Lam, 2000). The parallel between technology complexity and knowledge complexity allows us to extend the relationship between technology and coordination to complex knowledge in the context of knowledge sharing.

Proposition 2a. The higher knowledge complexity, the more decentralized and informal coordination is required for the sharing of knowledge between the units.

Another dimension of technology refers to interdependency; i.e. the extent to which different units are dependent on each other to perform their tasks (Thompson, 1967). Task interdependency is a major determinant in choosing coordination mechanisms (Grandori, 1997b; Heugens, 2005; Thompson, 1967). The higher the interdependency, the more horizontal coordination is required (Galbraith, 1973). Technology interdependency parallels knowledge complexity in terms of dependent knowledge because (technology) interdependency involves knowledge dependency. Furthermore, organization theory literature teaches us that the need for sharing information between units is a function of the interdependency between the units (Argyres, 1995; Heugens, 2005; Thompson, 1967). This can be extended to knowledge sharing; i.e. a higher need for knowledge sharing between units exists when these units are interdependent.

Proposition 2b. The higher the interdependency between the units, the more decentralized and informal coordination is required for the sharing of knowledge between the units.

Daft and Lengel (1986) added to the interdependency and coordination relationship that it is the combination of interdependency and differences between departments that requires the use of rich media to allow sufficient inter-departmental coordination; i.e. sufficient information sharing. This argument can again be extended to knowledge sharing between units. Hence, following Daft and Lengel (1986), it is the combination of interdependency and unit differences that requires informal and decentralized coordination for adequate knowledge sharing. The next proposition draws this relationship.

Proposition 2c. The higher the interdependency and differences between the units, the more decentralized and informal coordination is required for the sharing of knowledge between the units.

3. Method

3.1. Research setting

We opted for data collection in two organizations, because this allowed us for the testing of context embedded relationships. In studying knowledge sharing within one organization, there is control on the organizational context; while a comparison between the two organizations allows the exploration of the context-specificity of the relationships found. Two organizations were selected which were active in two different sectors of industry, allowing sufficient heterogeneity. We selected organizational settings with an organizational complexity that would necessitate significant efforts in knowledge sharing with a sufficient large size, allowing the study of a sufficient number of cooperative episodes. Within each organization cooperative episodes between units are selected as unit of analysis.

The two organizations were medium-sized companies in Europe with 13,600 and 15,000 employees, respectively. Both had international activities, but our study focused on the Belgian parts of the companies. The energy company went through a major restructuring and reduction in number of employees due to a change in market conditions. Reorganizations took place to increase efficiency in the production sites. As a consequence, many employees had to change locations or functions and had to learn new skills. The restructuring and reorganization also involved a reduction in hierarchical decision-making in favor of more decentralized decision-making, an increased use of teamwork and other horizontal coordination. Initiatives to increase inter-unit knowledge sharing were at the time of data collection still in a premature and mainly conceptual phase.

The financial company, active in retail, corporate banking and insurance could be considered as relatively centralized and bureaucratic. This organization also went through a major restructuring phase due to a large merger. At headquarters, some units disappeared; others were integrated, split-up or reoriented. Many employees had to change functions and location. Although the merger had a large impact on the organization, the main organizational structure dimensions, such as level of centralization and formalization, did not alter much due to the restructuring. Initiatives to increase inter-unit knowledge sharing were also premature and they were not considered a high priority.

Both organizations had a similar context regarding size, complexity, reorganizations, insufficient priority to knowledge sharing, and (high) levels of specialization. Contextual differences existed mainly in the activities because of the different sectors of industry. Structure features are considered not industry-specific and
therefore, it is expected that size among other characteristics is more relevant here than the sector of industry (Burton & Obel, 1995; Mintzberg, 1979).

3.2. Sample

In the energy company, all employees in the production sites of the company, on the management level and the level of senior staff – excluding manual labour workers – were selected to participate in our study. They received a questionnaire in which they were asked to select a cooperative episode with another unit in the production part of the company and to briefly describe this episode at the beginning of the questionnaire. Some of these cooperative episodes involved teamwork with team members of several units. The nature of the cooperative episodes varied widely, but typical examples were: cooperation between units on the control of production machinery, maintenance issues to do with installation, installation of new machinery in particular sites, or joint development of new procedures.

In the finance company, respondents were selected through different steps. The higher access level and engagement of the organizational representatives in our research project allowed a more controlled selection. First, department heads indicated cooperative episodes between a unit of their department and another unit in their or another department. The people involved in such cooperative episodes received a questionnaire and were asked to describe the cooperative episode. Examples of cooperative episodes were: work planning, budgeting planning, developing a marketing campaign, developing new procedures, handling exceptional and routine requests of customers, IT development projects, and writing internal courses.

The method of selection in the finance company resulted in a much larger response rate (53%) than in the energy company (15%), where no particular support of the department heads could be obtained. The final sample consisted of 408 correctly completed questionnaires, respectively 253 in the finance company and 155 in the energy company. Additional information about the formal structure of the organizations and the organizations’ activities was obtained from four key sponsors of our study in the companies.

3.3. Measures

A slightly adapted version of the Likert scaled questionnaire of Willem, Bue Is, & Scarbrough (2006), included in Appendix A, was used. In this questionnaire, individuals gave their perceptions on an inter-unit cooperative episode. Four independent variables were used to measure the coordination constructs that reflect the different levels of formalization and centralization in the cooperative episodes. The two variables, formal systems and formal hierarchy measured centralized and formal coordination. More decentralized and informal coordination was measured by the two variables, horizontal coordination and informal coordination. Three other independent variables were related to the specialization dimension and the parallel between technology and knowledge. Knowledge complexity was measured as the extent to which knowledge was tacit and dependent; hence, difficult to articulate and to transfer. The variable interdependency referred to task dependency between units. Unit differences were measured by dissimilarity in tasks and background between the units. The dependent variable knowledge sharing was hard to measure, and therefore proxies were more appropriate. Such proxies were also used in similar empirical studies (Hansen, 1999; Hoopes & Postrel, 1999; Szulanski, 2000).

Supported by those studies, we measured knowledge sharing by proxies in a more subjective and in a more objective way. The proxy, satisfaction with knowledge sharing, measured the perception on the intensity and quality of knowledge sharing between the units, among others by looking for indications of non-sharing or insufficient sharing. The other proxy measured time spent on knowledge sharing, and was an attempt to quantify knowledge sharing in a more objective way. Respondents in both organizations answered the questions only for the particular cooperative episode that they described in the questionnaire; considering only knowledge relevant for the tasks for which the cooperative episode was developed. There was no focus on particular tasks. Cooperative episodes ranged from routine to rare and from operational to strategic, resulting in a wide variation of knowledge implicitly referred to in the answers, such as daily work experiences, predictions for future planning or best practices.

3.4. Data analysis

Several tests were taken in the development phase of the questionnaire to assure the reliability of our measurement instrument (Nunnally, 1978). Pre-tests were done in two smaller companies, and with a group of management students. Cronbach alphas were used as a measure of reliability (Nunnally, 1978). Although a cutoff value of 0.7 for Cronbach alphas is recommended, 0.6 has been accepted as well (Hair, Anderson, Tatham, & Black, 1998; Peterson, 1994). One scale did not reach an adequate level of reliability ($\alpha > 0.6$). The scale on informal coordination had reliability above 0.5, risking type II errors in the conclusions (Lipsey, 1990; Peter, 1979). To estimate the risk of common method variance, we used the Harman’s one-factor test (Podsakoff & Organ, 1986). The test indicates that common method variance is present when one factor counts for a majority of the covariance in the variables. Applying the test to our data indicated that three factors arise (eigenvalues higher than one) and not one factor counting for the majority of the variance. Tables 1 and 2 list the intercorrelations, means, standard deviations and Cronbach alphas for the two studies.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Means, standard deviations and bivariate correlations of the variables for the finance company (Cronbach alphas in italic on diagonal)*.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>Formal systems</td>
<td>3.34</td>
</tr>
<tr>
<td>Formal hierarchy</td>
<td>3.15</td>
</tr>
<tr>
<td>Horizontal coordination</td>
<td>3.23</td>
</tr>
<tr>
<td>Informal coordination</td>
<td>3.73</td>
</tr>
<tr>
<td>Interdependency</td>
<td>2.60</td>
</tr>
<tr>
<td>Knowledge complexity</td>
<td>2.49</td>
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<tr>
<td>Unit differences</td>
<td>3.67</td>
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<tr>
<td>Time spent on knowledge sharing</td>
<td>2.61</td>
</tr>
<tr>
<td>Satisfaction with knowledge sharing</td>
<td>3.75</td>
</tr>
</tbody>
</table>

* $n = 249$.
** Correlation is significant at the 0.05 level (two-tailed).
*** Correlation is significant at the 0.01 level (two-tailed).
We analyzed our data using linear regression analyses. Time spent on knowledge sharing and satisfactions with knowledge sharing were not correlated; hence, it was useful to differentiate in our analysis between quantity (time spent on) and quality (satisfaction with) of knowledge sharing. Two separate models were constructed for the two organizations, one with regression on ‘satisfaction with knowledge sharing’ and one with regression on ‘time spent on knowledge sharing.’ Interaction effects were assessed by significant changes in adjusted $R^2$. The next section displays the regression results. We opted for a separate statistical analysis of the data of the two organizations because of contextual and sector differences that might influence the structure dimensions. In Section 5, a comparative analysis between the two studies reveals possible generic effects of our organizational structure dimensions on knowledge sharing.

4. Regression results

The standardized regression coefficients, $t$-values and $R^2$ for the finance company are listed in Table 3. Satisfaction with knowledge sharing significantly varied with the use of horizontal coordination mechanisms ($\beta = 0.17$) and the level of knowledge complexity ($\beta = -0.45$). Less knowledge complexity and more use of horizontal coordination was related to higher satisfaction with knowledge sharing. Higher satisfaction with knowledge sharing also existed when interdependent units were not too different ($\Delta R^2 = 0.019$). Moreover, satisfaction was further increased when such situation was accompanied with informal coordination ($\Delta R^2 = 0.017$). Hence, in the finance company, decentralized coordination increased the quality of knowledge sharing. Episodes involving high interdependency and low unit differences benefited from low formalization.

Time spent on knowledge sharing was related to the use of formal systems ($\beta = -0.22$), horizontal coordination ($\beta = 0.22$) and interdependency ($\beta = 0.40$). In particular, higher interdependency was related to or required more knowledge sharing, and such sharing was best organized by horizontal inter-unit coordination. Very formal systemic coordination was clearly related to less time spent on knowledge sharing. Several interaction effects revealed that the relationships between the organizational characteristics and knowledge sharing were more complex. High interdependency was best dealt with informal coordination. When interdependency was high but knowledge complexity low, informal coordination and horizontal coordination were preferred. Hence, the use of decentralized and informal coordination did increase knowledge sharing:

### Table 2

Means, standard deviations and bivariate correlations of the variables for the energy company (Cronbach alphas in italic on diagonal)*.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>S.D.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time spent on knowledge sharing</td>
<td>3.22</td>
<td>0.93</td>
<td>0.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction with knowledge sharing</td>
<td>3.44</td>
<td>0.66</td>
<td>0.04</td>
<td>0.13</td>
<td>0.43</td>
<td>0.01</td>
<td>0.08</td>
<td>0.26</td>
<td>0.12</td>
<td>0.74</td>
<td></td>
</tr>
</tbody>
</table>

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** Correlation is significant at the 0.01 level (two-tailed).

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*Correlation is significant at the 0.05 level (two-tailed).

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### Table 3

Regression analyses (finance company).

<table>
<thead>
<tr>
<th>Variable</th>
<th>$\beta$</th>
<th>t-Value</th>
<th>Regression on time spent on knowledge sharing</th>
<th>$\beta$</th>
<th>t-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centralized and formal coordination</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Formal systems</td>
<td>0.01</td>
<td>0.19</td>
<td>−0.22</td>
<td>−3.59**</td>
<td></td>
</tr>
<tr>
<td>Formal hierarchy</td>
<td>−0.06</td>
<td>−1.01</td>
<td>0.04</td>
<td>0.72</td>
<td></td>
</tr>
<tr>
<td>Decentralized and semi-formalized</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal coordination</td>
<td>1.07</td>
<td>2.81**</td>
<td>0.22</td>
<td>3.56**</td>
<td></td>
</tr>
<tr>
<td>Decentralized and informal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>coordination</td>
<td>0.10</td>
<td>1.79</td>
<td>0.04</td>
<td>0.77</td>
<td></td>
</tr>
<tr>
<td>Specialization</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interdependency</td>
<td>−0.07</td>
<td>−1.27</td>
<td>0.40</td>
<td>6.86**</td>
<td></td>
</tr>
<tr>
<td>Knowledge complexity</td>
<td>−0.45</td>
<td>−7.95**</td>
<td>0.04</td>
<td>0.72</td>
<td></td>
</tr>
<tr>
<td>Unit differences</td>
<td>−0.06</td>
<td>−1.04</td>
<td>−0.03</td>
<td>−0.48</td>
<td></td>
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<tr>
<td>Interaction effects</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Interdependency $\times$ informal</td>
<td></td>
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<td></td>
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<tr>
<td>Interdependency $\times$ complexity</td>
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<td></td>
</tr>
<tr>
<td>Interdependency $\times$ unit differences</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Knowledge complexity $\times$ horizontal</td>
<td></td>
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</tr>
<tr>
<td>Interdependency $\times$ complexity $\times$ informal</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

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*Correlation is significant at the 0.01 level (two-tailed).

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*Correlation is significant at the 0.05 level (two-tailed).
while formalized coordination negatively influenced knowledge sharing. Interestingly here was the fact that decentralized and informal coordination were useful in cooperative episodes with high dependency, especially when knowledge was not too complex.

The standardized regression coefficients, t-values and $R^2$ for the energy company are listed in Table 4. Satisfaction with knowledge sharing was not directly related to any of the coordination types. The lower the complexity ($\beta = -0.58$), the higher was the satisfaction with knowledge sharing. Interdependency ($\beta = -0.16$) reduced satisfaction, and this was even more so when the inter-unit integration was informal ($\Delta R^2 = 0.016$). Our independent variables had little effect on time spent on knowledge sharing ($R^2 = 0.05$). High interdependency ($\beta = 0.17$) and the use of horizontal coordination ($\beta = 0.20$) was related to more time spent on knowledge sharing. Hence, horizontal coordination was preferred for knowledge sharing but the effect was very marginal. More informal coordination was not preferred from an inter-unit knowledge sharing perspective in this organization.

Table 4

<table>
<thead>
<tr>
<th>Coordination Type</th>
<th>$\beta$</th>
<th>t-Value</th>
<th>$\beta$</th>
<th>t-Value</th>
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<tbody>
<tr>
<td>Centralized and formalized coordination</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Formal systems</td>
<td>-0.14</td>
<td>-1.82</td>
<td>0.01</td>
<td>0.11</td>
</tr>
<tr>
<td>Formal hierarchy</td>
<td>-0.11</td>
<td>-1.50</td>
<td>-0.06</td>
<td>-0.74</td>
</tr>
<tr>
<td>Decentralized and semi-formalized coordination</td>
<td>0.07</td>
<td>0.92</td>
<td>0.20</td>
<td>2.31*</td>
</tr>
<tr>
<td>Decentralized and informal coordination</td>
<td>-0.02</td>
<td>-0.31</td>
<td>0.06</td>
<td>0.72</td>
</tr>
<tr>
<td>Specialization</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interdependency</td>
<td>-0.16</td>
<td>-2.42*</td>
<td>0.17</td>
<td>2.05*</td>
</tr>
<tr>
<td>Knowledge complexity</td>
<td>-0.58</td>
<td>-7.56*</td>
<td>-0.04</td>
<td>-0.41</td>
</tr>
<tr>
<td>Unit differences</td>
<td>0.01</td>
<td>0.14</td>
<td>0.12</td>
<td>1.45</td>
</tr>
<tr>
<td>Interaction effects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interdependency $\times$ informal Coordination</td>
<td>$\Delta R^2$: 0.016*</td>
<td>adj. $R^2$: 0.40</td>
<td>adj. $R^2$: 0.05</td>
<td></td>
</tr>
<tr>
<td>$n = 155$</td>
<td>$n = 145$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Correlation is significant at the 0.05 level (two-tailed).
** Correlation is significant at the 0.01 level (two-tailed).

The dimensions of organization structure, specialization, formalization, centralization, and coordination are related to knowledge sharing but not to the extent and in the direction suggested by the literature.

5. Discussion

The dimensions of organization structure, specialization, formalization, centralization, and coordination are related to knowledge sharing but not to the extent and in the direction suggested by the literature.

5.1. Centralization and formalization in coordination

A comparative analysis of the two organizations did not indicate an overall negative effect of centralized coordination (systems and hierarchy) on knowledge sharing. No evidence was found for the effect of hierarchy (centralized coordination) on knowledge sharing. However, there was evidence that decentralization through the use of horizontal coordination, such as teamwork, resulted in more knowledge sharing in both cases. Horizontal coordination brought different knowledge stocks together, as was assumed in the literature (Nonaka & Takeuchi, 1995). Hence, knowledge sharing can be somewhat forced through literally putting people together. Furthermore, Zarrage and Bonache (2005) explain that several conditions in teams, such as trust and other psychosocial factors resulting in a ‘high care’ context, highly increase the positive effect of knowledge sharing within the team. We might expect that similar psychosocial factors also impact the use of teams for inter-unit knowledge sharing (Andrews & Delahaye, 2000; Muthusamy & White, 2005; von Krogh, 1998). This supports Proposition 1a because decentralized coordination resulted in more knowledge sharing. In the finance company, respondents indicated that they were also more ‘satisfied’ with knowledge sharing in teams. In this finance company, the use of systems lead to less time spent on knowledge sharing. Thus, formalization through systems coordination had a negative impact on knowledge sharing; however, this only seemed to be the case in the structure of the financial institution. Hence, evidence for hypothesis 1a is partly context-specific. Additional insights in the finance company provide an explanation. The strong formalization in this organization led to some levels of bureaucracy with the usual inefficiencies. Systems were not used for knowledge sharing but only for planning, control and standardization (Makhija & Ganesh, 1997). This reduced the need and possibility for more ad hoc communication and personal inter-unit relationships (Grant, 1996). Consequently, people in the cooperative episode had less possibilities to meet and to spend time on knowledge sharing. Satisfaction with knowledge sharing when horizontal coordination was used combined with the lack of time spent on knowledge sharing in the formal systems coordination might furthermore indicate that horizontal coordination was a counterbalance for the formal character of the organization; although, even horizontal coordination was still rather formal in this organization.

Both cases did not support the Proposition 1b that more informal coordination positively affects knowledge sharing. This is surprisingly because informal coordination is mentioned as a true knowledge integrator (Burt, 1997; Hansen, 1999; Jarvenpaa & Staples, 2001). Hence, neither system as highly formal, nor informal network coordination as highly informal inter-unit coordination is affecting knowledge sharing in the energy company; and in the finance company there is only partly evidence for the formalization impact through the negative effect of systems coordination. Our comparative analysis thus taught us that there is no evidence for a general rule that less formalization and centralization leads to more knowledge sharing. There is only evidence found on the fact that teamwork creates opportunities for knowledge sharing.
5.2. Specialization and coordination

We studied to what extent specialization (reflected in knowledge complexity), unit differences and interdependency affect inter-unit knowledge sharing. Knowledge complexity led to less satisfaction with knowledge sharing in both companies. This is in line with the literature that has pointed at the characteristics of knowledge influencing the extent to which knowledge can and will be shared (Hansen, 1999; Szulanski, 2000). However, the fact that complex knowledge is harder to share is already well known and it is no surprise that it also affects satisfaction with inter-unit knowledge sharing. Remarkable however, is the fact that time spent on knowledge sharing was not directly influenced by knowledge complexity. Time spent on knowledge sharing measured the time people spent on sharing the knowledge that is required in the particular cooperative episode, but this can be a negative as well as a positive sign. More time spent on knowledge sharing can mean that the parties are more willing and interested in sharing their knowledge. It can also mean that the units, which absolutely need to share knowledge to perform the tasks, have to spend more time on knowledge sharing because of difficulties in the sharing process. However, the existence of an interaction effect indicating that more time was spent when complexity was low, even with high interdependency, did not support the latter argument.

The impact of task interdependency between units is far less often studied than knowledge complexity. Interdependency clearly urged units to spend more time on knowledge sharing, confirming the assumption that interdependency does not only require the sharing of more information but also of more knowledge (Daft & Lengel, 1986; Galbraith, 1973). In the energy company only, the inter-depen-dency resulted in less satisfaction with knowledge sharing. This might indicate that in certain contexts, the required (or forced) knowledge sharing due to interdependency can lead to dissatisfaction; for instance, when insufficient knowledge was shared to reach successful cooperative episodes. The interdependency was clearly higher in the energy company than in the finance company, supporting the assumption that forced knowledge sharing due to high task interdependency will result in dissatisfaction with that knowledge sharing.

However, we are particularly interested in whether knowledge complexity and task interdependency alter the effects of inter-unit coordination on knowledge sharing. Comparative analysis revealed that interdependency had an impact on the relationship between informal coordination and knowledge sharing. However, the impact was clearly context-dependent. In the energy company, dissatisfaction with knowledge sharing in formally coordinated cooperative episodes increased when interdependency was high. The somewhat problematic forced knowledge sharing in cooperative episodes with high task interdependency clearly could not be solved by low formalization. Such a situation might have asked for a more formal approach. In the finance company, on the contrary, high interdependency was best dealt with informal coordination. Additional insights into the working of the organizations provided an – although not tested – explanation. These insights taught us that formalization was perceived differently. Formalization was perceived as rather high in the finance company; while formalization was perceived as not yet that high in the energy company.

Therefore, cooperative episodes in the Finance company with a perceived low level of formalization had a positive effect on knowledge sharing because the informal character might have created a favorable knowledge-sharing context. In the energy company, project and teamwork were often organized in a somewhat too informal way, leaving knowledge sharing too much upon altruistic behaviour, which was problematic when interdependency in the episodes was high. The energy company used significantly more horizontal coordination, and the cooperating units were less differentiated but more interdependent. Differences in interdependency and perceived formality might explain why t-tests in a comparative analysis revealed that significantly more time was spent on knowledge sharing, but less satisfaction with knowledge sharing existed in the energy company compared to the finance company.

In this energy company, organizational change resulted in more complex inter-unit cooperative episodes. Only horizontal coordination was sufficiently decentralized and reached an adequate level of formality to facilitate the required knowledge sharing in these complex cooperative episodes. Recent literature on inter-unit coordination has indicated that the less tight and formalized the horizontal coordination, the better it is for knowledge sharing (Ayas & Zeniuk, 2001). The communities of practice literature for instance, mention that communities can be formally established as a kind of formal networking but should be loosely organized to allow spontaneous and rich sharing of information and knowledge (Ayas & Zeniuk, 2001; Wenger & Snyder, 2000). This ‘the more informal, the better’ idea is not supported by our data. It suggests an ‘optimal’ level of formalization instead of minimizing formalization in the context of inter-unit knowledge sharing. Several other relationships, all influenced by the level of interdependency and level of complexity, appeared only in the finance company. More knowledge was shared when knowledge was not too complex, interdependency was high (creating a need for knowledge sharing) and the episode was coordinated in a decentralized and informal way.

There is no generic evidence that fully supports our Propositions 2a, 2b or 2c. Even in the finance company where several interactions were found, the data did not comply with the proposed relationships. Decentralized and informal coordination resulted in more knowledge sharing, but not specifically for the sharing of complex knowledge. Also, our data did not reveal that informal networking was particularly used for dealing with complex knowledge. Hence, we must conclude that the fact that horizontal coordination can deal with complexity and allow richer ‘information sharing’ (Daft & Lengel, 1986) does not extend to the sharing of complex knowledge. Sharing such knowledge is very difficult, slow and requires a lot of effort and good intentions (O’Dell & Grayson, 1998). It is also known that people have a tendency to share knowledge that is already in common and thus more easily shareable (Stasser & Titus, 1987).

6. Conclusions

Our study is grounded in the classic organization structure literature, which has been criticized as being too one-sided and rational (Koza & Thoenig, 2003). Nevertheless, this literature stream still has its merits. In fact, by bringing new issues such as knowledge management into organization structure theory, this theory might regain some of its lost value. Our findings indicate that the structure dimensions influence processes of knowledge sharing in cooperative episodes. To understand the relationships between units in which the inter-unit knowledge sharing is embedded, we must understand how these inter-unit relationships are structured and coordinated. Insight into organization structure provides information on how to make inter-unit knowledge sharing more effective, and contributes to knowledge management and information science literature.

Based on our data, we suggest that there might be an optimum in the formalization required for knowledge sharing, because neither absence of formalization nor strong formalization is optimal for enhancing knowledge sharing. Our results indicated that decentralization in the form of horizontal coordination was preferable.
for knowledge sharing but cannot compensate for high specialization increasing knowledge complexity and unit differences. There was no negative effect on knowledge sharing due to high centralization in the cooperative episodes. Hence, our findings do not fully contradict, but do also not fully support, the earlier research of Chen and Huang (2007) on structure and knowledge sharing; but more importantly our findings show that the relationship is much more nuanced and complex. The variable interdependency is also clearly a neglected factor in knowledge management research. Our data suggested that interdependency, which was important in the classic organization structure literature, remains crucial when we bring knowledge into the organization structure choices. Although knowledge complexity and interdependency influence knowledge sharing, we cannot conclude as Birkinshaw et al. (2002) suggests that knowledge is a contingency factor with similar effects as technology; nor can knowledge sharing be seen as an extension of the impact that information exchange and processing has on organisation structure choices. Knowledge and knowledge sharing are much more context-dependent, preventing the development of contingency relationships for the concept of knowledge sharing in organizations. Knowledge is making the differentiation-integration balance more complex, and the fact that knowledge is so strongly embedded in its context (Nidumolu et al., 2001) makes it hard to formulate general organizational structure principles that optimize intra-organizational knowledge sharing.

However, only two organizations were studied and both are large complex organizations; hence, our results cannot be generalized to all kinds of sectors of industry and environments without further research. It is for instance expected that the relationships found might not hold for small organizations. Other important limitations to our study are the cross-sectional character of the empirical study and the fact that we need to be cautious when assuming causal relationships based on a cross-sectional field study. The first step in further research should therefore be longitudinal research, which is also preferred to study processes and change patterns (Leonard-Barton, 1990; Pettigrew, 1990; Stoecker, 1991). A more processual view on knowledge sharing can complete the more structural view that was now taken in our study. Additional aspects that might also be very relevant to include in future related studies are: the (unit) environment as contingency factor (see Lawrence & Lorsch, 1967), types of knowledge (other than the level of complexity) and knowledge sharing needs.

Appendix A. Operationalization of the variables in the questionnaire

Satisfaction with knowledge sharing
Partly based on the research of Becerra-Fernandez and Sabherwal (2001) and Hoopes and Postrel (1999).

How satisfied are you with the exchange of information and experiences during cooperation between the units?
Was some specific information that was not shared or revealed the cause of delay or lower performance?
There was sufficient sharing of experiences and ideas during the cooperation.
Lack of information has disturbed the task accomplishment and cooperation.

scales used: not at all, rarely, regularly, often, continuously; not at all, to some extent, partly, to a great extent, completely.

Times spent on knowledge sharing
Objectification of intensity of knowledge sharing through objective measurement of times spent on the sharing of knowledge.

How much time did you spend on expressing your knowledge and experiences in oral communication to share it with the other units?
How much time did you spend on expressing your knowledge and experiences in written communication (exclusive the collection of information and writing reports) to share it with the other units?
scale: hardly any time spent, less than 2% of the time spent on the project, between 2 and 10%, between 10 and 25%, more than 25%

Operationalization of the independent variables

Formal systems
The scale on use of systems is based on the theory on coordination mechanisms (such as Galbraith, 1973 and Mintzberg, 1979).

Formal procedures determine how we work together with the other unit.
Information is mainly held in and exchanged through a large number of reports and formal documents.
We have clear goals for our daily work performance.
In general, our work is subject to a large number of rules.
The information that is required to do my job is laid down in procedures, goals and rules.

Hierarchy:
The scale on hierarchy is inspired by the questionnaire of Bacharach and Aiken (1976) and the theory of Simon (1945).

Our work methods follow from the decisions of our supervisors.
Our direct supervisors decide how we should execute our tasks.
Decisions of our supervisors determine how we work.
Our bosses have large impact on our way of working.

Horizontal coordination
The first two items are copied from Miller and Dröge (1986), while the other three items are newly developed and tested.

Inter-unit teams are set up to allow for cooperation and joint decision-making.
Task forces (project teams) are set up to facilitate inter-unit collaboration.
Information and experiences are often shared in meetings or during teamwork.
The person responsible for the cooperative activities is authorized to make all the necessary agreements with the other unit in order to facilitate cooperation.

Informal coordination
The scale is based on the theory on personal networking, such as Edelman, Bresnen, Newell, and Scarbrough (2004) and Hansen (1999).

We coordinate the activities with the other unit informally via personal contacts.
We confer directly with our personal contacts without consulting our supervisors.
We contact directly the colleagues who we know well in the other unit when we need information.
Cooperation with the other unit is based on personal contacts in that unit.

Items are on a five-point scale: totally disagree, disagree, neutral, agree, and totally agree.
Interdependency

Items copied from Gresov and Stephens (1993) (α = 0.8), except last item.

To what extent are the members of your unit depending on the other unit for doing their respective jobs? To obtain the information and materials needed to do their tasks, how much do members of your unit have to rely on the other unit? After your unit members finish their part of the task, how much do they rely on the other unit to perform the next steps in the process before the total task or service is completed? For your unit to accomplish their objectives, how much do you need services, resources or support from other unit?

scales used: not at all, rarely, regularly, often, continuously: not at all, to some extent, partly, to a great extent, completely.

Knowledge complexity

Based on Hansen (1999), Zander and Kogut (1995) and the literature on tacit knowledge, such as Baumar (1999); Polanyi (1997) and Tsoukas (1996).

Is the information that your unit acquired from the other unit written down? Is the information that your unit received from the other unit clearly explained and clarified, in order for your unit to be useful? (scale used: no, limited, partly, mainly, and completely)

Everyone in the other unit easily understands the know-how and information that we are sharing with them. Sharing experiences with the other unit is a quick and easy job. Even without specific skills, the other unit can understand the work and experiences of our unit. A brief explanation is sufficient to understand the information that we share with the other unit. We can share our experiences with each one of the other unit. We can explain to the other unit what competencies and skills we have. It is possible to express what we know in order to explain it to the other unit. Explaining how we do things to the other unit is possible. We can express and explain what we know to the other team.

Unit differences

Based on theory on common knowledge and absorptive capacity, such as Augier, Shariq, & Vendelo (2001); Cohen and Levinthal (1990); Kogut and Zander (1996). The daily tasks are very similar in the two units.

People in the two units have similar skills. People in the two units have comparable jobs. Our backgrounds (such as experience or training) are similar to the ones in the other unit.

References


