Organizing distributed knowledge for collaborative action: Structure, functioning, and emergence of organizational transactive memory systems

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APPENDIX 2. TOWARDS A KNOWLEDGE RESOURCE TAXONOMY

In Chapter 5 the development of a knowledge-resource taxonomy for TMS development has been forwarded as one of the leads for future research. The idea behind this lead is that a better understanding of the various characteristics of various types of organizational knowledge resources may help researchers and practitioners to discuss their particularities in relation to organizational TMS development (e.g. by transforming personalized knowledge to encoded knowledge) (cf. Chapter 2). To this end in this appendix a start is made to integrate the taxonomies that surfaced during the various literature studies that were carried out during the course of this dissertation.

Introduction

The Knowledge Based Theory (KBT) of the firm is based on the premise that knowledge is the most important resource of competitive advantage (Grant 1996; Nickerson and Zenger 2004; Spender 1996; Zack 1999). Unlike time, money, energy, technology, natural resources, knowledge increases when consumed. Moreover, knowledge is a sustainable resource, because through its development it may continue contributing to new solutions and increasing returns (Strong et al. 2008).

But what are we talking about when we speak of knowledge? An epistemological debate on knowledge is besides my interest to gain grip on this resource of competitive advantage. With Machlup (1972), who conducted an extensive study on the subject of knowledge production, I argue that a classification of knowledge is more informative than attempts to define it. Machlup adds two remarks about such classification. First, it needs to be open-ended, because an exhaustive classification would suggest a definition. Second, to make the classification meaningful, its purpose needs to be clear. In compliance with the first, not all features may be needed in all situations and features may need to be added in circumstances not foreseen in this version. With respect to the second, the
purpose of the taxonomy is to contribute to a more articulated language to discuss the particularities of knowledge resources in collaborative networks, needed to advance learning (Tsoukas 2000). Moreover, I concentrate on collaborations characterized by task-interdependence, which become organized through the development of transactive memory systems (Wegner et al. 1991).

**Method**

Following the KBT (Mahoney and Pandian, 1992; Penrose 1959; Prahalad and Hamel 1990; Wernerfelt 1984), and affirming that knowledge is an indivisible property of a system (Connell et al. 2003), I confine the classification to knowledge resources rather than the more abstract concept of knowledge. Where knowledge cannot be managed (Huizing and Bouman 2002; Tsoukas and Vladimirou 2001) knowledge resources can. Thus, where storage bins and repositories make a clear distinction between carrier and content, in knowledge resources this distinction is fused. Moreover, rather than focusing attention on the resources that the firm must use, KBT and KBT focus attention on the services that these resources may provide (Penrose 1959; Tsoukas 2000) and the combinations that can be made (Bosch et al. 1999; Ciborra 1996; Kogut and Zander 1992).

To arrive at the present knowledge resource taxonomy I undertook an extensive literature study. I used post-WO II IS literature as my primary source, making detours to psychology and pedagogy by following the trail of taxonomies used in IS literature. This search led to a myriad of knowledge related taxonomies, many of them developed in the last few decades. Using the perspective of organizational TMS development as criterion, 11 (clusters of) taxonomies were selected (see Table 1). Based on these taxonomies I suggest unifying labels, additions, exclusions, and hierarchical relations. By doing so I inevitably widen the scope of how knowledge is defined. Yet, the resulting articulated language will ease the practical and theoretical dialogue about the combination, integration, and exchange of distributed knowledge resources in firms, needed for organizational TMS development.
<table>
<thead>
<tr>
<th>Taxonomy</th>
<th>Main classes</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate level</td>
<td>Component; architecture</td>
<td>Henderson and Clark 1990; Matusik and Hill 1998;</td>
</tr>
<tr>
<td>Aggregate level</td>
<td>Individual; collective; team; organization; network</td>
<td>Nissen 2006; Matusik and Hill 1998; Spender 1996</td>
</tr>
<tr>
<td>Context</td>
<td>Situated; context independent</td>
<td>Nelson and Winter 1982, 2002; Walsh and Ungson 1991</td>
</tr>
<tr>
<td>Firm knowledge dimensions</td>
<td>Articulable; observable; complexity; dependence (rich, schematic); teachability; articulated; documented</td>
<td>Davenport and Prusak 1998; Zander and Kogut 1995</td>
</tr>
<tr>
<td>Life cycle</td>
<td>Creation; distribution; utilization; feed-back loop</td>
<td>Nissen 2006</td>
</tr>
<tr>
<td>Organizational knowledge types</td>
<td>Conscious; automatic; objectified; collective</td>
<td>Spender 1996</td>
</tr>
<tr>
<td>Repository type</td>
<td>Embrained; embodied; embedded (structures and transformations); encoded; encultured; ecology</td>
<td>Blackler 1995; Collins 1993; Huber 1991; Walsh and Ungson 1991</td>
</tr>
<tr>
<td>Tacit-explicit continuum</td>
<td>Explicit; implicit; tacit; deep tacit</td>
<td>Leonard and Sensiper 1998; Nonaka and Takeuchi 1995; Polanyi 1983</td>
</tr>
<tr>
<td>The 6 journalist questions</td>
<td>Declarative (know what); procedural (know how); causal (know why); relational (know who); spatial (know where); temporal knowledge (know when)</td>
<td>Alavi and Leidner 2001; Borgatti and Cross 2003; Mokyr 2002; Lundvall and Johnson 1994; Fu 2006; Walsh and Ungson 1991</td>
</tr>
<tr>
<td>Tightness</td>
<td>Reliability; complexity; uncertainty; ambiguity; equivocality</td>
<td>Mokyr 2002; Spender 1996; Zach 2007</td>
</tr>
<tr>
<td>TMS knowledge</td>
<td>Role; instance; transactive</td>
<td>Nevo and Wand 2005</td>
</tr>
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</table>

Table 1: Clusters of relevant taxonomies for organizational TMS development
Next I discuss the features of the knowledge resource taxonomy for organizational TMS development. At first order I distinguish four classes, i.e. content, state, resource type, and meta memory. The explanation of how current taxonomies are integrated in this one is given per section.

Content

The first element, content, is described by subject and granularity.

Subject

The subjects of interest of an organization are reflected by the organizational ontology (Nevo and Wand 2005). Alavi and Leidner (2001) identified five knowledge classes that specify a subject being dealt with, i.e. declarative knowledge, procedural knowledge, causal knowledge, conditional knowledge, and relational knowledge. From the perspective of organizational TMS development, this series could be complemented with what Hsiao et al. (2008) call temporal knowledge, clustering knowledge about timing, sequences, durations, age, etc., and spatial knowledge, clustering knowledge about locations, routes, geographical pattern, etc. An early version of this series is also known as ‘the six journalist questions’ (Walsh and Ungson 1991:62), addressing the who, what, when, where, why, and how-questions, merging the conditional and temporal class in a singular know-when.

Mokyr (2002) distinguishes two classes of knowledge that cover the same subject area, i.e. prescriptive knowledge and propositional knowledge. Prescriptive knowledge is defined as ‘instructions that can be executed’ (p4), which is synonym with procedural knowledge as described by e.g. Alavi and Leidner (2001). Propositional knowledge ‘describes and catalogues natural phenomena and the relationships between them’, but is covered in more detail by the six 'journalist questions' of Walsh and Ungson (1991). Thus, subject is described by declarative, procedural, causal, conditional, relational, temporal, and spatial knowledge.
Granularity

To delineate a subject, authors use descriptive phrases such as knowledge domains (Brandon and Hollingshead 2004), knowledge slices (Huizing and Bouman 2002), knowledge nuggets (Angele et al. 1998), or bodies of knowledge (Garud and Kumaraswamy 2005). A more generalized terminology may be derived from Henderson and Clark (1990). Like others (e.g. Spender 1996), they distinguish between architectural knowledge and component knowledge. Architectural knowledge is defined as ‘knowledge about the ways in which the components are integrated and linked together into a coherent whole’ (1990:2). Component knowledge is defined as ‘knowledge about each of the core […] concepts and the way in which they are implemented in a particular component’ (1990:2). Although both definitions emphasis intentional engineering aspects, Henderson and Clark do stress that much of the knowledge involved is tacit.

In the knowledge resource taxonomy, component knowledge and architectural knowledge are treated as instances of the class granularity. Thus, a given subject could be classified as component, architectural, or a mixture of both, as components may be hierarchically nested.

State

Most scholars recognize that knowledge is in a constant flux (e.g. Blackler 1995; Davenport and Prusak 1998; Tsoukas 2000). Hence, at any given point in time knowledge will have a state. Features in the literature that describe this state include tacitness, tightness, temporality, observability, and context.

Tacitness

The most widely referenced taxonomy of knowledge is the distinction between tacit, implicit, and explicit knowledge (Grant and Grant 2008). The concept of tacit, or hidden knowledge was introduced by Polanyi (1966), who used it to describe knowledge that cannot be articulated. Rather than in words, this type of knowledge is expressed in intuition, action, skill, art, etc. Although explicit and tacit knowledge are
often being discussed as if discrete types the two actually form a continuum (Spender 1996). True to the nature of a continuum, they are ‘mutually dependent and reinforcing qualities of knowledge’ (Alavi and Leidner 2001, p112). It would therefore be more appropriate to typify knowledge as either more or less tacit (Spender 2003). In this stream of thought Leonard and Sensiper (1998) speak of ‘deep skills’, which may take a decade to develop (Simon 1981). Griffith et al. (2003) refer to deep skills as deep tacit knowledge, which cannot be explicated. Contrary to the reading of Nonaka and Takeuchi (1995) and others (Al-Natour and Cavusoglu 2009; Alavi and Leidner 2001; Nissen 2006; Spender 1996), who support the stance that tacit knowledge may be externalized (although it may be hard to do so), I support the view that the inexpressible cannot be expressed (Kogut and Zander 1992; Polanyi 1966), and that the tacit knowledge Nonaka and Takeuchi refer to, is actually implicit knowledge, which potentially can be codified (Wilson 2002).

Tightness

Zach developed a taxonomy in which he addressed four problems intrinsic to knowledge, i.e. its complexity, uncertainty, ambiguity, and equivocality (2007). As a result, knowledge in practice is often contested (Blackler 1995; Sousa and Hendriks 2006). Mokyr (2002) developed the concept of tightness, defined as the level of confidence and consensus assigned to a knowledge component, to express how strong people believe that this knowledge component is true. The tighter a knowledge component, ‘the less likely it is that many people hold views inconsistent with it’ (p6).

Temporality

Time is generally indicated as a contextual factor in knowledge related issues (e.g. Boisot 1998; Davenport and Prusak 1998; Savolainen 2006). I only found one knowledge taxonomy that recognizes temporal features as intrinsic attributes of knowledge: Nissen (2006). Life cycle and time flow form two of the four dimensions of his knowledge taxonomy. In
my attempt to keep the taxonomy concise, I placed these two dimensions within the temporality class, allowing for additional temporal state-related features such as age and frequency.

Observability

Zander and Kogut (1995), and Davenport and Prusak (1998) developed knowledge taxonomies, describing ‘the degree to which a capability can be easily communicated and understood’ (Zander and Kogut 1995:79). One feature of this taxonomy is product observability, ‘developed in reference to imitability’ (p79). Within their study the construct is used within the context of industrial competition and reverse engineering (‘i.e., copying the components by inspection’, p79). However, it is just as relevant to other fields of expertise, such as law enforcement and criminal investigation, in which criminals try to outsmart the police. This negative connotation of observability alters into a positive one when observability aids internal capability transfer. Observability is a feature of state, as through time knowledge of knowledge components may proliferate, increasing observability.

Context

Nelson and Winter (1982, 2002) distinguish between knowledge that is context independent and knowledge which is situated. The latter is also referred to as ecological knowledge. Ecological knowledge is remembered through direct interaction with the environment (Walsh and Ungson 1991). Thus, elements within the environment serve as external memory source, which is activated through association. An example one may recognize is the case of a forgotten pin code: it may be remembered by visualizing the keyboard and recognizing the pattern of typing, and thus, remembering the code itself.

Resource type

Although TMS theory distinguishes between internal and external components of memory (Wegner 1986), little attention is being paid to memory resources other than people. Recently, however, Yuan and his
colleagues called for research on the inclusion of external (ICT) components in TMS (Yuan et al. 2007; 2010; 2011). In contrast, the literature on knowledge management and organizational memory does acknowledge a wide range of knowledge resource types. For example, Griffith and Neale (2001) and others (e.g. Moreland ea 1998; Levitt and March 1988; Walsh and Ungson 1991) point out that knowledge may be embedded in organizational structure, routines, processes, scripts, culture, norms, data, information systems. In this section I conduct a review of these alternative knowledge resource types from the perspective of TMS development (see Table 2). These are discussed next.

**Review of classifications**

In relation to organizational TMS Oshri et al. (2008) distinguish two classes, that is personalized and encoded knowledge. In their work, the personalized class refers to ‘personal memories of individual team members’ (2008:607), but includes social-collective knowledge as well. Where for their study on knowledge transfer within globally distributed teams this twofold may suffice, for the study of stimulating TMS development in collaborative networks the classification needs to be more fine-grained. To this end I start with a distinction that is made in the knowledge management literature, i.e. the distinction between individual knowledge and social knowledge (e.g. Alavi and Leidner 2001; Nonaka 1994; Spender 1996).

Alavi and Leidner define individual knowledge and social knowledge respectively as created by and existing in the individual, and created by and existing in the collective actions of a group (2001: 111). Individual knowledge consists semantic and episodic memories (also known as declarative knowledge), as well as a skill-based memory (Stein and Zwass, 1995:87). Since individual knowledge can only be acquired through social interaction, the two are mutually defined (Harre and Gillett 1994; Wetherell and Maybin 1996). They differ greatly, however, in the way they are materialized, which in turn influences the ways in which these types of knowledge resources may be transferred, combined, or integrated.
Collins (1993) and Spender (1996) both divide individual and collective knowledge in two subcategories. At the individual level Collins distinguishes between embrained (more tacit) and embodied (more explicit) knowledge. At the collective level he distinguishes between encultured (more tacit) and encoded symbol-type of knowledge (more explicit). Likewise, at the individual level Spender distinguishes between conscious (more explicit) and automatic (more tacit) knowledge. At the social level he distinguishes between objectified knowledge (more explicit) and collective knowledge (more tacit). Thus, where Collins emphasizes the properties of the carrier, Spender focuses on the properties of the content.

To address what Collins (1993) described as regular action, Blackler (1995) introduced the intermediary class of embedded knowledge, which he puts on par with organizational routines as introduced by Levitt and March (1988). He describes embedded knowledge as ‘analyzable in systems terms, in the relationships between, for example, technologies, roles, formal procedures, and emergent routines’ (1995: 1024).

Table 2: Relation between knowledge resource ideal types

<table>
<thead>
<tr>
<th>Author</th>
<th>Classes</th>
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</thead>
<tbody>
<tr>
<td>Alavi and Leidner 2001</td>
<td>Individual</td>
</tr>
<tr>
<td>Spender 1996</td>
<td>Individual</td>
</tr>
<tr>
<td></td>
<td>Conscious</td>
</tr>
<tr>
<td>Collins 1993</td>
<td>Individual</td>
</tr>
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<td></td>
<td>Embraieded</td>
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<tr>
<td>Blackler 1995</td>
<td>Individual</td>
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<tr>
<td></td>
<td>Embraieded</td>
</tr>
<tr>
<td>Proposed ideal types</td>
<td>Individual</td>
</tr>
<tr>
<td></td>
<td>Encoded</td>
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</tbody>
</table>

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Like encultured and encoded knowledge, embedded knowledge is social knowledge. And like technologies and routines may be nested, so are embedded knowledge resources.

Studying organizational memory, which is the hierarchical parent of TM (Jackson and Klobas 2008), Walsh and Ungson (1991) distinguish five internal organizational memory repositories, i.e. individuals and records, culture, ecology (i.e. physical working space), structure (i.e. organizational roles), and transformations (i.e. organizational routines), and a number of external archives, including former employees, competitors, governmental regulatory bodies, financial services, news archives, etc. These classes do not correspond well with the definitions described thus far. For example, the merge of individual and encoded (records) knowledge resources does not seem logical from a organizational TMS development perspective, as both require different knowledge management approaches (Oshri et al. 2008). Moreover, ecology, as described in their paper, is a physical reflection of the organizational culture (Alavi and Leidner 2001) and thus may be merged with encultured knowledge resources. Due to their omnipresence in organizations, organizational structure and roles are a notable class that is only indirectly mentioned in the classifications above. And final, the external knowledge resources mentioned by Walsh and Ungson (1991) are instances of the earlier classes. For example, former employees and competitors are instances of personalized directories, and news archives represent instances of encoded directories. Based on this analysis I forward five ideal types that will be used in the rest of this study (see Table 2). The remainder of this paragraph is used to elaborate on them.

**Individual Knowledge**

Individual knowledge, as defined by Alavi and Leidner (2001), may be embrained or embodied knowledge (Blackler 1995; Collins 1993). This distinction is of relevance for TMS in geographically distributed settings. Where physical presence is a prerequisite for the utilization of embodied knowledge (e.g. skills), the same restriction may not apply to embrained knowledge.
**Encoded knowledge**

Encoded knowledge resources represent symbol-type knowledge, i.e. ‘knowledge that can be transferred without loss’ (Collins 1993:99), whereby the information conveyed is decontextualized, and, as abstract symbols are being used, it is inevitable that it ‘is highly selective in the representations it can convey’ (Blackler 1995:1025). This class is of special relevance for future research with respect to the inclusion in TM theory of ‘digital knowledge resources that might serve as “nodes” for information allocation and retrieval’ (Yuan et al. 2010:39).

**Embedded Knowledge**

Embedded knowledge resources represent knowledge which resides in systematic routines and structures. The latter is also referred to as inscribed knowledge (Ellingsen and Monteiro 2003). Embedded knowledge resources, such as pre-established plans, schedules, forecasts, formalized rules and processes, policies, and standardized information and communication systems, may function as impersonal modes of coordination (as opposed to coordination based on feedback in personal and group modes of coordination) (van der Ven et al. 1976:323). Since in TMS, coordination complements differentiation, it is clear that embedded knowledge resources do play an important role in TMS development. This is amplified by the fact that impersonal modes of coordination require less communication than personal and group modes of coordination (Galbraith 1973) and thus increase efficiency and speed. Moreover, since organizational structures may be imposed or designed in a (possibly naïve) top-down fashion (Pentland and Feldman 2008), I dedicate one class for each of these variants.

**Encultured Knowledge**

Culture includes concepts such as belief systems, shared norms and values, language, icons and symbols, habits and stories (Brown and Duguid 1991; Walsh and Ungson 1991), needed to create ‘cultural meaning systems’ (Blackler 1995). These cultural meaning systems serve
as a shared framework for interpreting events (Marr et al. 2004) and serve as basis for action (Concise English Dictionary). Culture does vary among units and across organizations and may stimulate or hinder knowledge sharing and use (Bell and Kozlowski 2002; Boisot and Li 2005; Grabowski and Roberts 1999; Jones 2007; Lucas and Kline 2008; Workman 2005). For these reasons, from a TMS development perspective culture is an important type of resource on its own, as well as a dimension of all other types of knowledge resources (Aggestam and Backlund 2007).

Meta-memory

The fourth first order class of the proposed taxonomy for organizational TMS development is meta-memory, which is defined as memory about memory (Wegner 1986). Within the scope of the knowledge resource taxonomy for organizational TMS development, these memories are external knowledge resources. The meta-memory represents a referential type of knowledge, enabling (or if absent, hindering) the combination and integration of distributed knowledge resources. Nevo and Wand (2005) describe meta-memory as mixture of three distinctive types of knowledge: role knowledge, instance knowledge, and transaction knowledge: Role knowledge adheres to the identity and cognitive capabilities or responsibilities assigned to a role; Instance knowledge refers to the actual actors that are responsible for one or more roles. These actors may be formally assigned to this role, or perform this role on an informal basis; and transactive knowledge describes the knowledge of an actor about the roles in the network and of the actors that are capable of performing these roles. These three types of meta-knowledge are the angles needed to identify and mobilize distributed knowledge resources, sine que none (Wegner 1986). As such, meta-memory functions as a bridge between distributed knowledge resources and the processes that work on them (see Figure 5.1): i.e. information allocation (to a role), retrieval coordination (of an instance), and directory updating (after a transaction) (Wegner et al. 1991).
Discussion

The taxonomy presented in this chapter provides an overview of the properties of knowledge and the properties of the knowledge resources (cf. Argote et al. 2003). As such it forms the first half of the answer to research question 1, i.e. what types of knowledge resources can be distinguished in TMS and how do they interact? The second half (how do they interact) is subject of the next chapter.

One of the basic assumptions behind the knowledge resource taxonomy is that all components of the scheme have to be described to understand the type of knowledge we are dealing with. Referring to a type of knowledge as being explicit or tacit restricts our understanding. Besides the fact that all knowledge has a tacit component (Orlikowski 2002; Polanyi 1986; Tsoukas 2000), it also has a number of other characteristics that describe its state, i.e. temporality, tightness, and context. Moreover, apart from a status of a knowledge component, it can (and should) be described in terms of content, resource type, and meta-memory as well. Limiting ourselves to only one of these characteristics over-simplifies the concept of knowledge, leading to a container concept of knowledge with limited theoretical and practical value.
The knowledge resource taxonomy developed in this chapter describes the following features: content, state, resource type, and meta-memory, where

- **content** is described by subject and granularity, where
  - subject is described by declarative, procedural, causal, conditional, relational, temporal, and spatial knowledge
  - granularity is described by architecture and components.
- **state** is described by temporality, tacitness, tightness, context, and observability, where
  - temporality is described by life cycle and time flow
  - tightness is described by confidence and consensus
  - context is described by ecology and dispersion
  - observability (observable or not)
- **resource type** is described as either individual (embrained or embodied) or as collective (encoded, encultured, embedded).
- **meta-memory** is described by role, instance, and transaction

As knowledge is highly dynamic and contextual the various taxonomies reviewed in this chapter can be understood to be a result of their pragmatic focus. Hence, none of them can be judged in terms of good or wrong. However, from a perspective of organizational TMS development they do not provide sufficiently insight.

Following Crowston (1997) the evaluation of this taxonomy should be based on construct validity (Borsboom et al. 2004), comprehensiveness, and parsimony (Whetten 1989). Construct validity has been ensured by using constructs of established scholars. This taxonomy may fall short in comprehensiveness, as I did not attempt to be comprehensive. Instead I followed the advice of Machlup (1972) and established an open-ended classification to avoid suggesting a definition. With respect to parsimony, the four first order classes (content, state, resource type, and meta memory) cover descriptive aspects of knowledge resources that inform different aspects of organizational design (OD), and
thus, cannot be missed. Content informs OD of what is known, or should be known, to deliver organizational services. State informs OD of the stickiness of organizational knowledge (Szulanski 1996). Resource type informs OD to match the properties of the resource with the methods of knowledge transfer (Oshri et al. 2008). And meta-memory informs OD of the extent to which the knowledge resources are known and (made) accessible throughout the organization (Wegner et al. 1991).

Conclusion
The knowledge resource taxonomy forwarded in this analysis is a first attempt to integrate the various views on properties of knowledge, required to describe the knowledge resources within the firm. The dimension of state within this scheme stresses that knowledge is highly dynamic and in a constant flux. The same flux is stressed by a dimension which lacks in all other knowledge taxonomies: meta-memory. This dimension forms the bridge between what could be considered the knowledge assets (or stock, directories, or knowledge base) of the firm, and the knowledge related processes that work on them and change their properties in the process.