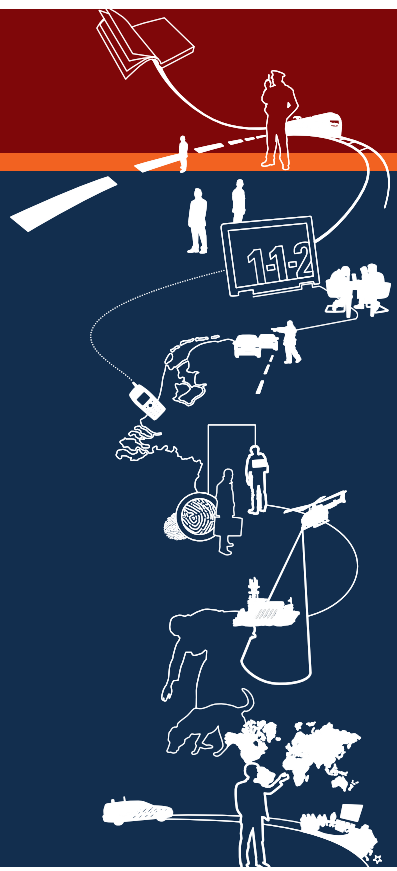
Organizing Distributed Knowledge for Collaborative Action

Structure, Functioning, and Emergence of Organizational Transactive Memory Systems

Jan-Kees Schakel



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This dissertation is dedicated to Willem Adriaan Schakel

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1 INTRODUCTION

no research without action, no action without research
Kurt Lewin (Marrow 1977: 193)

1.1 Positioning of Research Theme

In the domain of safety and security (such as e.g. organizing a response after a crisis, or fighting organized forms of crime) specialized organizations often have to collaborate on an occasional basis with other specialized organizations to head challenges that none of the participants can head (as easily) on its own (*cf.* Agranoff and McGuire 2001; Wastell *et al.* 2004). Such collaborations are assembled and dissembled per assignment, while the situation at hand leaves participants little time to prepare and mandates them to perform instantly. Moreover, roles, tasks, and organizational arrangements to coordinate action may not be present ex ante the operation, and consequently have to be negotiated while going, or are being challenged or disrupted by unique circumstances or events (*cf.* Jarvenpaa and Majchrzak 2008; Majchrzak *et al.* 2007). Another characteristic of such temporary collaborations is that they are often more or less virtual in nature, i.e. participants are distributed in time and space and depend on technology to communicate (Cramton 2001; Griffith *et al.* 2003).

Temporary collaborations are known to be difficult, but failure may lead to severe consequences, as is demonstrated by the Tenerife air disaster (Weick 1990), the Mann Gulch fire-fighters disaster (Weick 1993), the friendly fire incident in Northern Iraq (Snook 2000), or the hurricane Katrina disaster (Congress 2006). In the literature temporary collaborations are being addressed from many different perspectives, including leadership (e.g. Jones and Hinds 2002), knowledge management (e.g. Rosenberg 2000), coordination (e.g. Bechky 2006; Faraj and Xiao 2006; Majchrzak *et al.* 2007), communication (e.g. McKinney *et al.* 2004), sensemaking processes (e.g. Weick 1990; 1993), and in terms of virtualness (e.g. Saunders and Ahuja 2006). One emerging theme is that of

transactive memory systems (TMS), which are shared cognitive systems that collaborating group members develop to divide responsibilities and integrate individual capabilities during interdependent problem solving (Ren and Argote 2011). Research findings suggest that well developed TMS provide the group access to a larger pool of knowledge (Hollingshead 1998; Wegner 1986), help to reduce the cognitive load of any one individual (Hollingshead 1998; Kieser and Koch 2008), improve task coordination (Lewis 2003), and as such lead to superior performance (Brandon and Hollingshead 2004; Hsu *et al.* 2011; Lewis 2004; Lewis *et al.* 2005; Littlepage *et al.* 2008), which may be expressed in both effectiveness and efficiency (Faraj and Sproull 2000). At the same time, TMS research on temporary collaborations is still scarce and does not relate TMS of temporary collaborations to the TMS of the involved ongoing organizations. The interrelations between these types of TMS form the ultimate research theme of this dissertation.

Before elaborating on the scientific and managerial motive for selecting this research theme, and before the research objective and research questions of this dissertation can be presented, an introduction to TMS theory is needed.

1.2 An Introduction to TMS theory

To help understanding how TMS-related concepts such as memory, knowledge, or information are being used, I first should explicate my ontological (concerning the nature of reality) and epistemological (concerning the nature of knowledge) perspective (*cf.* Davison *et al.* 2004), which is an interpretive-constructivist perspective (*cf.* Feldman and Feldman 2006; Orlikowski 2002). Such perspective holds that multiple realities are socially constructed by individuals, gained through understanding the meaning of processes and experiences (Carr and Kemmis 1986). Moreover, I adopt a widely accepted yet limited utilitarian perspective on TMS, i.e., 'for instrumental reasons, to provide lessons for improving present organizational performance' (Rowlinson *et al.* 2010: 83). It is limited in the sense that it pays little attention to socially constructed issues such as culture, morality, power, tradition, and

emotions (Feldman and Feldman 2006). Keeping these perspectives in mind, TMS theory can now be introduced.

Wegner (the originator of TMS theory) and his colleagues define a TMS as ‘a shared system for encoding, storing, and retrieving information’ (Wegner *et al.* 1991: 923), a property of a collection of actors who are assembled in a ‘social network of individual minds’ (Wegner 1986: 206). The development of a TMS is the result of (conscious or unconscious) cognitive efforts to cooperate and divide responsibilities across knowledge domains, aiding to the ‘social organization of diversity’ (Wegner 1986: 206). TMS become transactive through informational interactions among the members involved (Wegner 1986). One of the prerequisites for TMS development is shared task interdependence (Hollingshead 1998). This in turn leads to cognitive interdependence, meaning that actors rely on each other’s expert knowledge to finish a joint task (Hollingshead 2001). This reliance could be more, or less explicit, the distinction being the presence or absence of formal agreements and plans as to ‘who is to do what and when they are to do it’ (Wittenbaum *et al.* 1998: 179). Although most TMS studies emphasize the differentiating function of TMS, the distribution of knowledge within groups may also be more integrated. Wegner (1986) in fact used the phrase 'integrated transactive memory' to represent those items of information that are held in common by all team members, while the team members ‘are aware of the overlap as they do share label and location information as well’ (Wegner 1986: 204). This extreme form of having in common is also known as mutual knowledge (Cramton 2001), or common knowledge (Geanakoplos 1992).

A TMS may be described in terms of representational and procedural components (Theiner *et al.* 2010). First, with respect to representational components Wegner (1986) differentiates between internal an external knowledge resources. External knowledge resources concern knowledge that resides in the memory of others, but may also include artifacts, or encoded knowledge resources, such as a telephone directory (Wegner 1986). External knowledge resources can be both cognitive and behavioral Ellis 2006), explicit and tacit (Griffith and Neale

2001). To be able to make use of external knowledge resources, the internal memory of actors within the network should at least contain a label and a location (Wegner 1986), also known as meta-knowledge or 'who knows what' (Lewis and Herndon 2011). Other meta-knowledge may include knowledge of allocation, updating, and retrieval coordination (Brandon and Hollingshead 2004); emergent behavioral knowledge, such as task credibility expressing the level of trust in each others' knowledge (Moreland and Myaskovsky 2000; Moreland *et al.* 1996); soft knowledge, such as belief structures, judgment, intuition (Anand *et al.* 1998), capability and motivation (Majchrzak *et al.* 2007), and affect (Huang 2009).

Second, the creation and maintenance of representations is performed by the procedural components of a TMS (Theiner *et al.* 2010). The procedural part of a TMS consists of three processes, i.e., directory updating, information allocation, and information retrieval coordination (Wegner 1986). Directory updating is the process of learning where particular knowledge can be found; information allocation represents the process of assigning and distributing new knowledge to those whose characteristics are best suited for its storage, which may include the transformation of incoming information to suite the characteristics of the group; and information retrieval coordination represents the process of accessing distributed knowledge resources. In addition, Wegner *et al.* (1991) identified three progressively sophisticated learning methods through which meta-knowledge develops. That is, people gain almost instant knowledge about someone's capabilities through stereotyping, such as inferences from roles, uniforms, posture, age, or sexe (Hollingshead and Fraidin 2003). Perceptions are further developed by self-disclosure of traits, skills, past activities, preferences, and emotions. The ultimate learning method is to develop meta-knowledge based on facts about the other's access to information. Like knowing who accessed the source, accessed it the longest time, or most recently.

TMS structures and processes are intertwined (Wegner 1986). To describe this intertwinement Klein and Kozlowski depict TMS as a multi-level construct, i.e. 'a complex configuration of individual memory,

distributed knowledge of the contents of individual memory, and the interaction process that links that information into an emergent whole' (Kozlowski and Klein 2000:74). Within this context emergence is defined as a bottom-up process where individual characteristics, cognition, behavior, affect, and interactions among these individuals, evolve into a higher level phenomenon. Thus, a TMS emerges and evolves as a result of transactions (Ren and Argote 2011), which result in converging images about the team's knowledge distribution (Brandon and Hollingshead 2004) and to increasing knowledge differentiation (Wegner 1986). At the same time, higher level constructs condition lower level constructs and processes (Gittell and Weiss 2004)[1]. Hollingshead and Brandon (2003), for example, found that better directory development (directory updating) results in clearer demarcations of responsibilities (information allocation). Gupta and Hollingshead (2010) found that the TMS knowledge patterns that emerge (e.g. more integrated or more differentiated) are determined by the characteristics of the task at hand.

The notion that TMS are multilevel phenomena has two implications for (organizational) TMS development. First, TMS are emergent and, hence, cannot be designed. Second, by devising organizational principles and structures, its emergence can be influenced. Hence, like is the case with communities of practice (*cf.* Wenger 1998), TMS can be designed for. Where the latter implication justifies an interventionist approach to TMS development, the former directs the focus of possible interventions.

1.3 Motivation

The choice to study organizational TMS in relation to temporary collaborations is driven by a dual motive, i.e. a scientific motive and a managerial motive.

[1] For an overview of emergent TMS characteristics and conditioning contextual features and effects that have been addressed in the literature, cf. Appendix 1.

1.3.1 Scientific motive

TMS support collaborative action and are antecedent to it (Jarvenpaa and Majchrzak 2008). Rosen *et al.* (2007) found that, among other factors[2], failure of distributed collaboration can often be traced to the absence of a well-functioning TMS. Thus, if TMS are to be strengthened, it is important to understand their structure, functioning, and emergence.

Empirical TMS research has been conducted at various levels of analysis, including dyads (Wegner *et al.* 1991), groups (Moreland *et al.* 1996; Rau 2005), virtual teams (Griffith *et al.* 2003; Kanawattanachai and Yoo 2007), globally distributed teams (Oshri *et al.* 2008), organizations (Jackson and Klobas 2008), emergent response groups (Majchrzak *et al.* 2007) and inter-organizational level (Jarvenpaa and Majchrzak 2008). A review of TMS research between 1985 and 2010 by Ren and Argote (2011) revealed that the vast majority of these studies has been conducted at team level. Studies at organization level and at the level of temporary collaborations are scarce. This lack of research hinders organizational TMS development efforts, because TMS-related findings at one level of analysis are often not applicable to other levels of analysis (*cf.* Peltokorpi 2008). Consequently, several scholars call for TMS research at organization level (e.g. Jackson and Klobas 2008; Peltokorpi 2008; Ren and Argote 2011), while others call for studying TMS in geographically distributed collaborations; the latter not only because they received little attention, but because still little is known about short-term collaborations in real-life settings, how experiences in temporary collaborations impact future collaborations, what the effects are of management structures (as most studied collaborations were highly self-directing), and how technologies can help the group to develop a shared cognitive division of

[2] Factors mentioned in the literature include the building of trust, the use of compatible technologies, the role of team leaders, differences of routines, diversity of contexts and cultures, failures of communication, and time constraints (e.g. Cramton 2001; Hinds and Mortensen 2005; Rosen et al. 2007).

labour (*cf.* Cordery and Soo 2008; Kanawattanachai and Yoo 2007; Lewis *et al.* 2007; Powell *et al.* 2004; Ren and Argote 2011).

The scientific motivation of this dissertation is rooted in these two types of calls for research, to which one dimension is added: organizational TMS should provide for stable structures to enable future temporary and geographically distributed collaborations (*cf.* Moreland and Argote 2003; Powell *et al.* 2004). Thus, the scientific motive of this dissertation is to increase our understanding of the structure, functioning, and emergence of organizational TMS, and understand its relation with the TMS of temporary and geographically distributed collaborations.

1.3.2 Managerial motive

This research is conducted at the Dutch National Policing Services Agency (Korps Landelijke Politiediensten, KLPD), an institution which is comparable to national police organizations in other countries. Organizational units of the KLPD are often engaging in temporary collaborations to solve problems that the units cannot solve (as easily) by their own. Strategic management theory suggests that through the combination of distributed resources an organization is able to develop novel capabilities and services (Bosch *et al.* 1999; Matthews and Cho 2001). These novel services add value for its stakeholders (Barney 2001), which in the case of public services (such as provided by the police) may be expressed in increased effectiveness or responsiveness (Batley and Larbi 2004). Recognizing the potential value and complexity of temporary collaborations, the managerial motive of the KLPD to support this research is twofold. First, to increase the effectiveness and responsiveness of the organization through exploring and exploiting the potential of distributed knowledge resources in temporary collaborations. Second, to increase the robustness and resilience of temporary collaborations in order to gain control over, and maintain control in erratic situations, and forestall failure.

1.4 Research Perspective and Objective

At organization level, three TMS studies have been published (Ren and Argote 2011). The perspective taken in this dissertation deviates from the ones taken by these studies. Anand *et al.* (1998) conceptually discussed organizational TMS from an information management perspective. Nevo and Wand (2005) conceptually discussed organizational TMS from an organizational memory management perspective. And Jackson and Klobas (2008) empirically studied how TMS theory could be extended from team level to organization level. Given that TMS have a function in the development, management, and coordination of expertise (Oshri *et al.* 2008), the perspective adopted in this dissertation surpasses the management perspective of the two conceptual studies (i.e. Anand *et al.* 1998 and Nevo and Wand 2005), as emphasis is given to organizational development aimed at strengthening temporary collaborations. And rather than extending TMS-theory from teams to organizations, in this dissertation I try to identify how the two levels are intertwined in terms of structure, functioning, and emergence. This perspective is chosen because it more fully treats the interplay between the enduring organization (accent on development and management) and temporary collaborations in which the organization participates (accent on coordination).

Following the scientific and managerial motivation behind this dissertation, the objective of this dissertation has been formulated as:

1. to develop organizational TMS theory as a lens to study how distributed knowledge resources may be involved in collaborations, which are temporary and geographically distributed, to head tasks that none of the participants can head (as easily) on its own, and
2. to identify which features of organizational TMS contribute to the robustness and resilience of these collaborations.

1.5 Research Questions

This dissertation starts from the finding that organizational TMS do exist (*cf.* Anand *et al.* 1998; Jackson and Klobas 2008; Nevo and Wand 2005; Wegner 1986) and that they play a critical role in the development,

management, and coordination of distributed knowledge resources (*cf.* Oshri *et al.* 2008).

At organization level, knowledge may be retained in various types of knowledge resources, including people, information systems, documents and archives, routines, processes and procedures, organizational standards and structures, etc. (*cf.* Griffith *et al.* 2003; Oshri *et al.* 2008; Wegner 1986; Yuan *et al.* 2010). The choice of where to allocate the responsibility for the development or retention of a certain knowledge domain affects the processes of knowledge transfer and integration at a later stage (Carlile 2004; Desouza *et al.* 2008) and is subject to knowledge management (Alavi and Leidner 2001; Oshri *et al.* 2008). Approaching organizational TMS from this angle, the first explorative research question is:

RQ 1: How can knowledge transfer among (different types of) knowledge resources in an organizational TMS be strengthened to support temporary and geographically distributed collaborations?

This research question is addressed by the first research project, reported in chapter 2. This research project was conducted in an experimental yet real-life environment. The number of people involved in the experiments was limited to 10 to 30 people. They made use of supportive information systems and worked together in a geographically distributed setting, and thus, could be typified as a virtual team (Griffith *et al.* 2003). The main conclusion of the first research project was that knowledge transfer in organizational TMS can be strengthened by 1) organizing for transactivity among knowledge resources of the same type, 2) transforming knowledge from one type of knowledge resource to another, and 3) by organizing differently, e.g. through virtual teaming.

Where the first research project shows that different types of knowledge resources may be used to strengthen organizational TMS, much remains unclear about how various types of knowledge resources are formally related to TMS theory. It is only since recent that information systems (Choi *et al*. 2010; Jackson and Klobas 2008; Nevo and Wand

2005; Yuan *et al*. 2007), organizational rules (Kieser and Koch 2008), and e.g. standards, guidelines, and templates (Oshri *et al*. 2008) have been included in TMS research as alternative resources for knowledge storage and retrieval. All of these studies, however, adhere to the description of TMS as a 'social network of individual minds' (Wegner 1986: 206). Hence, there seems to be consensus that IT and other types of knowledge resources may be used in TMS. But how this relation looks like is still being subject for future research. Yuan *et al*. (2011), for example, call for research to better understand the choice between interpersonal and technological resources for knowledge storage and retrieval, and to what extent the two complement each other. Likewise, Choi *et al*. (2010) ask for future research to learn how TMS and IT tools interact, while Lewis and Herndon (2011) go as far as hypothesizing that artificial knowledge resources may substitute (parts of) TMS, but only if they can emulate and facilitate transactive processes. In line with these calls for research and the scope of this dissertation, the second question is formulated as follows:

RQ 2: how are different types of knowledge resources related to a TMS, which develops for supporting temporary collaborative action in a geographically distributed setting?

This research question is subject of the second research project and reported in Chapter 3. The question was studied by analyzing and intervening in the tasks of planning and executing a collaborative police operation, involving circa 600 officers. The division of labor between these two tasks is common-place in organizations which partition complex organizational tasks, and integrate the results at a latter stage. Where the processes of dividing and integrating responsibilities for knowledge domains over actors (what and who) are being described by TMS theory, the processes of dividing and integrating actions (what and how) are being described by organizational routines theory (*cf.* Feldman and Pentland 2003; 2008). Or in other words, where TMS theory describes patterns of actors, organizational routines theory describes patterns of actions. As these patterns are obviously related, it may be expected that borrowing

insights from organizational routines theory may shed light on how different types of knowledge resources are related to TMS. This thesis has been worked out in the second research project. Next to formally describing different types of knowledge resources in TMS theory, the findings of the second research project suggests that organizational TMS consist of multiple functionally nested TMS, which' interrelations can be characterized in terms of overlap in actors, actions, relations among these actors or actions, the content of informational interactions, and supporting artifacts.

As will be shown in Chapter 3, these observations provide angles to devise interventions to strengthen organizational TMS in support of temporary collaborations. But they also raise new questions. For example, contrary to extant TMS research (e.g. Brandon and Hollingshead 2004; Lewis 2004), TMS appear to be interrelated and nested and do not require all members to be equally well informed of the capabilities of all other members. Moreover, collaborative patterns that these members develop in one TMS in support of one task may differ from collaborative patterns in other TMS that are developed to support other tasks (*cf.* Gupta and Hollingshead 2001). This raises the question how TMS associated with enduring organizational tasks are related with TMS associated with temporary organizational tasks. The latter question formed the lead for the third and last research project, which is introduced next.

Public organizations, responsible for particular sets of services, are structured by function, product or region, or combinations thereof (Daft 2012). The resulting organizational structures are predominantly vertical in nature, meaning that similar tasks and functions are grouped in specialized units, decision-making is centralized, and communication and reporting follow hierarchical lines (Andrews *et al.* 2007). Temporary collaborations, on the other hand, are predominantly horizontal in nature, meaning that responsibilities for tasks are shared, decision-making is decentralized, and communication and information exchange is based on personal contacts (Andrews *et al.* 2007). Within the context of this research predominant vertical modes of organizing are associated with functional enactment, while predominant horizontal modes of organizing

are associated with networked enactment. To describe the ability of an organization to switch forth and back between its regular functional mode of organizing and a temporary network mode of organizing, the concept of hybrid enactment is introduced. Given the dialectical structures of functional enactment (vertical) versus networked enactment (horizontal) the question is how an organizational TMS can develop which supports hybrid enactment: how can it support both modes of enactment? Further using and developing TMS theory as a theoretical lens to study hybrid enactment, the third and last research question is formulated as follows:

RQ 3: How can functionally structured organizations develop their ability to engage in networked operations, in addition to their functional mode of organizing?

This research question is subject of the third research project and reported in Chapter 4. It was studied by analyzing a small-scale networked operation, involving three collaborating teams. The study brings to light subsystems of organizational TMS which emerge in support of hybrid enactment, and a learning cycle among these subsystems. Both subsystems and the learning cycle provide opportunities for organizational development.

1.6 Contribution of Research Questions to Research Objective

The answers to the three research questions provide the building blocks required to reach the objective of this research. First, knowledge of knowledge transfer processes among (different types of) knowledge resources in TMS (research question 1), understanding the formal relation between different types of knowledge resources and TMS (research question 2), and the relation between vertically and horizontally organized knowledge patterns (research question 3), together provide for a theoretical lens to study how distributed knowledge resources may be occasionally involved in collaborations which are temporary and geographically distributed (first part of research objective).

Second, increased knowledge of the structure, functioning, and emergence of organizational TMS, TMS of temporary and geographically distributed collaborations, and the relations among them, contribute to the identification of features of organizational TMS that contribute to the robustness and resilience of these collaborations (second part of research objective).

Finally, as will become apparent in the overall reflections in Chapter 5, the three empirical studies provide valuable cues for future research surpassing the overall objective of this dissertation. This includes a promising lead with respect to the linkage between organizational TMS theory and the knowledge-based view (KBV) of the firm (*cf.* Barney 2001; Spender and Grant 1996). KBV holds that knowledge is a strategically important resource for competitive advantage (Wiig 1997), and that consequently the integration of specialized knowledge is one of the essential capabilities of an organization (Grant 1996). KBV, however, is a macro theory, meaning that it lacks (a much wanted) explanation of how capabilities are rooted in micro level individual actions and interactions (Abell *et al.* 2008; Felin *et al.* 2012; Foss 2011). Organizational TMS theory as being developed in this dissertation does provide such micro-level foundations. Another promising lead for future research concerns the role of organizational TMS theory in constructing an information governance framework, aimed at the development, management, and coordination of organizational knowledge resources.

1.7 Research Context

The opportunity for this dissertation stems from my position as senior advisor at the National Policing Services Agency (KLPD) (*cf.* Figure 1.1).

The KLPD carries out coordinating and supportive tasks for 25 regional police forces and is responsible for a number of autonomous tasks that are most effectively handled at (inter) national level. These include the fight of serious and organized crime, and safety and security-related to the national infrastructure (highways, waterways, railways, and airways). The KLPD employs over 5000 employees (circa 10% of the

total Dutch police force). Its departments vary in size from circa 100 to circa 1000 employees.

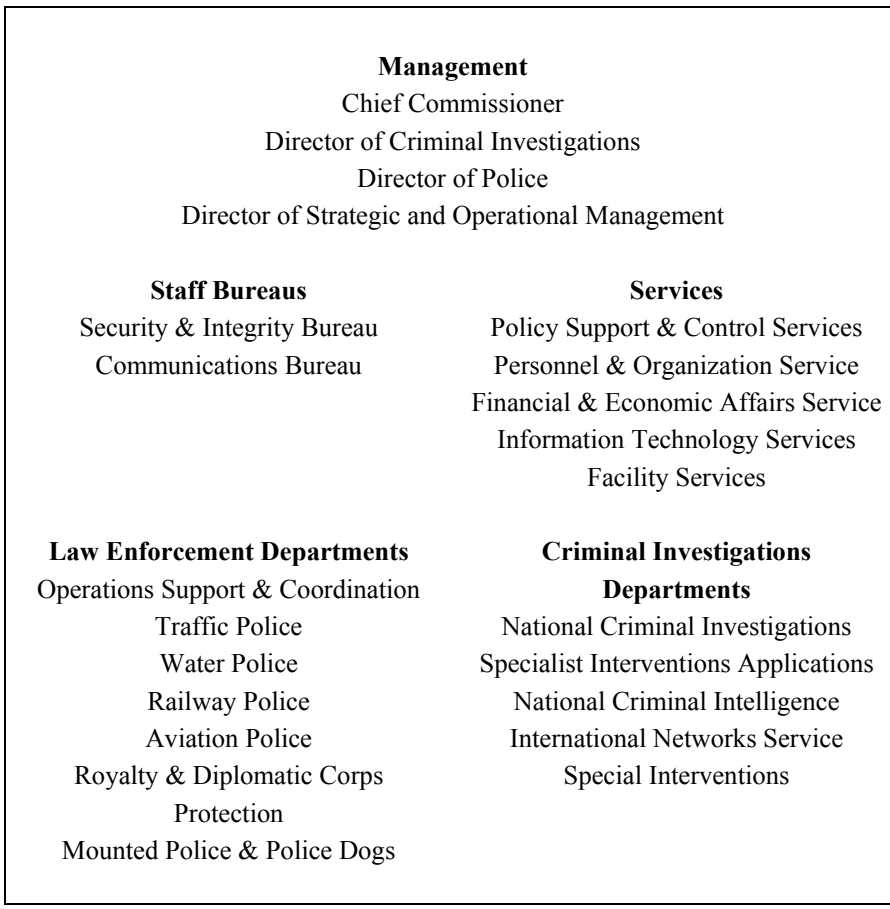

Figure 1.1: KLPD organizational structure

In the aftermath of 9/11 and the terrorist attacks in Madrid and Amsterdam in 2004, the KLPD initiated several projects aimed at strengthening coherence among its departments. The general idea behind these initiatives was that through knowledge sharing and collaborative action the contributions of the KLPD to national safety and security could be increased. Or theoretically formulated: that additional value could be created by developing the combinative capabilities of the organization. Being involved in these initiatives as senior advisor, the quest of the

KLPD provided opportunities to develop organizational TMS theory as a lens to study the exploration and exploitation of knowledge resources in temporary and geographically distributed collaborations.

1.8 Research Methods

In Table 1.1 an overview is given of the research methods used in this dissertation.

	Chapter	Research design
1	Introduction	Literature study
2	Empirical research 1	Canonical Action Research
3	Empirical research 2	Canonical Action Research
4	Empirical research 3	Interpretive Case Study
5	Reflections	Conceptual work

Table 1.1: Applied research methods

As the research design of the first two empirical studies is identical, its description is included in this introductory chapter. All other details are specific to one study and, hence, reported in their respective chapters.

1.8.1 Design

In the first two research projects, the research objective was pursued by introducing changes (the application of theory in practice) and observing the effects of these interventions (academic reflection), which is the basic contention of action research (AR) (Baskerville 1999). Due to the dual motive of this dissertation, i.e. a scientific motive aimed at increasing understanding, and a managerial motive aimed at organizational development through the initiation of interventions, AR is conceived the most appropriate research method (Argyris and Schön 1996; Reason and Bradbury 2001; Cummings and Worley 2004). To ensure rigor, I sought a research relationship with an external researcher to provide for psychological and emotional distance and shared reflections on theoretical lessons learned (*cf.* Markus *et al.* 2002), and followed the five principles for canonical action research put forward by Davison *et al.*

(2004), which have been followed in other AR studies as well (e.g. Iversen *et al.* 2004; Lindgren *et al.* 2004). These are elaborated next.

The Principle of Client-Researcher-Agreement.

A researcher-client agreement (RCA) is a major aspect of rigorous AR (Davison *et al.* 2004; Hult and Lennung 1980). Hence, for each of the two AR-projects a formal agreement has been drafted with the client. Both client and researchers agreed that AR was suitable for these studies because they adhere to all elements of Hult and Lennung's widely cited definition of AR: 'Action research assists in practical problem solving, expands scientific knowledge, enhances actor competencies, is performed collaboratively in an immediate situation, uses data feedback in a cyclical process, aims at an increased understanding of a given social situation, is applicable for the understanding of change processes in social systems, and is undertaken within a mutually acceptable ethical framework' (Hult and Lennung 1980: 247).

Client commitment has been established by the participatory and collaborative approach (*cf.* Avison *et al.* 2001). In both AR projects, practitioners were actively involved in the reconnaissance of the problem situation and the formulation of solutions and interventions. Due to my position as senior advisor I had full access to the KLPD and took shared responsibility for actions taken. Line managers in the organization acted as decision-making authorities. One of the challenges of doing research within one's own system is to build on the closeness which one has with the system and at the same time create and maintain a distance towards it (Coghlan and Brannick 2001). I could draw on being an insider because I had build relationships with many parties involved. Having such a network and understanding the language of the organization are general advantages of being an insider researcher (Roth *et al.* 2007). To provide for psychological and emotional distance and shared reflections on theoretical lessons learned, cooperation was established with dr. Erik J. de Vries of the University of Amsterdam. Such role taking has been reported in an AR study of Markus *et al.* (2002) as well. The financing of the study was in line with this role taking. Being employed by the KLPD I could

focus entirely on the research projects. Erik de Vries was employed by the University of Amsterdam and participated as part of his regular research work.

Ethical issues have been addressed in the RCA to ensure that consequences on personnel, privacy and confidentiality of information about project members and safety of the project members during experiments were well understood and taken care of, and that the legal rights of citizens were respected. With regard to editorial control and publication the RCA did not include any restrictions other than that secret or confidential information on criminal investigation routines could not be made public (for obvious reasons).

The Principle of a Cyclical Process Model

In accordance with the Principle of the Cyclical Process Model the most widely adopted cyclical process of AR forwarded by Susman and Evered (1978) is being followed: diagnosis, planning, action, evaluation, reflection (D-P-A-E-R). In this approach practical problem solving and theory development inform and support each other. For such studies it has been recommended to differentiate between problem solving activities (D-P-A-E) and contributions to theory (the R-phase and Discussion) (Chaisson *et al.* 2008). These phases are reflected in the structure of chapter 2 and 3.

The Principle of Theory

In accordance with the Principle of Theory the relevance of the research projects has been elicited earlier in this chapter, and will further be elaborated upon in the theory sections in Chapter 2 and 3. In addition, the findings are reflected upon in Chapter 5. Moreover, theories used to guide diagnosis, interventions and reflections are described within the respective AR cycles. Both AR-projects have characteristics of an explorative study which is reflected in the AR cycles and which accord with the AR principle of Learning through Reflection. Although several authors claim that the validity of AR depends on the presence of a theoretical framework as a premise (Baskerville and Wood-Harper 1996;

Baskerville and Myers 2004), others disagree because especially at the start of the project theoretical preconceptions might be counter-productive (Davison *et al.* 2004), or might restrict multiple interpretations (Walsham 1995). This suggests more openness to AR studies that do not start from detailed theoretical preconceptions right away (an example of such a study is Kock (2001) who inductively derived patterns from statistical and grounded theory- based analysis), or studies in which theoretical conceptions change along the way (e.g. Markus *et al.* 2002, and Kohli and Kettinger 2004).

The Principle of Change through Action

A description of actual actions taken in the two AR-projects is given in Chapter 2 and 3. In this section the Principle of Change through Action is being described in terms of action researcher role-settings. In the first study my role can be depicted as collaborative, meaning that all decisions on interventions have been taken collaboratively. Due to the duration and sheer size of the second AR-project (involving several 100s of people of various organizational departments), my role in this project was facilitative. That is, I functioned as 'an expert among the study subjects' while the responsibility for immediate solving rested by these subjects (Baskerville and Wood-Harper 1998: 95). In such setting 'the task of the researcher is to facilitate or help the subjects with expert advice, technical knowledge or an independent viewpoint. However, the subjects are responsible for determining exactly what interventions will be created' (Baskerville and Wood-Harper 1998: 95). Hence, instead of directly intervening in the process, observations and recommendations were discussed with the senior management. In addition, for the second research project I participated in an evaluation committee who visited action sites, interviewed stakeholders and operational participants, and drafted and presented evaluation reports. In both projects the Principle of Change through Action was followed by describing the diagnosis of the problem and its causes, and how interventions addressed these causes in the AR cycles. To do so the organizational situation before and after the

interventions was assessed together with members of the KLPD. The nature and timing of interventions are being described in the AR cycles.

The Principle of Learning through Reflection

The dissertation adheres to the Principle of Learning through Reflection by the semi-thick description of findings and coverage of implications for practice and theory in the discussion and conclusions section of each chapter, and the overall reflections presented in Chapter 5. The outcomes of both studies have been reflected on collaboratively with the practitioners involved, and the degree of success is described in each of the two chapters.

Data Collection

The descriptions of the five AR-phases (D-P-A-E-R) derive from three forms of data that have been collected: direct observations, collective reflections and organizational documentation (*cf.* Table 1.2).

Direct observations were being recorded in personal notes. Resulting notebooks provided the qualitative datum required to codify incidents. Recorded is all that is related to changes in concepts (or new ones being introduced) and progression in understanding and changes in attitude of project members. Data on collective reflections stems from reflection sessions on the grounds and multi-interpretable outcomes of interventions (as proposed in Guba and Lincoln, 1989). These reflections not only led to new insights, they also stimulated political support from the participating departments and provided directions for new data to be collected and concepts to be developed. All material was stored in project directories, which were available to all participating project members.

	First Action Research	Second Action Research
Direct observations	Notes of personal observations made during field visits, brainstorm sessions, workshops, management meetings, and consultation and advising activities over a period of 30 months (October 2006 – March 2009) (ca 840 pages).	Notes of personal observations made during field visits, brainstorm sessions, workshops, management meetings, and consultation and advising activities over a period of 20 months (April 2009 – December 2010) (ca 970 pages).
Organizational documentation	Project plans (11); Minutes of meetings (61); Expert interviews (6); Powerpoint presentations (65) and other project materials (17); Minutes of workshops (4); Intranet and KLPD Magazine articles (many).	Action plans, scripts and briefing materials (many); Powerpoint presentations (2); Intranet and KLPD Magazine articles (many).
Collective reflections	Evaluation reports (4).	Evaluation reports (2).

Table 1.2: Overview of empirical data

1.9 Structure of this Dissertation

In this chapter the overall objective and guiding research questions have been presented, as well as an introduction to TMS theory, a description of the research context, and the action research method that has been used in the first two research projects (*cf*. Figure 1.2).

In chapter 2, 3, and 4 the three empirical research projects are being reported. These chapters include (additional) details about the theories used in these studies, their respective research context, the research method, and the data collection. Due to the exploratory nature of this dissertation, each research project fueled the next research question and subsequent research project, which is visualized by the arrows in

Figure 1.2. The concluding reflections of this dissertation, as well as leads for future research, are presented in chapter 5.

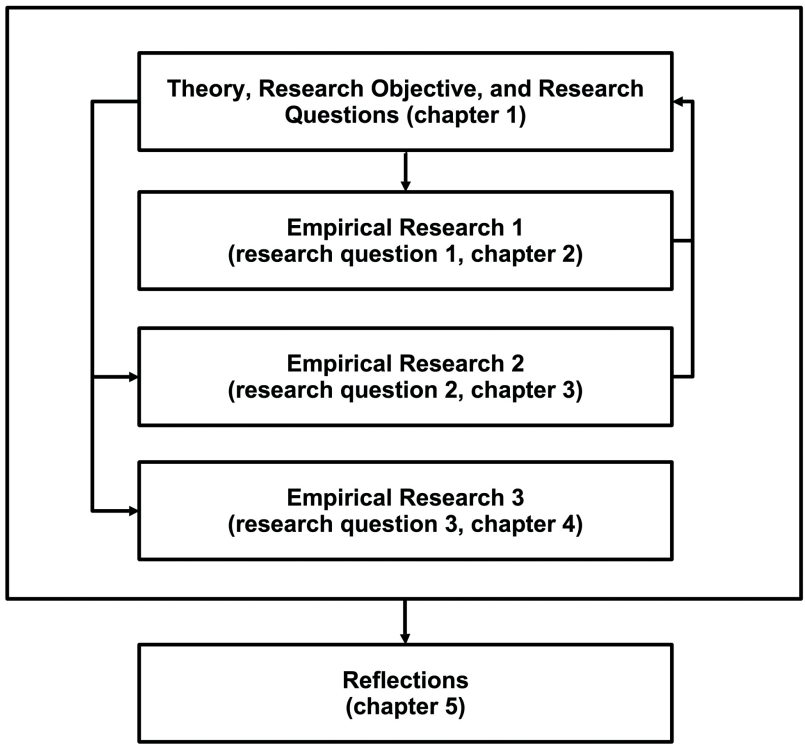

Figure 1.2: Setup of this dissertation

Adapted versions of chapter 2, 3 and 4 are in the process of publication. In addition, a paper addressing a number of ethical issues related to advanced data processing techniques as discussed in Chapter 2 and 3 has been published as chapter in an anonymously peer-reviewed book (Schakel *et al.* 2012). Appendix 1 provides an overview of antecedents, moderators, and effects of TMS that have been studied at dyad, triad, or team level. Finally, in support of organizational TMS development, Appendix 2 entails a preliminary outline of a taxonomy of knowledge resources, which is forwarded in Chapter 5 as one of the leads for future research.

2 ORGANIZATIONAL TMS DEVELOPMENT[3]

2.1 Abstract

Transactive Memory Systems (TMS) are hold to facilitate knowledge transfer and to contribute to people's abilities to coordinate specialized knowledge. Till date, however, research on organizational TMS is scarce. This study is the first Action Research on organizational TMS development. On the organizational level we differentiate between three types of knowledge resources: personalized, encoded, and embedded. The latter includes amongst others organizational structures, routines, processes, and technology. This study shows that one way to develop organizational TMS is to organize for transactivity among resources of the same type; a second way is to transform resources from one type to another type, and a third way is to organize differently. This study further illustrates how ICT and information-related methodologies provide opportunities to intervene in organizational TMS. This chapter ends with a discussion, leads for future research, and a conclusion.

2.2 Societal Rationale

In response to the terrorist attack in Madrid in March 2004 and the murder of Theo van Gogh in Amsterdam in November 2004, the Dutch government intensified its policies on anti-terror considerably (AIVD 2006). Inspired by Castells (2000, 2000a) who described the rise of a network society, the Board of Chief Commissioners of the Dutch police recognized that in addition to their traditional orientation on communities, a supplementary type of orientation was needed. In their vision memorandum Police in Evolution (NPI 2006) they expressed this

[3] An adapted version of this chapter has been submitted for publication by Jan-Kees Schakel (lead researcher and author) and Erik J. De Vries (external research partner who like in the study of Markus *et al.* (2002) provided psychological and emotional distance to facilitate reflection and discussion on theoretical and methodological lessons learned).

as, ‘Traditionally, the Dutch police mostly focus on locations (areas, territories). Social processes, however, are more and more defined by flows of people, goods, money and especially information. The same applies to crime and terrorism. This operational area is also referred to as the space of flows … where the nodes in the infrastructure serve as the point of intervention’ (NPI 2006: 16).

Within the Netherlands, the National Police Services Agency (Korps Landelijke Politie Diensten, KLPD) is responsible at national level for public safety and security of the infrastructural networks (highways, waterways, railways, and aviation). Taking her responsibility on the national infrastructure the KLPD initiated two initiatives. The first aimed at strengthening information and intelligence led policing (ILP) by developing a methodology which aids the description and subsequent efficient detection of (criminal) phenomena in traffic control actions and to strengthen the cooperation between four participating departments (therefore it was given the name Quattro Stagioni (QS)). The second initiative, called Transport Security (TS), was set up to address four main themes: connecting information sources; detecting criminal patterns and describe these using indicators; establishing intelligence software that could help identify indicators that can be derived from digital data; and setting up an organizational structure to mobilize available information and scarce expertise. The core interest of these two initiatives was to organize the KLPD so that distributed information and knowledge could be put into practice while in action, taking into account geographical distances.

2.3 Theoretical Rationale

In this chapter we approach transactive memory systems from a knowledge management perspective. Argote *et al*. (2003) categorize knowledge management themes along two dimensions: knowledge management outcomes, and context. Outcomes are the creation, retention or transfer of knowledge. Based on this division the organizational problem in this study is primarily concerned with knowledge transfer. More specifically, we study the organization of distributed information

and knowledge resources to support policing teams in action. Thus, within the context of this chapter the concept of knowledge transfer includes knowledge translation (to other contexts) and knowledge integration and application (joint problem solving) (*cf*. Carlile 2004). With respect to knowledge management context Argote *et al*. (2003) differentiate between studies focusing on the properties of the knowledge, properties of units (people, organizational units, groups, organizations), and properties of the relationships among them.

Properties of knowledge. The knowledge management literature provides a myriad of knowledge related taxonomies and theoretical frameworks offering diverse concepts, terminology, hypotheses and empirical data (Nonaka and Nishiguchi 2001). A review of this literature is beyond the scope of this study. We coalesce with those taking a continuum perspective with explicit and implicit knowledge at opposite ends of the continuum, indicating that particular characteristics are more profound (e.g. Choo 2006; Griffith *et al.* 2003; Leonard and Sensiper 1998). We further converge with the general assumption in the knowledge management literature that the type of knowledge needs to match the type of knowledge transfer approach (Oshri *et al.* 2008). For instance, explicit knowledge could be transferred to organizational members by technological means like databases, records or reports, whereas tacit knowledge requires to be shared mainly through person-to-person contacts (Desouza and Evaristo 2004).

Properties of units. Our level of analysis is the organization, accommodating the ad hoc and temporal forming of problem solving teams. Due to time and other constraints problem solving teams are often geographically distributed and thus, may be typified as virtual teams.

Properties of relationships. Systems people develop to divide knowledge domain responsibilities, keep each other informed, and coordinate knowledge transfer, are known as transactive memory systems (TMS) (Kanawattanachai and Yoo 2007; Wegner *et al.* 1991). Consequently, TMS are seen as an important theme in the knowledge management literature (Argote *et al*. 2003). The principle hypothesis of TMS theory is that by knowing in general terms what the other knows in

detail, people can 'share the detailed memories enjoyed by both' (Wegner *et al*. 1991: 924). TMS become transactive through the communications that occur amongst the actors involved (Wegner 1986). TMS functions through three basic processes: the process of directory updating, i.e. the process of learning where knowledge is likely to be stored amongst group members; the process of information allocation, i.e. distributing knowledge to those whose expertise is best suited for its storage; and retrieval coordination, i.e. the process of accessing each others knowledge (Wegner 1995). TMS research has shown that TMS improves group performance by facilitating people to specialize on tasks while they rely on complementary task knowledge of other group members, resulting in a larger pool of task-related knowledge available to the group (Peltokorpi 2008). TMS helps to reduce the cognitive load of any one individual (Kieser and Koch 2008), improves task coordination (Lewis 2003), knowledge transfer and retention (Argote and Ingram 2000) and performance (Rulke and Rau 2000).

Information systems (IS) may have a function in TMS (Oshri *et al*. 2008, Griffith and Neale 2001, Nevo and Wand 2005, Jackson and Klobas 2008, Choi *et al*. 2010). In the IS literature TMS has been studied in teams Choi *et al*. 2010, in virtual teams (Griffith and Neale 2001; Kanawattanachai and Yoo 2007), between globally distributed teams (Oshri *et al*. 2008), in organizations (Jackson and Klobas 2008; Nevo and Wand 2005) and at the inter-organizational level (Lin and Lin 2001). Kanawattanachai and Yoo (2008) showed in their study on 38 virtual teams of MBA students that TMS can be formed in virtual teams solely relying on electronic communication and that such teams can perform effectively. Choi *et al*. (2010) conclude in their survey among 942 individuals from 259 teams in two firms that IT facilitates the development of TMS, whether it is specifically designed for knowledge management purposes or conventional ICT systems. Oshri *et al*. (2008), who studied the role of TMS in knowledge transfer between onsite and offshore teams in globally distributed software development projects, show how the three main processes in TMS to share knowledge (directory updating, information allocation and retrieval coordination) are related to

building codified and personalized knowledge directories in globally distributed teams. At the organizational level Jackson and Klobas (2008) have shown that TMS processes and knowledge directories are present and suggest that organizations can be seen as TMS. Moreover, they suggest that IS can support organizational TMS and can be part of it.

In the IS literature and in the wider literature on transactive memory systems (TMS) calls have been made for more empirical work on TMS at the organizational level (Jackson and Klobas 2008; Ren and Argote 2011) and on how TMS are formed and function in various organizational task contexts (Peltokorpi 2008). In this AR the suggestion was followed to develop TMS not at the level of the problem-specific collaboration, e.g. the virtual team, but at the higher organizational level to provide for stable structures supporting knowledge collaboration (Moreland and Argote 2003). This is linked with the call of Powell *et al.* (2004) for specific research attention on structural and contextual issues surrounding virtual teams instead of research on the traditional unit of analysis, the team itself, and the more general call to study how 'to organize what can be done with information' (Zammuto *et al.* 2007: 749) and engage people in activities they otherwise would not have the opportunity to, by bringing them together dynamically and supporting them with sets of organizational, informational and technological arrangements (Zammuto *et al.* 2007). In line with these calls and the findings of these earlier studies, the research reported in this chapter deals with organizational TMS development to accommodate knowledge transfer in virtual teams and incorporating IS support for organizational TMS.

To existing research this study adds an intervention perspective on organizational TMS development. At the organizational level knowledge can be retained, developed, and transferred by three (ideal) types of resources, or in TMS terminology, three types of knowledge resources (by others referred to as directories, repositories, bins, or containers). That is, 1) organizational members; 2) organizational routines and structures; and 3) encoded knowledge sources, such as organizational records and (information) technology (*cf.* Griffith *et al.* 2003; Oshri *et al.*

2008; Wegner 1986; Yuan *et al.* 2010). Based on this classification three perspectives can be envisaged from which to intervene in organizational TMS. The first is to organize for transactivity between knowledge resources of the same type, and a second way is to transform knowledge from one type of knowledge resources to another through processes like explication, encoding, contextualizing and interacting. A third way is to organize differently, e.g. through virtual teaming. Moreover, this study extends the discussion of IS support in organizational TMS by studying the role of a complex event processing system in assessing real-time events and transferring related information to a temporary virtual team for further action.

The research method and context of this study have been elaborated on in Chapter 1. Hence, the next section continues with describing the four interrelated interventions. This chapter ends with discussion and conclusions, including directions for further research, emphasizing the relevance of TMS research for the IS field.

2.4 Four Action Research Cycles

The description of the four AR cycles in this section follows a logical sequence without being exactly chronological, as a linear interval type of scale is not always suitable to explain multiple emerging and interrelated change processes (van der Ven and Poole 2005). The time ordering is conceptualized in Figure 2.1.

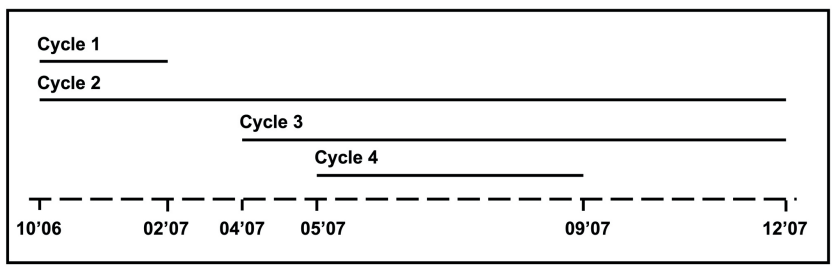

Figure 2.1: Time order of AR cycles

Cycle one describes how we arrived at a common goal and framework to share understanding and divide work among the projects,

i.e. the forming of an initial TMS at organizational level. Cycle two describes the development of a methodology to support experts on criminal practices to explicate their experience and to arrange this knowledge into profiles, i.e. the QS project. In parallel TS developed a complex event processing software prototype that is described in cycle three. In cycle four, the prototype and the profiling methodology have been combined with several organizational arrangements in a real life test. This section is ended with how the AR was exited.

2.4.1 Cycle 1, aligning the three initiatives

Diagnosis phase. In this study I started with what Checkland and Poulter (2006) denote as a problem situation, knowing only the contours of the problem. Although the three initiatives appeared to be interrelated, there was no overarching problem definition nor were project members aware of the interrelatedness or did the stakeholders share an understanding on how the initiatives related to the idea to fighting crime on the national infrastructure. The affinity of the people involved in the projects with IS varied widely. As a consequence they all attached different meaning to ambiguous words such as data, information, knowledge, expertise, methodology, and models. For example, where QS was talking about triggers and keys that needed to be explicated to increase sentience, TS talked about indicators and profiles, while others in the organization referred to them as knowledge models. Shared perspectives, however, are critical for TMS development (Wegner *et al.* 1991).

Planning phase. The aim of the first intervention was to align the initiatives and build sufficient clarity, trust, and support to divide the tasks at hand. A concise overview was developed which did help to develop common language and put the various interventions into perspective, the information framework (*cf.* Figure 2.2). The framework was built from the well known continuum perspective with explicit and tacit knowledge at opposite ends of the continuum indicating that particular characteristics are more profound (*cf.* Choo 2006; Griffith *et al.* 2003; Leonard and Sensiper 1998). The first segment represents knowledge that can be

codified and represented in data, which in turn can be stored in information systems. In terms of organizational TMS these may be referred to as codified knowledge resources, i.e. organizational records and in technology encodable (business) rules or procedures (Oshri *et al.* 2008). Encoded knowledge resources can be organized in types and categories, can easily be transferred but are defined and established for a specific purpose. Consequently they may not be accurate, current, or appropriate outside their original context. Interventions in this segment are mostly technical and procedural in nature.

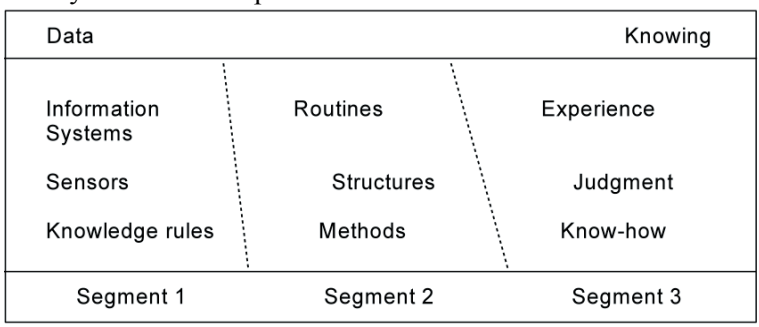

Figure 2.2: Information framework

The other extreme of the information framework represents the concept of knowing, embedded in organizational members, or personalized knowledge resources (Oshri *et al.* 2008). This segment is dominated by tacit knowledge. Tacit knowledge is intrinsic to action (Cook and Brown 1999; Polanyi 1966), relations, or cultural values and beliefs (DeLong 2004). Sharing tacit knowledge is complicated and demands personal interaction and socialization. As one cannot manage social processes, solutions to this type of problems cannot be designed but should be designed for, aiming at the facilitation of sense making interactions (Wenger 1998).

Segment two represents a transformational zone in between segment one and three. In our quest to utilize existing knowledge in all its forms we try to learn from unstructured, semi-structured and structured data, for example through the application of statistical methods, text mining (*cf.* van der Putte *et al.* 2009) and geographical information systems techniques. Thus, segment two deals with the organization's

standard operating procedures, routines, methodologies, scripts, and structure (Griffith *et al.* 2003), in short, its embedded knowledge (*cf.* Blackler 1995; Nicholson and Sahay 2004; Volkoff *et al.* 2007). The transference of embedded knowledge across organizational units forms a special class of knowledge transfer (Argote *et al.* 2003). Interventions affecting embedded knowledge resources are aimed at developing structures, routines, methodologies, etc.

Knowledge can be transferred from one type of knowledge resource to the other, although by transforming its nature the knowledge is transformed as well, which may have consequences for practice (Carlile 2004). Nonaka and Takeuchi (1995) and others (e.g. Boisot 1998; Zander and Kogut 1995) use the continuum from tacit to explicit knowledge to describe externalization and encodeability of knowledge. Using this continuum four processes can be formulated interlinking the three knowledge resource types. The process to facilitate the translation from experience of individuals (personalized knowledge resources) to structural interventions (embedded knowledge resources) is labelled explicating. The process of establishing data collections and knowledge rules (encoded knowledge resources) through the enactment of routines and structures (embedded knowledge resources) is labelled encoding. Where these first two processes cater for the storage of knowledge in other than personalized knowledge resources, the second two processes cater for its retrieval and application, requiring translation to the situational context of the actors (Wilson 1997). The process of accessing encoded knowledge resources and putting the data in context using embedded knowledge resources developed and deployed to support that purpose, is called contextualizing. The final process, interacting, describes the development and deployment of embedded knowledge resources to inform action.

Action phase. During a brainstorm with department heads we inferred a common goal to bound the initiatives: ‘improve the observation capacity of the force and its subsequent ability to act selectively and in a timely manner’, after which core and peripheral activities of the initiatives were identified. This sensitizing aim could be connected with the information framework. The information framework has been presented in

the KLPD many times as follows. First a number of terms related to data, information and knowledge were plotted on a clean sheet, apparently at random. Then the following story was told to show that these concepts were distinct yet related: 'Illegal activities call for an appropriate answer. To formulate such an answer, a wide range of information is required. Assume Figure 2.2 to be the space that contains all possible forms of information that is at our disposal. Some of the information may be stored as data in police records and other information systems. Other information may only surface in patterns that require the interaction of experts, knowledgeable analysts and possibly large volumes of data. Other information may be less accessible, as it is encapsulated in private observations and the intuition of experienced police officers. Knowing this, it is evident that to strengthen the information position of the police force, attention should be paid to all three segments and their integration'.

After the introduction the vertical hashed lines were added, after which the practical characteristics of the segments could be explained. In addition to this explanation the idea was added that segment 1 would probably only cover around 10 to 15% of the total organizational information potential and segment 2 another 10 to 15%. Realizing this, one important lesson had to stick to mind: to be successful one should pay attention to all three segments and hence, facilitate the utilization of unstructured and idiosyncratic knowledge (segment 3) as well (*cf.* Orlikowski 2002).

Based on the information framework, it has been decided that QS would develop a methodology to support experts on criminal practices to explicate their experience, to arrange this knowledge into profiles of indicators and to make indicators observable in coherent sets (profiles). In terms of the information framework the process from experience to explication to (if possible) encoding. TS would develop a complex event processing software, the iFunnel, aimed at using these profiles to analyze real-time sensor data in relation with other data collections to indicate criminal practice and to initiate subsequent action. In terms of the information framework, the iFunnel utilizes encoded data in segment one, which would be utilized in action through a process of contextualization

and interaction. To support the latter the iFunnel technology would be combined with organizational arrangements to transfer the knowledge of experts to police officers in action in a real life test as part of the TS project. In this division of labor it was decided that QS would refrain from technology development (which was part of their initial approach) and that TS would refrain from developing methodologies to devise indicators and profiles. To further synergy among the projects four types of crime were selected that aligned with political and business interests, i.e., illegal export of waste materials across EU-borders; transport of nuclear, biological and chemical (NBC) goods; cargo theft; and people trafficking.

Evaluation phase. The common goal was approved of and was recognized as highlighting the shared ambitions. The information framework connected the first half of the common goal (enhancing the observation capacity of the force) with processes to expand knowledge in all three segments of the information framework (experience, explication and encoding). It connected the second part of the aim (enhancing the ability to act) with processes supporting the actual utilization of knowledge (contextualizing and interaction).

Reflection phase. The three segments of the information framework represent three types of knowledge resources of organizational TMS. This division builds on work of Oshri *et al.* (2008) and others (Jackson and Klobas 2008; Yuan *et al.* 2011) who distinguish between encoded and personalized knowledge resources. Extending the types of knowledge resources enabled the distinction between people, routines and structures, and data and technology more explicitly. The formulation of a shared goal and vocabulary proved fundamental for organizational TMS development. It increased common knowledge, provided the teams with a shared ambition, and allowed them to distribute interdependent tasks at organizational level. The framework made team members aware that the three types of knowledge resources required different types of interventions (and thus, expertise) to enable knowledge transfer to people in action. As such this AR cycle contributed to increased organizational level TMS sharedness (degree to which members have a shared representation of the TMS), TMS accuracy (degree to which members'

perceptions about others' task-related expertise are accurate), and TMS validity (degree to which members participate in the TMS) (*cf.* Brandon and Hollingshead 2004).

2.4.2 Cycle 2, knowledge explication and encoding

Diagnosis phase. In a National Threat Assessments of the KLPD the Netherlands is typified as international hub, socially, logistically, and financially. Criminals exploit this characteristic as well. Being responsible for national infrastructures the KLPD wanted to increase its grip. At that time, however, cooperation between the departments investigating serious and organized crime, and law enforcement departments active on the national infrastructural networks was not self-evident. Moreover, the latter did not have methods or means to recognize behavior related to such crimes in massive traffic flows. The main objective of the QS project was to bridge this gap by developing a methodology that would support knowledge collaboration among criminal investigations officers and law enforcement officers.

Planning phase. QS would develop a methodology to support criminal investigations experts to explicate their experience, to arrange this knowledge into indicators and profiles describing criminal practice, and to make these indicators observable. We expected to arrive at indicators strengthening all three segments of the information framework. Having indicators spread over the three segments would mean that we knew the properties of that knowledge and could match the type of knowledge needs with the type of knowledge transfer (Oshri *et al.* 2008). The methodology was branded ILP+. Intelligence Led Policing (ILP) is a policing model which originated in Britain (*cf.* NCIS 2000). It provides practical guidelines on how to collect and analyze data on criminal trends, hotspots, underlying causes, etc. ILP, however, does not include learning methods on how criminal practices can be recognized and encoded in profiles. That would be the plus of ILP+.

Action phase. To develop and test the methodology people trafficking was chosen as subject. Specialized investigation officers are almost exclusively dealing with this field. Enabling interventions by non-

specialized general police officers provided true challenges. The research team planned interviews with experts within and outside the KLPD to determine high-risk groups, possible norms and detectable deviations to these norms, indicators, and methods and tools to identify these deviations. The interviews yielded 84 indicators that potentially could be integrated into the work practices of general police officers. To this end a workshop was held with QS members, domain experts on people trafficking, traffic policing experts, and experts on technical criminal investigation methods. By the end of the workshop 74 indicators had been selected. The technical criminal investigation experts identified 19 indicators that could potentially be detected using artificial sensors such as Automated Number Plate Recognition (ANPR) systems, infrared meters, CO^2 meters, or depth meters, and which could be processed by the iFunnel prototype. The other indicators were of the segment two or three type. Table 2.1 shows some examples of indicators. These are rather general in nature because the actual list of indicators is restricted information for national security reasons. The indicators are only valuable in combination with other indicators (i.e. as a complete profile).

Evaluation phase. The ILP+ methodology made it possible to come to profiles on certain types of crime based on the knowledge of different KLPD's experts through a rather efficient process of interviews and workshops. Indicators in the resulting profiles are spread over the three segments of the information framework, providing opportunities to determine suitable approaches to transfer this knowledge to general police officers in the field. It was concluded that continuous attention was needed to keep profiles up to date to keep one step ahead of the criminals. The team decided to use existing routine debriefing sessions to evaluate indicators and discuss new ones. Moreover, by frequently working together on certain criminal practices the people involved would naturally form a community of practice (CoP), in the sense of Leonard and Sensiper (1998).

Segment	Nature	Examples of indicators
One	Indicators that can be processed fully automatically.	License plate of suspect; vehicle-country match
Two	Indicators that can be assessed through analytical methods	Route; frequency
Three	Indicators that can be assessed through interaction and human observation	Whether co-travels do know each other; whether people are confused about their destination; whether people carry their own passport

Table 2.1: Examples of indicators in the profiles

Reflection phase. The ILP+ methodology shows how experience with action could be externalized through a process of explication and encoding, leading to profiles of indicators spread over all three segments (types of knowledge resources). In the process of explication of experiences, implicit knowledge can be made explicit, thus changing the properties of knowledge such that it becomes easier to transfer. The process of encoding contributes further to this as it enables the transference of knowledge through routines, tools and techniques to data (Argote *et al.* 2003). Explicating and encoding affect the knowledge resources in the sense that knowledge embodied in organizational members is being transformed through a communicative process and gets embodied in organizational procedures, routines, scripts or technology.

In TMS terminology such transfer signifies gaining access to distributed knowledge resources, reallocating responsibilities for knowledge domains, and updating subsequent meta-knowledge. In this case this was achieved by bringing people together through meetings and workshops. Organizing communities of practice, contextualization and determining profile maintenance as being part of an expert's job adds to information allocation at organizational level (and higher). Discussing experiences explicitly, scripting of work practices, and using technology to identify indicators all add to retrieval coordination at organizational level. AR cycle 2 shows that the introduction of a methodology to externalize experience through explication and encoding may strengthen

organizational TMS. A methodology like ILP+ showed to be a manageable intervention for organizational TMS development.

2.4.3 Cycle 3, combining organizational records

Diagnosis phase. It was recognized that real-time sensor data and other data collections available within the organization was under-utilized and that ICT provided potential. Or in the words of the head of the KLPD Intelligence Unit: 'We are sitting on a stack of gold but no-one knows how to finds it or how to ask the right questions'.

Planning phase. To exploit this perceived data potential Transport Security (TS) had as its objective to develop a complex event-processing tool, the iFunnel. One of the input sources would be the segment-one indicators uncovered through the ILP+ methodology. Real life events would generate data that had to be matched against profiles, which in turn would trigger follow-up action through workflow management facilities. Moreover, metadata files were being designed to support the contextualization and interaction processes of iFunnel outcomes (*cf.* Table 2.2).

Action phase. The research team developed functional requirements based on visiting partner organizations like the London Metropolitan Police, and organizing a meeting with a number of key players from KLPD departments. The output of the iFunnel needed to initiate follow-up actions, i.e. feeding the output to investigation processes, and initiating instant real-time action. Operational instructions supporting these functions would be included in the metadata file. Of the short-listed vendors, three were able to demonstrate their solution in a real-life setting using real-time sensor data.

Evaluation phase. Having their roots in business intelligence all three vendors were able to support profile-based search across a plenitude of data sources. They all fell short, however, on operational management functions (profile management, scheduling, and output management). One vendor was selected to build these functions.

Class	Description
Administrative data	Hierarchical structure; principal; profile origin and ownership (KLPD's experts); profile purpose and criteria for hits; weight of profile (life threatening / important / law enforcement); timing (creation date, validity, notification terms), and prioritization of hit management.
Legal issues	Legal argumentation of profile; reference to formal approval of profile (incl. period of validity, approving prosecutor, involved lawyers, etc.).
Hit management	Instructions for actions, including mandates and possible actors.
Profile structure and constituent data	Indicators and related data sources.
Profile scheduling	Activation periods of profile, frequency, expiration dates.
Authorization	Who is authorized for different actions on the profile and the iFunnel.

Table 2.2: Description of the content of the metadata files

Reflection phase. The iFunnel strengthened the real-time utilization of encoded knowledge resources in the organizational TMS. This was achieved by scripting organizational routines and methods using profiles and metadata files (thus, transforming embedded knowledge resources, such as routines and organizational structures into encoded knowledge resources), and presenting these to help officers contextualize the hits and suggest interaction pattern (i.e. aiding the transformation from encoded to personalized knowledge resources). The organizational TMS is strengthened as follows. First, information allocation is supported by describing the origin, ownership, and authorization of (new) profiles, and the names of organizational members who potentially are capable of following up its resulting hits. Second, updating is supported by indicating the period in which the profile should be active, notification terms, hit-instructions, and the real-time monitoring of sensor data. And retrieval coordination is supported by metadata related to the data sources being used and contact data of the officers involved. As those involved in

creating profiles are not the same people coordinating and executing follow-up actions, the system is an example of how cognitive efforts at the organizational level can be coordinated in a real-time fashion. Such interdependence across knowledge domains is characteristic for TMS (Hollingshead 2001). The introduction of iFunnel technology proved to be a manageable intervention to strengthen organizational TMS.

2.4.4 Cycle 4, knowledge transfer in action

This paragraph describes two iterations where the evaluation of the first cycle formed the diagnosis of the next.

Diagnosis phase. The first prototype of the iFunnel and results of the ILP+ methodology had to be put to the test to show that geographically distributed information and knowledge resources could be integrated while in action. The challenge was to find an economical balance between encoded, embedded, and personalized indicators, while achieving concerted action in pursuit of people trafficking.

Planning phase. To thus pattern the organizational TMS the project members were challenged to divide cognitive labor and device ways of sharing and integrating distributed knowledge while in action. To this end examples were used of the knowledge exchange literature (Argote *et al.* 2003; Cramton 2001; Dixon 2000; Wu *et al.* 2007; Zander and Kogut 1995), telemedicine (Paul 2006), tele-guidance of astronauts in space, and the science fiction movie the Matrix (Wachowski and Wachowski 1999). The resulting division of labor and interaction patterns forms an example of TMS at organization level.

Action phase. The team recognized that indicators and profiles allow for segmentation of knowledge into different parts that can be distributed asynchronously through different communication channels depending on the type, generalizability, and situational characteristics of the indicators. For example, many indicators related to criminal behavior that can be detected in the case of people trafficking can be found in cases of arms trafficking or drug trafficking as well. Hence, this type of indicators could be communicated in regular training programs. Current groups, destinations, and routes, however, are more ephemeral and, hence,

need to be communicated just before the action. Assessment of complex situations may require the judgment of experts who may join the team physically or may assist the team by virtually teaming up through rich media communication channels. Electronically detectable indicators could be assessed by sensor technology in combination with the iFunnel prototype.

The team became aware that existing briefing structures were solely aimed at sharing information, not at learning from past experience. After action reviews, focusing on learning and improvement and being a standard practice in e.g. special arrest squads (*cf.* Dixon 2000), were not yet practiced by general law enforcement officers. Hence, an enriched version of briefing, incorporating learning, was planned for.

A test-team consisting of 10 police officers executed a field test to review whether the indicators could indeed be recognized. Based on last-minute intelligence of the human trafficking expertise unit of the Criminal Investigations Department a location along a current people trafficking route was selected. In a 30-minute briefing the aim of the action and the indicators were explained to the officers. An ANPR-camera virtually connected to the iFunnel prototype (indicators: country of origin and destination, type of vehicle, list of known traffickers), one car, one motorbike, and two observants posted on a bridge (visual indicators: number of people in vehicle, signs of illegal entry in trucks) were used to select and stop vehicles that met two or more indicators.

Evaluation+Diagnosis phase. Selection based on ANPR-techniques showed to be efficient but the used intelligence proved to be too coarse. Regarding the assessment of indicators after stoppage it was recognized that general police officers did not have sufficient individual knowledge to assess sufficient segment three indicators. The officers gave three suggestions for improvements. First, a few indicators that could indirectly be related to license plates should be assessed by segment one technology, too. Second, a rich-media connection should be established between the officers in the field and an expert on criminal behavior at the office to test whether his co-observations would lead to higher detection rates of human behavior-related indicators. Third, the briefing needed to

be organized in two sessions. In the first session the phenomenon and purpose of the exercise needed to be explained, after which role-based instructions needed to be given in a second session just before the start of the action.

Planning phase. The action plans were adjusted accordingly. For example, the specification of vehicle details could be made more specific (and be recognized by technology), while other indicators were elaborated and explained per role (motorcycle policeman, observers and apprehension team). Moreover, to bridge the distance between officers in action and the specialist the department of Specialist Investigations Applications developed a 'camJacket' (jacket with incorporated camera system). Due to time pressure, the incorporation of sound was not yet possible, but this shortcoming could for the time being be overcome by using cellular phones.

Action phase. During the second field-test about 4200 vehicles passed of which 26 were selected for control of which three were actually related to people trafficking. One of these had been selected by the motor-cyclist based on the interpretation of two visual indicators (segment 3 type). The other two had been detected by ANPR-systems (segment 1 type).

Evaluation phase. The action was evaluated by the involved police officers as realistic and effective, although the data preparation for the ANPR-systems could still be improved. Due to the lack of sound the specialist on criminal behavior judged the camJacket as moderately effective. Indicators that could be identified through digital sensors proved essential. Combined with segment three indicators (mainly behavioral, detectable during interaction) two of the three cases were identified as being cases of people trafficking. The evaluation report concluded:

The systematic approach through the iFunnel and ANPR technology is of great value to trace criminals and delivers significantly better results than traditional selection methods.

Reflection phase. The field test confirmed that the exchange of distributed knowledge to general police officers in action could be accommodated through differentiating between different knowledge and

indicators and transferring these through different approaches, which are summarized in Table 2.3.

Segment 1: organizational records and technology	**Segment 2: organizational routines and structures**	**Segments 3: minds of organizational members**
Sensory detectable indicators; ANPR and other related sensor technology like depth meters; iFunnel technology; Digital metadata files.	Indicators detectible by analytical methods; ILP+ methodology; Standard communication protocols and codes of conduct.	Human observable indicators; Regular training programs; Two staged SKI briefings; Co-observation by experts through rich communication media.

Table 2.3: Interventions applied to enable knowledge transfer

The field test confirmed that virtual teaming of experts with officers in action was possible. Virtual teaming proved to extend the action as its members were also involved in the ILP+ methodology to come to profiles, prepare for contextualization and interaction, and maintenance. Hence expert knowledge is not only distributed to officers in action through direct interaction (camJacket), but also through encodable indicators (through the iFunnel and related technologies) and through procedures for contextualizing and profile maintenance. Thus, encoded, embedded, and personalized knowledge resources are being integrated while in action. This means that the 'knowledge potential' of experts is present in many of the aspects of the virtual team. The experts in turn retrieve feedback through participating in the action and attending debriefings. This not only adds to their personal expertise but adds to their meta-knowledge of other team members, too, including ways to integrate knowledge while in action.

The organizational measures taken strengthened the organizational TMS of the KLPD stimulating transactivity between organizational members. Moreover, throughout the field tests police officers experienced how recognition of criminal behavior could be aided

by technology, procedures, and distant experts. This not only updates their personalized knowledge resources, it also helps them to allocate (operational) knowledge responsibilities to other knowledge resource types as well. The same counts for the experts who discovered new ways of contributing their expert knowledge to the operation. Moreover, virtual teaming provided new options for organizing distributed knowledge resources (in particular information allocation) and proved a manageable intervention to strengthen organizational TMS.

2.4.5 Exiting the AR

The TS steering committee believed that cooperation between the departments in real-time collaborations supported by technology could extend the footprint of the KLPD organization considerably, especially on the national infrastructures. In a reflection session with the steering committee the project outcomes were discussed. As a result the KLPD departments agreed upon points of departure for the future and contributed positions to further develop the concepts. Based on the results it was decided to end the experimental phase and extend the program and AR for two years to make results sustainable.

2.5 Discussion

This study is one of the first empirical studies focused on TMS at the organizational level, and the first to have an interventionist approach, for which AR is an appropriate method because studying the application of theory in practice and observing the effects of interventions is its basic contention (Baskerville 1999). Where in the previous sections short theoretical reflections per AR cycle are provided, in this section a more comprehensive review is given of what has been learned. The findings are accompanied with leads for future research and a conclusion.

This study was focused on organizational TMS development through interventions aimed at stimulating knowledge transfer transactions. Through this focus this study differs from earlier studies on TMS in the IS field which tend to focus on understanding how TMS work in organizations or distributed teams by analyzing case studies (Jackson

and Klobas 2008; Oshri *et al.* 2008), offering conceptual work (Griffith and Neale 2001; Nevo and Wand 2005) or testing hypotheses (Choi *et al.* 2010). This study also differs from earlier work related to TMS development. Rather than taking an interventionist approach, these studies tend to be analytic, describing phases of TMS development (e.g. Brandon and Hollingshead 2004; Kanawattanachai and Yoo 2007; Littlepage *et al.* 2008) and do not take the organizational level as their unit of analysis. In IS literature only one exemplar is known of empirical research on organizational TMS (i.e. Jackson and Klobas 2008) (Ren and Argote 2011).

Following Oshri *et al.* (2008), in this study a distinction is made between personalized and codified knowledge resources. By introducing a class of knowledge resources for embedded knowledge (i.e. organizational routines and structures), clearer distinctions could be made between types of interventions to strengthen organizational TMS. That is, where social processes among people cannot be designed, but should be designed for (Foss 2011; Wenger 1998), embedded knowledge resources are the typical domain of organizational design, while data structures (encoded knowledge resources), on the other hand, are the typical domain of ICT. This study suggests that for organizational TMS development all three ideal types of knowledge resources have to be taken into account.

As shown in this study, one way to develop organizational TMS is to increase transactivity among knowledge resources. Another way is to transform knowledge resources from one resource type to another. In the latter case, this not only affects knowledge form, but also its meaning, context, and applicability (Carlile 2004). Earlier research has shown that the emerging structure of a TMS (e.g. more differentiated of more integrated) is related to the characteristics of the task at hand (Gupta and Hollingshead 2010). In the case of the KLPD, several tasks, such as e.g. fighting people trafficking or arms trafficking, show an overlap of required expertise and knowledge of e.g. current modes operandi. These similar yet divergent knowledge patterns raise questions about the flexibility and coherence of organizational TMS over time. Indeed, parts of TMS related to people trafficking may become outdated, which does

not necessarily mean that these knowledge patterns have become outdated for other knowledge domains, such as arms trafficking, as well. In this respect, one special case of established knowledge patterns are the transactions among knowledge resources that are automated or routinized, i.e. translated to encoded or embedded knowledge resources. The advantage of such translation may be that access and updating processes may become extremely efficient and predictable. In turn this may increase the sharedness or validity of knowledge. It may, however, also affect its accuracy. Because, unlike personalized knowledge resources, encoded and embedded knowledge lack the quality of improvisation, mutual adjustment, and learning, more research is needed to learn how knowledge resources in organizations, other then individuals, relate to TMS development – which is the subject of the second empirical study reported in the Chapter 3.

Organizational TMS may also be strengthened by developing alternative forms of organizing. Cycle 4 of this AR shows how virtual teams can benefit from organizational TMS and can be used as a means to strengthen it. By uniting officers and experts in temporary virtual team settings, directory updating, information allocation, and retrieval coordination of all involved are strengthened, providing a basis for collaboration in future virtual teams. Thus, the virtual team TMS strengthens the organizational TMS, while the established organizational TMS functions as a basis for future collaborations. The consequence for practice is that project efforts aimed at strengthening organizational TMS should not be viewed in isolation. Indeed, ICT project activities involve processes of explication, encoding, contextualizing, and interacting, and may lead to new forms of collaboration. The TMS to support virtual teams in this study was not developed at the level of the problem-specific collaboration (the planned action) but at a higher organizational level to provide for stable structures supporting knowledge collaboration among members that did not work with each other before (*cf.* Moreland and Argote 2003). The complete set of organizational arrangements (including organizational structures, methods, and technological support) spans an organizational level workspace that can be used by (virtual) teams within

the organization. The knowledge potential of the experts is represented in this workspace through profiles and metadata files and is made accessible to officers through knowledge transfer arrangements. Potentiality and overcoming distances through technology define the virtuality of teams in this case. Thus, strengthening the organizational TMS sets conditions for virtual teams. In cases in which collocated teams do not form a viable option for problem solving, the creation of a rich virtual workspace may be the best option at hand to achieve business goals. It may provide a way to engage people in activities they otherwise would not have had the opportunity to (*cf.* Zammuto *et al.* 2007). Given that knowledge exchange in virtual teams is difficult because of factors like diversity of local contexts, differences in local routines, and failures in communication (Cramton 2001; Desouza and Evaristo 2004; Hinds and Mortensen 2005), the mutually constitutive relation between organizational TMS and the TMS of virtual teams represents an important venue for future research. This issue is being addressed by the third empirical study reported in Chapter 4.

This study adds to the discussion in the literature about how IS relates to TMS. IS are hold to have a function in TMS (Griffith and Neale 2001; Nevo and Wand 2005; Jackson and Klobas 2008; Oshri *et al.* 2008). IT has been shown to facilitate the development of TMS (Choi *et al.* 2010). Some technological TMS supporting mechanisms have been discussed in the literature, including standardization of templates, methodologies, and teleconferencing (Oshri *et al.* 2008). Moreover, three studies have proposed requirements for TMS supporting systems (i.e. Jackson and Klobas 2008; Nevo and Wand 2005; Ren and Argote 2011). This study adds to this discussion in two ways. First, it is shown that IS, an IS-related framework like the information framework, IS-related communication channels, and information-related methodology (ILP+) provide opportunities to intervene in organizational TMS. Second is the identification of a transformational knowledge resource ideal type in between personalized and encoded knowledge resources, i.e. embedded knowledge resources, providing a clearer distinction between ICT-related interventions and organizational development interventions. This

distinction leads to interesting questions about the potential contribution of IS design and implementation (independent of implementation and use of its artifacts) to organizational TMS development and the question how TMS of different functionally related groups are interrelated. These questions are further investigated in the following two chapters.

The results of this study have implications beyond the KLPD. Other types of swift starting action teams (McKinney *et al.* 2004), fast response organizations (Faraj and Xiao 2006), extreme teams (Jones and Hinds 2002), or temporary problem solving teams (Rosenberg 2000) include teams such as crisis response teams, fire brigades, medical teams, flight crews, special weapons and tactics teams, and military combat teams. Another area that comes to mind is that of commercial field jobs, like for instance consultative selling where salesmen often need support from various experts to arrive at an offer. Yet another field is that of ICT services in which different people from the user organization might need to team up with experts from different ICT supplier organizations which are located throughout the world as was the case in Oshri *et al.* (2008). Distributed supply chain coordination is another application field in which some studies on complex event processing technology, which resembles the iFunnel technology, has been done (Soroor *et al.* 2009). Further research on the development of organizational TMS, including its function for supporting temporary (virtual) teams, is required to develop our knowledge and learn from similarities and differences in different areas of society.

2.6 Conclusions

In the relevance and rigor debate that has been going on in the IS field (Cohen 2007; Davenport and Markus 1999; Kieser and Leiner 2009) AR has been put forward as one of the solutions to the lack of relevance (Baskerville and Wood-Harper 1998; Baskerville and Myers 2004, 2009). This AR shows how practical and societal relevance can be combined with theoretical relevance without compromising AR rigor, as this AR adheres to all principles for AR put forward by Davison *et al.* (2004). The practical relevance of this study lies in the development of an

organizational TMS to enable knowledge integration between experts and officers in action in temporary (and often virtual) teams. As such this study's social relevance lies in increasing opportunities for catching criminals, not by increasing the number of officers but by making police work more effective and efficient. The theoretical relevance of this study lies in its contribution to the understanding how organizational TMS, comprised of personalized, embedded, and encoded knowledge resources, may be used to increase the potential contribution of distributed knowledge to problem solving in action.

Where in this chapter different types of knowledge resources were being identified as means to strengthen organizational TMS development, in the following chapter the question is being addressed how these different types of knowledge resources are actually related to TMS.

3 TMS DEVELOPMENT IN A LARGE COLLABORATIVE NETWORK: THE ROLE OF DIFFERENT KNOWLEDGE RESOURCE TYPES[4]

3.1 Abstract

In the previous chapter TMS development has been studied from a knowledge management perspective. Like in other TMS research, different types of knowledge resources were identified as potential actors for knowledge storage and retrieval. The question remaining, however, is how different types of knowledge resources should conceptually be related to TMS. This question is important for several reasons: TMS are antecedent to combining capabilities; failure to develop an effective TMS is one of the most common barriers to distributed team success; and through increased understanding of TMS one may better understand why interventions are (not) successful. To address the question, in this chapter TMS theory is being extended by borrowing insights from organizational routines theory. The resulting theoretical lens is used to study and strengthen TMS in a large-scale policing operation. Next to formally including different types of knowledge resources in TMS theory, this study demonstrates that where TMS in organizations are interrelated, these relations can be described in terms of actors, artifacts, relationships, and type and content of interactions. This study ends with implications for research and practitioners, and conclusions.

[4] An adapted version of this chapter has been submitted for publication by Jan-Kees Schakel (lead researcher and author) and Erik J. De Vries (external research partner who like in the study of Markus *et al.* (2002) provided psychological and emotional distance to facilitate reflection and discussion on theoretical and methodological lessons learned)

3.2 Introduction

Public organizations are frequently involved in large scale collaborative operations to head challenges that none of them can handle, or not as effectively, on their own (*cf.* Agranoff and McGuire 2001). Such task-interdependent groups of organizational units (e.g. departments, teams, individuals) that occasionally work together may be framed as a temporary collaborative network (Provan and Kenis 2008). As shown in many studies, the execution of interdependent tasks in temporary collaborative networks is difficult (Congress 2006). This difficulty is amongst others related to its emergent nature (Agranoff and McGuire 2001), a lack of (time for) advance preparations, inadequate communication, and impaired coordination (Congress 2006; Snook 2000). As demonstrated by the Tenerife air disaster (Weick 1990), the Mann Gulch fire-fighters disaster (Weick 1993), or the friendly fire incident in Northern Iraq (Snook 2000), failures of collaborative networks may lead to severe consequences. Improving our understanding of interdependent action in collaborative networks may help increasing their robustness and resilience, and hence, is of vital importance.

In this research temporary collaborative networks are being studied from a TMS perspective. Kozlowski and Klein, who identify TMS as a multi-level construct, describe it as 'a complex configuration of individual memory, distributed knowledge of the contents of individual memory, and the interaction process that links that information into an emergent whole' (2000: 74). As such, transactive memory is a property of a collection of actors, assembled in a 'social network of individual minds' (Wegner 1986: 206). It is the result of (conscious or unconscious) cognitive efforts to cooperate and divide responsibilities across knowledge domains (Wegner 1986; 1987). TMS become transactive through the informational interactions (transactions) that occur among the members involved in the network (Wegner 1986). Since its inception TMS has empirically been studied at various levels of analysis, including dyads (Hollingshead 1998), groups (Rau 2005), virtual teams (Kanawattanachai and Yoo 2007), globally distributed teams (Oshri *et al.* 2008), organizations (Jackson and Klobas 2008), emergent response groups

(Majchrzak *et al.* 2007), and inter-organizational networks (Jarvenpaa and Majchrzak 2008).

One element still underdeveloped in TMS theory is the formal inclusion of different types of knowledge resources, including the use of technology. As Wegner noted, "Our walls are filled with books, our file cabinets with papers, our notebooks with jottings, our homes with artifacts and souvenirs, our floppy disks with data records, and at times, our palms with the scribbled answers to a test. Quite simply, we seem to record as much outside our minds as within them" (Wegner 1986: 187). It is only since recent, however, that information systems (Choi *et al.* 2010; Jackson and Klobas 2008; Nevo and Wand 2005; Yuan *et al.* 2007), organizational rules (Kieser and Koch 2008), and e.g. standards, guidelines, and templates (Oshri *et al.* 2008) have been included in TMS research as alternative resources for knowledge storage and retrieval. All of these studies, however, adhere to the description of TMS as a 'social network of individual minds' (Wegner 1986: 206). Hence, there seems to be consensus that IT and other types of knowledge resources may be used in TMS, but are not part of it. How this relation looks like, however, is still being mentioned as subject for future research. Yuan *et al.* (2011), for example, call for research to better understand the choice between interpersonal and technological resources for knowledge storage and retrieval, and to what extent the two compliment each other. Likewise, Choi *et al.* (2010) ask for future research to learn how TMS and IT tools interact, while Lewis and Herndon (2011) go as far as hypothesizing that artificial knowledge resources may substitute (parts of) TMS, but only if they can emulate and facilitate transactive processes.

In line with these calls for research, in this chapter an attempt is made to address the question how different types of knowledge resources are related to TMS. That answers to this question are urgently needed may be demonstrated by the study of Bell and Kozlowski (2002) and others (Kanawattanachai and Yoo 2007; Martins *et al.* 2004; Oshri *et al.* 2008), who conclude that still little is known about knowledge coordination in real world distributed settings, the notion of Jarvenpaa and Majchrzak (2008) that TMS are antecedent to the capability of organizations to

combine distributed knowledge resources, and the study of Rosen *et al.* (2007), who identify the failure to develop an effective TMS as one of the most common barriers to distributed team success (the others being: time pressure, constraints on building trust, technology-, leadership-, and cultural constraints). Improving our understanding of how different types of knowledge resources relate to TMS may help to devise more effective interventions to strengthen organizational TMS.

To better understand the relations between various types of knowledge resources in TMS, insights are borrowed from organizational routines theory. The idea behind it is that one of the principle reasons for developing organizational routines is to deal with the problem of storing and accessing knowledge (Nelson and Winter 2002), which is the main reason for developing TMS as well. Where TMS theory focuses on knowledge distribution among actors who are task interdependent (Ren and Argote 2010), organizational routines theory focuses on activities which show 'repetitive, recognizable patterns of interdependent actions carried out by multiple actors' (Pentland *et al.* 2011: 1370). It may be presumed likely, therefore, that the well-described role and function of different types of knowledge resources in organizational routines (*cf.* Pentland and Feldman 2003) do apply to TMS theory as well.

Empirically, the relations between TMS and different types of knowledge resources are studied during an operation involving four rounds of preparing action and action. This operation, called Operation Vigilance, was aimed at recognizing and intercepting drug traffickers along highways. Circa 600 geographically distributed police officers of diverse specialized teams of the Dutch National Police Services Agency (Korps Landelijke Politiediensten, KLPD) participated. The research objective was pursued by introducing changes (the application of theory in practice) and observing the effects of these interventions (academic reflection), which is the basic contention of action research (AR) (Baskerville 1999). Moreover, while collaboration among teams in networks could involve both intra-organizational and inter-organizational networks, in this chapter the focus is on the former. This allows me at this

stage to ignore the complexities of combining intra- and inter-organizational processes (*cf.* Gittell and Weiss 2004).

This chapter is organized as follows. First, the theory section is used to discuss extant TMS studies at organization level and to extend TMS theory with insights from organizational routines theory by formally relating different types of knowledge resources to TMS. This section is followed by an account of the research results (the research method is described in Chapter 1). The reflection-phase of the AR is used to analyze the TMS that developed. In the discussion section the implications of the findings of this analysis are being presented, followed by a conclusion.

3.3 Theory

Below an introduction is given to organizational TMS theory and organizational routines theory, after which the latter is being used to extend the former. This section closes with a review of theoretical consequences for TMS development, which have been used to inform the interventions undertaken in the action research reported in section 3.4.

3.3.1 Organizational TMS

Anand *et al.* 1998), who sought to conceptually extend TMS theory from group to organization level, approach organizational TMS from an information management perspective. They hypothesize that group TMS may include members from outside the organization, while organizational members may participate in group TMS outside the organization. Furthermore they hypothesize that an organizational TMS consists of the collection of group TMS that exist within the organization, and be interlinked to organizational TMS of partner organizations. And because people may be member of multiple (formal and informal) groups, they hypothesize that they may also be member of multiple group TMS.

Nevo and Wand (2005), who approach organizational TMS from an organizational memory perspective, hold that individuals in larger organizations cannot develop accurate (meta)knowledge of all organizational members and propose that information systems (IS) could be used to develop comprehensive information directories. Two

alternative views are developed by respectively Jackson and Klobas (2008) and Jarvenpaa and Majchrzak (2008). Jackson and Klobas (2008), who sought to upscale group TMS to the organization level, de-emphasize the role of group TMS and interpersonal TMS, emphasizing instead that IS and organizational TMS processes could be used 'to access knowledge anywhere in the organization, thus, without the need always to access that knowledge through sub-groups' (Jackson and Klobas 2008: 410). Jarvenpaa and Majchrzak (2008), too, de-emphasize the role of group TMS, but rather than focusing on IS and organizational TMS processes, they emphasized the role of ego-centered networks (i.e. personal network of contacts). They found that due to the fact that the size of ego-centered networks is restricted to approximately 150 individuals (Hill and Dunbar 2003), people deploy semi-structures to help clarify expectations in absence of shared experiences. In this context, they define semi-structures as ‘simple or minimalist rules that help members of a group organize their knowledge integration processes, yet remain flexible enough to adapt to an evolving situation’ (Jarvenpaa and Majchrzak 2008: 262). Moreover, rather than having knowledge about person-expertise combinations, research related to the functioning of temporary teams revealed that its members may have transactive memories based on task-expertise combinations (i.e. roles) and stereotypes instead (Bechky 2006; Majchrzak *et al.* 2007; Weick 1993).

To formally describe the role of different types of knowledge resources in organizational TMS, insights are borrowed from organizational routines theory, which is being discussed next.

3.3.2 Organizational routines

Organizational routines may be defined as 'repetitive, recognizable patterns of interdependent actions carried out by multiple participants' (Pentland *et al.* 2011: 1370). With respect to these patterns of action, people maintain shared mental representations consisting of 'abstract regularities and expectations that enable participants to guide, account for, and refer to specific performances of a routine' (Pentland and

Feldman 2008: 241). These mental representations are called the ostensive aspects of the organizational routine (see Figure 3.1).

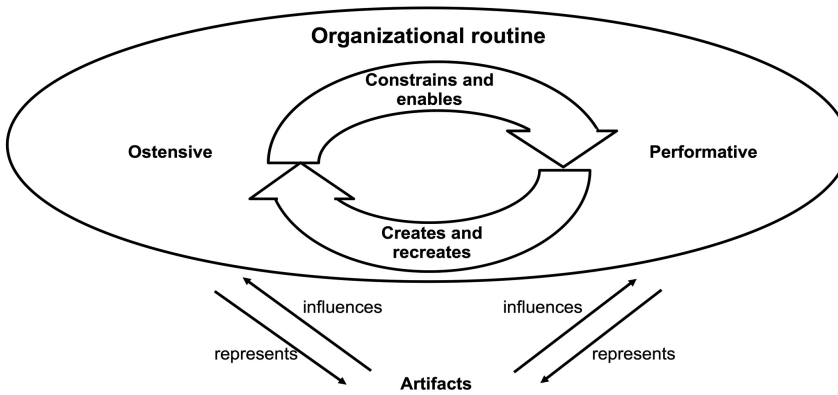

Figure 3.1: Organizational routines as generative systems *(adapted from Pentland and Feldman 2008)*

The actual performances of an organizational routine, executed by specific people at a specific time and place, and making use (or not) of specific artifacts, represent its performative aspects (Feldman and Pentland 2003). The ostensive aspects of an organizational routine constrain and enable the performative aspects of the organizational routine, while through carrying out the routine the performative aspects create and recreate the ostensive aspects of the organizational routine. Thus, the two types of aspects are mutually constitutive and form a 'generative system'. Generative in this respect may be interpreted as the interplay between knowledge and knowing (*cf.* Orlikowski 2002), where 'the source of new knowledge and knowing lies in the use of knowledge as a tool of knowing within situated interaction with the social and physical world' (Cook and Brown 1999: 383).

In addition to the ostensive and performative aspects of organizational routines, Pentland and Feldman (2008) describe how artifacts such as software, digital data, or written procedures, may be related to organizational routines, but are not part of it (see Figure 3.1). First, artifacts may represent the ostensive or performative aspects of organizational routines. For example, written procedures may reflect ostensive aspects of a routine, while transaction data may reflect

performative aspects of a routine. Second, artifacts may influence the ostensive or performative aspects of organizational routines. This influence, however, is not a given, as people may decide to neglect the artifact, use it in unintended ways, or use alternative options instead (Pentland and Feldman 2008).

A special type of artifacts are those that represent fully automated routines. Following Cohen (2007), Pentland and Feldman refer to such routines as 'dead', because they are 'rigid, mindless, and can be explicitly stored' (Pentland and Feldman 2008: 240). In contrast, 'live' routines involve people who through learning may 'produce a wide variety of performances depending on the circumstances' (Pentland and Feldman 2008: 241). Thus, each time a live routine is carried out, the way it is performed as well as its results will differ from previous performances as it is being adjusted to local circumstances and needs (Feldman and Pentland 2003).

3.3.3 Projecting various types of knowledge resources in TMS

To understand how different types of knowledge resources relate to organizational TMS, it is useful to frame a TMS like organizational routines, as a generative system (see Figure 3.2).

Translated in TMS terms, the ostensive aspects of a TMS include the overlapping mental representations of the distribution of responsibilities for knowledge domains. This includes meta-knowledge of 'who knows what', but also knowledge about the allocation of responsibilities for knowledge domains, the process of updating each other about what has been learned, and knowledge retrieval coordination (Brandon and Hollingshead 2004); emergent behavioral knowledge, such as task credibility expressing the level of trust in each others' knowledge (Moreland and Myaskovsky 2000; Moreland *et al.* 1996); soft knowledge, such as belief structures, judgment, intuition (Anand *et al.* 1998), capability and motivation (Majchrzak *et al.* 2007), and affect (Huang 2009). Likewise, the mental representations of organizational rules that serve as resource for information storage and retrieval (*cf.* Kieser and Koch 2008) form ostensive aspects of TMS.

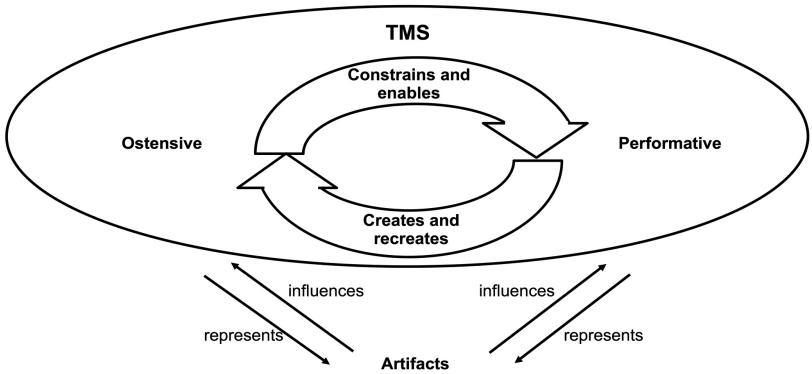

Figure 3.2: TMS as generative system *(adapted from: Pentland and Feldman 2008: 241)*

The enacted processes of allocating, updating, and retrieval coordination (i.e. transactions) form the performance aspects of a TMS through which the ostensive aspects are being created and recreated (*cf.* Palazzolo *et al.* 2006), which in turn constrain and enable the performative aspects of the TMS.

Like is the case in organizational routines, the ostensive and performative aspects of a TMS may be influenced or represented by artifacts, but these types of knowledge resources are not part of the TMS. Artifacts mentioned in TMS literature include encoded directories, forms, and templates (Oshri *et al.* 2008), explicated organizational rules (*cf.* Kieser and Koch 2008), and various types of IS (Jackson and Klobas 2008; Nevo and Wand 2005; Yuan *et al.* 2010).

3.3.4 Theoretical consequences for TMS development

Realizing the emergent nature of organizational routines and TMS it may be inferred that TMS cannot be designed, but should be designed for (*cf.* Foss 2011; Wenger 1998). That is, organizational design should be directed at creating a context in which a TMS can evolve.

Artifacts, such as software and written procedures, may be part of that context and used to influence the development of a TMS. As such they are not a sufficient means to establish a TMS. Indeed, artifacts may be ignored, or used in different ways then intended (*cf.* Pentland and

Feldman 2008). To effectuate change, Pentland and Feldman (2008) advice to invest in the ostensive aspects. From the perspective of organizational TMS, this involves the creation of opportunities to practice (*cf.* Moreland *et al.* 1998) during which the TMS processes of allocating, updating, and accessing distributed knowledge resources are enacted to create a TMS structure (i.e. more differentiated or more integrated) that matches the task at hand (*cf.* Gupta and Hollingshead 2010; Nissen 2006). An alternative method to establish the ostensive aspects of a TMS is priming, defined as providing participants with a description of the capabilities of others in the network (Moreland and Myaskovsky 2000). In the early development phase of a TMS, which due to its lack of shared understanding has much in common with an adhocratic organizational structure, an important mechanism to create and recreate the ostensive aspects of a TMS is mutual adjustment (*cf.* Albert and Nissen 2009; Mintzberg 1979). To enable mutual adjustment the creation of a 'shared understanding of the task goals and the current state of accomplishment' should be stimulated by creating 'opportunities to organize monitoring and feed back' (Curşeu *et al.* 2007: 645).

In the AR reported next the perspective on TMS presented in the previous section is used to inform interventions. The research method has been elaborated upon in Chapter 1. Hence, in the next section the results are being presented.

3.4 Results

The following paragraphs are structured in accordance with the AR phases diagnosing, planning, action, evaluation, and reflection (*cf.* Susman and Evered 1978).

3.4.1 Diagnoses phase

The diagnoses phase of an AR covers two elements, 1) diagnosing the practical problem situation or opportunity, and 2) drafting relevant research questions (McKay and Marshall 2001).

Practical diagnoses

The start of this AR was initiated by a three-fold ambition of the senior management of the KLPD. First, they wanted to improve synergy and stimulate collaboration among the specialized departments of the KLPD, as they believed that by combining capabilities, innovative policing services could be developed to fight crime. Second, they wanted to 'deny criminals access to the road' by learning how to apply profiling methods and sensor technologies to better recognize criminal behavior on the national infrastructures (roads, railways, waterways, airway) (*cf.* Schakel *et al.* 2012). And third, they wanted to double the number of arrests by intercepting criminals red-handedly. As lead for the first collaborative action the senior management opted for fighting drug-related crime in the southern parts of the country, and called it 'Operation Vigilance'.

Research question

The preparation and execution of a large-scale operation provided opportunities to study the development and functioning of an organizational TMS. In line with this opportunity, the question being addressed in this AR is: how are different types of knowledge resources related to a TMS which develops for supporting temporary collaborative action in a geographically distributed setting?

3.4.2 Action planning phase

This phase in AR covers the planning of practical problem solving activities, and the planning and design of the research project (McKay and Marshall 2001). The latter has been described in the Method section of Chapter 1.

To materialize the ambitions formulated during the Diagnoses phase it was decided by the top management to set up an operation (operation Vigilance) focused on intercepting drug traffickers on highways. The concept of the operation was the following (*cf.* Schakel *et al.* 2012). First, an attempt would be made to uncover the travel characteristics of drug traffickers. This included identifying logical routes

of drug traffickers between source cities in the Western parts of the country and destination cities in the Southern parts, and favored travel schema. Second, at critical points along these routes automated number plate recognition (ANPR) sensors would be set up. By connecting these sensors to a central information system, called the iFunnel, passing license plates could be analyzed on time-spatial patterns and vehicle characteristics, and matched against the time-spatial travel and vehicle characteristics of drug traffickers (called profiles). These vehicle characteristics could be made accessible through a connection of the iFunnel-system with the national vehicle register of the Dutch Agency of Road Transport (RDW). In case of a match (called a hit) an interception team would be used to intercept the identified vehicle, after which an inspection team would carry out the inspection. In-depth information about passengers would be made accessible through the information coordination unit of the KLPD, called Delta. The actual design of the division of work among the various participants in operation Vigilance is summarized in Table 3.1 and explained next.

First, a chief commander was assigned, nick-named Alpha. While he took charge of the logistical preparations, the Sensing-team, which is expert in using technological sensors to augment the sentience of the police, played a critical role in the tactical preparations. Through discussions with experts on drug related crime the Sensing-team collected data about cities of origin, destination of the drugs, names of drug traffickers, their modus operandi, favorite days, times, places, car rentals, etc. Analysis of this data revealed regularities in drug trafficking behavior, which could be explicated in knowledge-rules. These explicated knowledge-rules were used to construct profiles, i.e. sets of related knowledge rules that can automatically be evaluated. The profiles were evaluated by the iFunnel IS, which received its input from two sources. First, the iFunnel was connected to a network of distributed electronic traffic surveillance units (ETS). These ETS-units are vans equipped with automatic license plate readers (ANPR) which, based on the data analysis discussed above, were positioned at strategic locations along the highways.

Actor or artifact	Action Planning phase TMS: task during action planning	Action phase TMS: task during the action phase
Alpha (commander)	Overall command and coordination	Overall command and coordination, based on management by exception
Sensing-team	Intermediaries between police officers and the use of sensor technology; Construction of profiles;	Ad hoc adjustment of profiles
Expert	Knowledge resource for modus operandi, latest trends, etc.	Distant support of police officer (judgment of facts, interpretation of complicated cases)
Profile	Repository for encoded knowledge rules, logistical, juridical, and other information	Central overview of logical, logistical, juridical, and other information; Instructions for handling hits
iFunnel	Processing test data stream, executing profiles and automated enquiries (e.g. RDW)	Forwarding hits to Delta; Processing ANPR-data stream, executing profiles and automated enquiries (e.g. RDW); Forwarding hits to Delta
ETS	Knowledge resource for positioning of Electronic Transport Surveillance (ETS) units, equipped with automated number plates recognition systems (ANPR)	Scanning license plates for iFunnel Relaying hits from Delta to interception team
RDW	Data source vehicle ownership registrations	Data source vehicle ownership registrations
Delta	Knowledge resource for operational information coordination	In-depth information enquiries; Contextualization of hits; Relaying hits to ETS; Providing inspection team with background information of the interception and the intercepted

Actor or artifact	Action Planning phase TMS: task during action planning	Action phase TMS: task during the action phase
Interception team	Knowledge resource for interception	Interception of vehicle on initiation of ETS; Relaying lead information to inspection team
Inspection team	Knowledge resource for inspection	Performing check; Release subject or start investigation

Table 3.1: Transaction patterns during action planning and action phase

Second, the iFunnel was connected to the register of the Agency of Road Transport (RDW), containing car-related data, including ownership. Through these two connections, vehicles could be identified based on their license plate numbers, while multiple time-location observations (used to deduct traveling behavior), combined with vehicle-specific data such as make and age, and name and home city of registered owner, could be used as parameters to evaluate the explicated knowledge rules. To enable the swift handling of positive evaluations (hits), the profile were complemented with follow-up instructions. These instructions resulted from discussions between the Sensing-team and the officers that would be involved in the action, i.e. members of the information coordination center (Delta), and police officers with experience in intercepting and inspecting vehicles on highways.

3.4.3 Action phase

This phase in AR covers the implementation of practice and research related action plans (McKay and Marshall 2001). The latter concerns the collection of data, which has been described in Chapter 1.

The description of activities in the action phase are summarized in Table 3.1 (third column) and elaborated upon next. Operation Vigilance was organized and executed in four episodes of circa 48 hours each, spanning a period of 9 months. The actions were distributed over 6 geographic locations and involved circa 600 officers. Roles and responsibilities were explicated in

briefings, while the central commander (Alpha) managed the operation on a management-by-exception basis. During the operation, license plates of vehicles that passed the electronic traffic surveillance (ETS) units were automatically forwarded to the iFunnel which processed them in accordance with the prepared profiles, including the automated enrichment of the data with data from the Road Traffic Authority (RDW). Positive profile evaluations (hits) were forwarded to the operational information coordination unit (Delta) where additional police records were being consulted to determine whether the subject would be worthwhile for inspection. If so, the hit, including handling instructions recorded in the meta-file, was forwarded to the nearest ETS-unit, which provided the interception team (consisting of a motor cyclists and a number of unmarked cars) with instructions for interception. In turn, the interception team intercepted the selected vehicle and delivered it at the police officers who carried out the inspection. During handover the interception team provided the inspection team with the lead information they had received from the ETS-unit. Starting from this information position, the inspection team conducted the inspection. Information uncovered from the inspection was shared with people from Delta, who provided additional information about the vehicle and its passengers. If additional expertise was needed, an expert was brought in contact with the inspection team through intervention of the chief commander (Alpha). If during the process subjects being inspected became suspects (in a legal manner), a formal investigation was started.

3.4.4 Evaluation phase

In the evaluation phase of an AR, practical progress and theoretical interests are being monitored, allowing the stakeholders to take corrective action when needed (McKay and Marshall 2001). True to the cyclical nature of AR, this process is iterative and ends when practical goals are achieved and research questions can be answered (McKay and Marshall 2001).

The first iteration of Operation Vigilance was used as a learning-by-doing exercise, aimed at forming the ostensive aspects of the organizational TMS, including the use of new methods, tools, and tactics. Debriefing sessions and observations of the Evaluation Committee were

used to improve subsequent iterations. Following Pentland and Feldman (2008) three categories of interventions were used to strengthen organizational routines, and thus organizational TMS. That is, 1) interventions aimed at developing the ostensive aspects of organizational TMS; 2) the development of artifacts to influence or represent the ostensive aspects of organizational TMS; and 3) the development of artifacts to influence or represent the performative aspects of organizational TMS. Moreover, the critical aspects of the TMS designed to identify possible drug traffickers and initiate interception were locked-in (i.e. fully automated), resulting in a 'dead TMS', as the system had no built in capacities to learn, improvise, or adapt to local circumstances (*cf.* Pentland and Feldman 2008). An overview of the interventions taken is shown in Table 3.2 and discussed next.

TMS object of intervention	**Examples of interventions**
Ostensive aspects of TMS	Principles of learning-by-doing, early involvement, and boundary crossing; Priming; Introduction of role-based briefings; Distribution of discretion; Directions with respect to information sharing; Internalization of new norms and values with respect to focus on crime; Explaining differences between old and new routines; Develop common language.
Artifacts influencing or representing the ostensive aspects of TMS	Powerpoint briefings, including e.g. formal communication schema, location maps, and instructions; Written procedures and protocols.
Artifacts influencing or representing the performative aspects of TMS	Meta-files of iFunnel-profiles; Inspection fly-leafs for inspection team; Police Report templates; Shared electronic log-file.
'Dead TMS'	Lock-in of the ETS-iFunnel-RDW-Profile-related TMS

Table 3.2: Examples of interventions in organizational TMS (based on Evaluation Committee report)

Developing the ostensive aspects of organizational TMS

As TMS represent relational patterns of knowledge distribution among actors (*cf*. Nissen 2006), for operation Vigilance new patterns had to be learned. To this end the principle of learning-by-doing was introduced by presenting the entire first iteration of Operation Vigilance as a learning-by-doing exercise. Because many officers, however, were only involved in one or two of the four 48-hour episodes of Operation Vigilance, the principle of early involvement was introduced to engage as many managing officers as possible in action-related preparations and thus become accustomed with the aim, approach, partners, and their personal role in the operation. To further increase the ostensive aspects of the organizational TMS it was advised to stimulate cross-team observations (principle of boundary crossing). Where these principles are based on learning through personal experience, other measures taken were based on the technique of priming, defined as providing participants with a description of the capabilities of others in the network (Moreland and Myaskovsky 2000). This included the distribution of discretion and was effectuated by briefings participants per role.

To provide a basis for mutual understanding and minimize the need for explicit coordination, interventions were taken aimed at strengthening the common knowledge-base of all involved (*cf.* Cramton 2001). Indeed, Operation Vigilance meant a cultural shift for both law enforcement and criminal investigation officers in their respective every-day focus on crime. Where the first were not focused on criminal investigations, the latter were exclusively focused on serious and organized crime. Moreover, both groups have a different professional attitude with respect to information sharing, and have developed different jargon. To breach these differences it was suggested to aim for internalization of the new norms and values propagated by the senior management, provide directions with respect to information sharing, and suggest shared meaning of terminologies in use.

Developing artifacts to influence or represent the ostensive aspects of organizational TMS

Artifacts to influence or represent the ostensive aspects of organizational TMS are those that are used to raise the level of shared knowledge of participants through documentation and other explicit means, in advance of an actual performance. In Operation Vigilance these included the preparation of Powerpoint briefings that could be used by local commanders to brief their people. These standard briefings included formal communication schema, location maps, and juridical mandates and other work instructions. Moreover, the briefings consisted of two parts. The first part consisted of a general overview of operation Vigilance, its goal, and a global description of all participants. The second part was customized to the local situation at hand, i.e. for the ETS vehicles, the interception and inspection teams, and Delta. Each iteration these briefings and protocols were refined, based on the comments received during the debriefing and observations of the Evaluation Committee.

Developing artifacts to influence or represent the performative aspects of organizational TMS

Artifacts to influence or represent the performative aspects of organizational TMS are those that are used while in action. Such artifacts included meta-files with work instructions for Delta-officers to handle warnings produced by information systems; inspection fly-leafs for inspection team to be used during inspection; Police Report templates including standard text about the legal offense; and a shared electronic log-file which could be used to share information between the inspection site and Delta (the home-based information coordination unit).

Creating 'dead routines'

The identification of known modus operandi of drug traffickers required collaboration among several actors and information systems in the network, including an ETS-unit (electronic traffic survey vehicle) responsible for reading passing license plates; the iFunnel software, which is used for analyzing the license plates based on predefined profiles; the

RDW, owner of the national license plate register; followed by the ETS-unit to communicate warnings to the interception team. By automating large aspects of this critical routine, the routine was 'locked in' and thus became a 'dead routine' (*cf.* Pentland and Feldman 2008).

3.4.5 Effect of interventions

Where the first Vigilance episode was first and for all a learning exercise, the second to fourth episodes were aimed at improving operational results. Incrementally improving the functioning of the collaborative network resulted in a sharp decrease of cars selected for inspection and an increase in the average amount of drugs caught (Table 3.3).

	Second episode of Vigilance action	**Fourth episode of Vigilance action**
Number of selected cars for inspection	286	34
Average amount of drugs per catch (in gram)	15	100

Table 3.3: Results of Operation Vigilance (source: Evaluation Committee report)

Where in the first and second episode only drug users (but no drug traffickers) were caught, carrying a few gram of drugs for own use (a result typical for regular control actions), in the fourth episode three drug traffickers were caught, carrying over 1 kg each. By spring 2012 (thus, well after this AR ended) the experiments reported in this research have become routine operations. Due to the combination of investing in the organizational TMS (the action planning phase) and ad hoc activation of the temporary collaborative network, preparation time is limited to several interviews between the team leader (Alpha) and the Sensing-team, while the number of officers involved in the temporary collaborative network is reduced to less then 10. The latter is achieved by mobilizing the network for single interceptions only, in which the interception team also carries

out the inspection. At the time of writing interceptions of dozens of kilo's are no exception (source: Sensing-team).

3.4.6 Reflection phase

The reflection phase in AR is used to draw theoretical lessons (this section) and consequences for theory and practice (Section 3.5, Discussion) (McKay and Marshall 2001).

Although it may be expected that TMS were present within the participating teams (*cf.* Wegner 1986), meta-knowledge of the other participating organizational units only existed to the extent that they had shared work experiences. Where new routines required new work relations to be established, two types of interventions were taken to realize them. First, artifacts such as communication schema and check lists were developed and handed out during briefings. These interventions were aimed at priming participants with meta-knowledge regarding who is to do what and when they are to do it, and thus influence the development of the ostensive aspects of the TMS. Second, as the effect of influencing a TMS through artifacts may be limited (*cf.* Pentland and Feldman 2008), interventions were devised to create the ostensive aspects of the TMS. For example, the first iteration of Operation Vigilance was used as a learning-by-doing exercise. In addition, collective and team-based debriefing sessions were organized to evaluate working procedures, the division of labor, and ideas for improvement. While trying to strengthen the TMS for Operation Vigilance it became clear that actually two intertwined TMS emerged.

Two intertwined TMS

In TMS literature various scholars have described TMS development as going through a development and utilization phase (e.g. Brandon and Hollingshead 2004; Kanawattanachai and Yoo 2007). Taking a closer look at the action planning phase and the action phase of Operation Vigilance (*cf.* Table 3.1) reveals that this relation may be more complicated. In fact, it shows that only representatives of the participating partners are involved in the design of the organizational TMS that is being

developed for the collaborative action. Moreover, although these representatives were involved in both phases, their task and required expertise differed for each of these two phases (*cf.* Table 3.1). Thus, tasks (T), expertise (E), and people (P) differed per phase of the operation. As TEP-combinations form the basic building blocks of TMS (*cf.* Brandon and Hollingshead 2004), it may be concluded that not one, but two interrelated TMS were being developed.

In order to further analyze the two TMS, the formal (designed) and informal (implicit) work relations between actors have been mapped for the action planning phase (left), the action phase (center), and the overlap in formal work relations (right) (*cf.* Figure 3.3.).

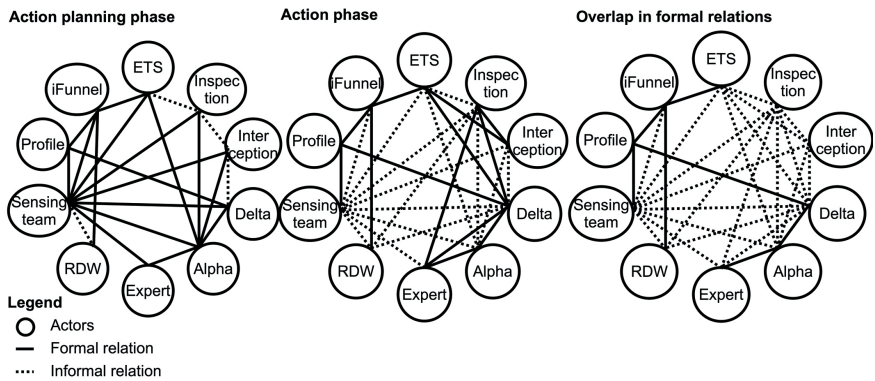

Figure 3.3: Relational patterns during the action planning phase and the action phase

Based on these relations, five types of overlap (or interrelatedness) among the two TMS can be distinguished, which proceed the notion of hierarchically nested TMS or the notion that people may be member of multiple TMS (Anand *et al.* 1998; Jackson and Klobas 2008; Nevo and Wand 2005).

Overlap of artifacts

Artifacts may be used in several routines, and thus, may function as boundary object, i.e. have meaning across practices and as such have the potential to improve coordination and synthesis across heterogeneous disciplines (*cf.* Bechky 2003; Carlile 2004). For example, during

Operation Vigilance artifacts were used to identify drug traffickers, after which 'live routines' were used to coordinate interception and inspection. Due to the fact that automated routines have to be configured by people involved in the action planning phase before they can be used by others who are involved in the action phase, the corresponding relations that emerged among artifacts (ETS, iFunnel, profile, and RDW), and among artifacts and their principle users, overlapped (Figure 3.1, right). As such, these artifacts functioned as boundary object among the two TMS.

Overlap of actors

As hypothesized by Nevo and Wand (2005), actors of TMS may overlap with actors who participate in other TMS. As shown in Figure 3.3, and contrary to the concept of convergence which assumes that well developed TMS require all members to know each other well (Brandon and Hollingshead 2004), for the execution of a complex organizational task not all members do have to know each other equally well. Although all members contribute and none of these contributions can be missed, the contributions are complexly related, not linearly. To perform well, actors need to know well the actors with whom they directly interact, but may not need to know as well actors further away in the network (which should not be confused with not knowing them).

Overlap in (types of) relationships

Overlap in actors does not necessarily mean that the relations they develop for one task are the same as the relations they develop within the context of another task. For example, for one task the relation may be formalized, while for another task the relation is informal (*cf.* Figure 3.3). Because they are member of the same group, however, members did have the opportunity to develop meta-knowledge about participants' belief structures, judgment, intuition, capability and motivation, and affect.

Overlap in (types of) interaction

In addition to the above, the division of labor that actors develop for one task may be the same as the division of labor they develop for

another task. For example, an officer on the street who wants to check a car establishes a relation with Delta (the information coordination unit of the KLPD). This (sub) routine is part of several larger tasks involving partly overlapping groups of actors and overlapping relations among these actors.

Overlap in (types of) content of interactions

When the type of interaction is the same, the type of content of these interactions may still be different. For example, in one type of context the inspection team may request information from Delta regarding the vehicle, while from the perspective of another task, information about the driver and his/her criminal antecedents is needed. For the latter the information officer of Delta has to access different information systems for which s/he needs a different set of skills and legal mandates.

3.5 Discussion

Although various types of knowledge resources are being recognized as nodes for information storage and retrieval (e.g. Kieser and Koch 2008; Oshri *et al.* 2008; Yuan *et al.* 2007), till date the literature remains unclear how these various knowledge resources relate to TMS. That is, if these alternative knowledge resources are not capable of autonomous learning, mutual adjustment, and improvisation, how could they be part of a TMS? Understanding how different types of knowledge resources relate to TMS is of utmost importance to devise effective interventions to strengthen TMS. The latter is important because TMS are antecedent to the capability of organizations to combine distributed knowledge resources (Jarvenpaa and Majchrzak 2008), while the failure to develop an effective TMS is one of the most common barriers to distributed team success (Rosen *et al.* 2007). To address this gap in the literature, insights are being borrowed from organizational routines theory (*cf.* Pentland and Feldman 2003; 2008). The theoretic lens that emerged as a result was used to study and intervene in four iterations of planning and executing a large-scale policing operation.

This AR resulted in two findings. First, in relation to organizational TMS, the various types of knowledge resources mentioned in the literature play a role in either of three classes, i.e. knowledgeable participants (i.e. personalized knowledge resources); mental representations of the TMS shared by these participants (i.e. the ostensive aspects); and artifacts that represent or influence the ostensive or performative aspects of the TMS. The latter are also referred to as encoded knowledge resources (Blackler 1995; Oshri *et al.* 2008) and are not part of the TMS.

Second, TMS may be interrelated. These interrelations surpass the notion of people being member of multiple TMS (e.g. Anand *et al.* 1998; Jackson and Klobas 2008) or of multiple group TMS being hierarchically nested in organizational TMS (e.g. Nevo and Wand 2005). This AR provided indications that the relations among different TMS can be characterized in terms of overlap in actors, actions, relations among these actors or actions, the content of informational interactions (i.e. transactions), and in overlap in artifacts that represent or influence these TMS.

3.6 Implications for Research

The observations discussed above have several implications for TMS research with respect to: the function of various types of knowledge resources in TMS; how we depict organizational TMS; how we may intervene in organizational TMS; and the way we think about well-developed TMS.

To start with the first, borrowing insights from organizational routines theory provides opportunities to functionally distinguish between different types of knowledge resources in organizational TMS, i.e. knowledge resources may be related to individuals, to the ostensive aspects of TMS, or to artifacts. In analogy with organizational routines, artifacts may represent or influence TMS, but are not part of it (*cf.* Pentland and Feldman 2008). This distinction has consequences for how we view potential repositories for information storage and retrieval, such as written or unwritten rules (e.g. Kieser and Koch 2008), templates and

formats (e.g. Oshri *et al.* 2008), or information systems (e.g. Jackson and Klobas 2008; Yuan *et al.* 2007). To further our understanding of artificial repositories for information storage and retrieval, I propose they should be studied in terms of influencing the ostensive aspects of TMS (e.g. Moreland and Myaskovsky 2000) or the performative aspects of TMS (e.g. Faraj and Sproull 2000); or in terms of representing the ostensive aspects of TMS (e.g. Nevo and Wand 2005), or the performative aspects of TMS (e.g. iFunnel technology used during Operation Vigilance).

Second, where in some conceptual papers organizational TMS are depicted as hierarchically nested (Anand *et al.* 1998; Nevo and Wand 2005), others depict organizational TMS more horizontally, i.e. in terms of processes (Jackson and Klobas 2008) or ego-centered networks (Jarvenpaa and Majchrzak 2008). In addition to both perspectives, in this research we developed an organizational routines (thus functional) perspective on TMS. One of the findings derived from this functional perspective is that TMS in organizations may overlap in terms of artifacts, actors, actions, relations among these actors and actions, and the content of informational interactions (transactions). Knowledge of these forms of overlap represent the ostensive aspects of TMS, which enable and constrain the performative aspects of TMS, which in turn create and recreate the ostensive aspects of TMS. As such this functional perspective provides an important insight, sought by e.g. Lewis and Herndon: acknowledging that activities are varied and change over time, they ask for future research to study 'how multi-activity tasks and the sequencing of activities within those tasks affect a TMS' (Lewis and Herndon 2011: 1263). The functional TMS perspective presented in this study shows that activities (but also actors, artifacts, and the type and content of transactions) may be part of multiple TMS, while depending on context the sequencing of activities within multi-activity tasks may vary per actual performance, thus creating and recreating the ostensive aspects of the TMS involved. The latter explains how these activities and the related TMS change over time (*cf.* Pentland and Feldman 2008).

Third, artifacts and the ostensive aspects of organizational TMS provide valuable cues for devising interventions aimed at strengthening

organizational TMS. For example, when aiming at strengthening an organizational TMS, artifacts may be used to lock-in critical routines or serve as boundary objects to improve coordination and synthesis across heterogeneous disciplines (*cf.* Bechky 2003; Carlile 2004). Artifacts, however, do only represent or influence a TMS and consequently are not a sufficient means to strengthen a TMS; to this end the ostensive aspects should be strengthened (Pentland and Feldman 2008). This can be achieved through e.g. priming (Moreland and Myaskovsky 2000), the creation of opportunities to organize monitoring, feed back, and evaluation (*cf.* Curşeu *et al.* 2007), or the creation of semi-structures (Jarvenpaa and Majchrzak 2008). The latter are mechanisms used by (temporary) collaborating individuals to determine how knowledge is disseminated, owned, and discussed in ego-centered networks. The conclusion that TMS, although emerging, can be strengthened through intentional interventions, is supported by the work of Gittell and Weiss (2004) who indicate that organizational design may be used to shape networks. Moreover, it illustrates Wegner's early notion that 'the structuring of an organization is clearly an exercise in structuring transactive memory' (1986: 204), and the notion that TMS cannot be designed, but can be designed for (*cf.* Wenger 1998).

Finally, the previous paragraphs may nuance the way we think about well-developed TMS. Brandon and Hollingshead (2004) hold that in its optimal state of development (called, convergence), a TMS reflects high levels of accuracy (degree to which perceptions about group members are accurate), sharedness (degree to which perceptions of group members are shared by all group members), and validity (degree to which group members actually make use of group members' expertise). At the organization level, in which TMS are functionally nested, it may be difficult to speak of 'a' TMS or a final state. Indeed, a TMS is a generative system and thus is constantly created and recreated, through which it changes (*cf.* Feldman and Pentland 2003). Moreover, as shown in Figure 3.3, for the execution of a complex organizational task not all members do have to know each other equally well: although all contribute and none of these contributions can be missed, the contributions are complexly related,

not linearly. To perform well, actors need to know well the actors with whom they directly interact, but may not need to know as well actors further away in the network (which should not be confused with not knowing them).

3.7 Implications for Practice

Like was done in this AR, the TMS for temporary collaborative action was not developed at the level of the problem-specific collaboration, but at higher organizational levels to provide for stable structures to support future knowledge collaborations (*cf.* Moreland and Argote 2003). To aim such interventions, much can be learned from organizational routines theory (Pentland and Feldman 2008: 249): invest in the ostensive aspects of TMS (see Table 3.2); draw a map like Figure 3.1 and consider the point of view from each actor; map the relationships from each actor and think them through in terms of (alternative) patterns of actions; attempt to create favored default patterns; consider points in the work process that may be used to design alternative routes; lock in critical events (such as done with the iFunnel technology) and avoid single points of failure. And last but not least, be prepared for continued engagement as organizational TMS are generative systems, and thus, are always changing and never complete or finished. Such continued engagement sheds light on patterns of actors (each with its own capabilities) and patterns of actions. Knowledge of the two patterns enable the organization to switch between alternative actors or alternative actions, and thus strengthen its robustness and resilience.

3.8 Conclusions

Although IS and other types of knowledge resources are hold to have a function in organizational TMS, the question remained how they relate to TMS. Borrowing insights from organizational routines theory (Feldman and Pentland 2003; 2008) this AR showed how different types of knowledge resources can be formally related to TMS theory. Analysis of these types of knowledge resources within the context of planning and executing a large-scale policing operation revealed that multiple TMS

may develop which may be interrelated in terms of overlapping actors, actions, relations among actors and actions (patterns), type of informational interactions, and artifacts. This extension of contemporary TMS theory is useful for identifying opportunities to strengthening organizational TMS. Moreover, knowledge of how patterns of actors (TMS) are related to patterns of action (routines) in collaborative networks enables organizations to switch between alternative actors or alternative actions, thus strengthening its robustness and resilience.

While this chapter uncovered how different group TMS in organizations may be interrelated, the question remains how TMS of enduring organizational units are related to the TMS of temporary collaborations in which these organizational units participate. This question is addressed in the next chapter.

4 TMS DEVELOPMENT FOR HYBRID ENACTMENT[5]

4.1 Abstract

In this chapter the third research question is being addressed, i.e. how can functionally structured organizations develop their ability to engage in networked operations, in addition to their functional mode of organizing? Hybrid enactment is introduced to conceptualize the ability of an organization to switch between functional and networked enactment. The latter is mandated in situations in which diverse specialized units are interdependent in heading challenges that exceed their specialization. These collaborations may be infrequent and brief, yet they are very common in e.g. law enforcement, crisis response, and the military. Contemporary research tends to frame functional and networked enactment as mutually excluding, rather than considering the transitioning processes between these modes. The purpose of this study is to understand how the two modes of enactment are interrelated and accomplished, and to identify opportunities to strengthen hybrid enactment. To this end we draw on the Resource and knowledge based theory of the firm to develop a multilevel distributed systems perspective, and use transactive memory systems (TMS) theory to conceptualize mechanisms for achieving coherence. Using an interpretive case study approach, we studied hybrid enactment at a national police organization. We took a failed case of networked enactment as a starting point for examining networked enactment of specialized departments as well as their functional background. Networked enactment in our case study concerned a routine operation aimed at eavesdropping a conversation between two criminals. Flexibility and resilience of the network was out-stretched when one of the two suspects was murdered by an unexpected third party. Analysis of

[5] This research has been conducted in close collaboration with Paul C. van Fenema. During all phases of the research project Jan-Kees Schakel functioned as lead-researcher. A shortened version of this chapter has been submitted for publication.

the departments' TMS revealed (underdeveloped) TMS components and relations among these components for hybrid enactment. This chapter concludes with implications for research, including cues for strengthening hybrid enactment.

4.2 Introduction

Complex tasks, such as dealing with large natural or man-made crises, require diverse (public) organizations to form temporary ad hoc collaborations (Provan and Kenis 2008). The underlying principles and structures that guide these collaborative activities differ from those guiding organizations' regular activities (Nissen 2006). For example, (public) organizations responsible for particular sets of services are often structured by function, product or region, or combinations thereof (Daft 2012). The resulting organizational structures are predominant vertical in nature, meaning that similar tasks and functions are grouped in specialized units, decision-making is centralized, and communication and reporting follow hierarchical lines (Andrews *et al.* 2007). Temporary ad hoc collaborations, on the other hand, are predominantly horizontal in nature, meaning that responsibilities for tasks are shared, decision making is decentralized, and communication and information exchange are based on (informal) contacts (Andrews *et al.* 2007). In this chapter we associate vertical modes of organizing with functional enactment, and horizontal modes of organizing with networked enactment. We introduce the concept of hybrid enactment to describe the ability of an organization to switch forth and back between its regular functional mode, and a temporary network mode of organizing.

While commonly performing successfully in a functional mode, organizations fail to marry this mode with networked enactment (Congress 2006). Since failure may lead to severe consequences, professionals and academics in organization science, information management, and disaster studies have invested in knowledge and capabilities for improving network robustness and resilience (Kleindorfer and Wind 2009; Miles and Snow 1992). These approaches build on the assumption that functional and networked modes of organizing are

mutually exclusive (e.g. Miles and Snow 1992). Yet, in many cases stakeholders expect organizations to be successful in both modes. Research relevant to our understanding of hybrid enactment remains limited to first, theorizing on structural properties of organizations (matrix organizations, ambidexterity, platforms) (e.g Bartlett and Ghoshal 1993; Ciborra 1996; Jansen *et al.* 2009). This structural approach ignores the dynamic processes involved with networked enactment, and the ongoing transitioning between functional and networked enactment. Second, research on repertoires to alter routines (organizational flexibility, meta-routines, and dynamic capabilities) focuses on changing routines but not on the challenge of switching between routines related to different modes of organizing (Adler *et al.* 1999; Prieto and Easterby-Smith 2006). The objective of this chapter is therefore to analyze how organizations can organize for hybrid enactment, that is, how can functionally structured organizations develop their ability to engage in networked operations in addition to their functional mode of organizing (*cf.* Agranoff 2006). While networked enactment could involve both intra-organizational units and inter-organizational relationships, we focus on the former. This allows us at this stage to ignore the complexities of combining intra- and inter-organizational processes (*cf.* Gittell and Weiss 2004). In order to conceptualize hybrid enactment a theoretical framework was needed that could cater for functional, networked and hybrid enactment. To this end three steps were taken. First, we build on theory on knowledgeable resources and distributed systems. Second, we conceptualize the process of organizing distributed systems by using levels of agency (strategic, tactical and operational). And third, we insert transactive memory systems theory to frame how organizations engage in functional and networked enactment.

Empirically, hybrid enactment concerns the relatedness of functional and networked enactment. It represents a derivative construct that cannot be studied directly: data comes from organizational enactment in a functional or networked mode. We studied hybrid enactment at a Dutch police organization (Korps Landelijke Politiediensten, KLPD, in English National Policing Services Agency). In this type of organization,

which can be found in most nations, our starting point was a case in which units planned a networked operation and encountered disruptive events that could not be handled effectively. Our study then relates this networked enactment to the units' functional mode of organizing, i.e. their 'daily business'. We structure our results and analysis following the distinction between functional, networked, and hybrid enactment. We conclude this chapter with specifying our contributions and outlining implications for research.

4.3 Conceptual Framing: Distributed Systems and Levels of Agency

4.3.1 Knowledgeable resources and distributed systems

First, studying organizations which units are expected to engage in both functional and networked modes of organizing raises the question which conceptual starting point to choose. It should cater to the analysis of both modes of organizing and the transitioning between them. Building on the resource based theory of the firm (KBT) (Barney *et al.* 2001; Penrose 1959) and its spin-off, the knowledge based theory of the firm (KBT) (Grant 1996). We took the idea of knowledgeable resources yielding services as our starting point. KBT acknowledges that the 'distribution of knowledge in an organization […] reflects the social division of labor' (Brown and Duguid 1998: 98). KBT emphasizes the knowledge-intense nature of organized activities and the inseparability of knowledge ('knowing') and organizational practice (Orlikowski 2002). Scholars in related streams of research refer to distributed cognition at the micro level (Hutchins 1991), and distributed knowledge systems at the organizational level (Orlikowski 2002).

We built on the notion of KBT that organizations can be considered a collection of resources capable of providing a range of services (Penrose 1959). Organizations combine these resources into processes that generate benefits at a certain cost (Sirmon *et al.* 2007). For coherent action, organizations develop routines for combining resources' knowledge and services (Feldman and Pentland 2003).

Returning to hybrid enactment, we can now state that functional enactment refers to a particular mode of organizing in which knowledge of resources and services is patterned in accordance with a specialized and rather homogeneous and predictable task goal (*cf.* Nissen 2006). Networked enactment, on the other hand, would require the same resources to (partially) activate their actionable knowledge and services for a combined task goal that is less homogeneous and predictable, and which transcends goals defined for functional enactment. Networked enactment and the transitioning between functional and networked enactment increases complexity as new connections between resources emerge (*cf.* Kogut and Zander 1992; Simon 1962) to form novel combinations (*cf.* Feldman 2004).

4.3.2 Levels of agency

Second, in accordance with Emirbayer and Mische we define agency as 'the temporary constructed engagement by actors of different structural environments … which, through the interplay of habit, imagination, and judgment, both reproduces and transforms those structures in interactive response to the problems posed by changing historical situations' (Emirbayer and Mische 1998: 970). Common perceptions of levels of agency describe these in the sense of granularity or aggregation, e.g. the well-known individuals – teams – organizations continuum. Others use the distinction between strategic, tactical and operational levels, referring to the vertical division of work in hierarchical organizations in relation to value creation. In the latter tradition, granularity relates to differences in scope, level of abstraction of goals, and time horizon, and are subsequently associated with operational, middle, and top management (e.g. Tarafdar and Qrunfleh 2009).

Hybrid enactment is an example of organizations becoming more complex than this hierarchical distinction in management levels can capture. Hence, following Mantere (2008) and others (e.g. Simon 1962), we dissociate strategic, tactical, and operational levels of agency from the vertical division of work in hierarchical organizations. Instead, we revert to the substantive content of levels of agency, associating them with

orders of governance. We link strategic level agency with third order governance (Sorensen and Torfing 2009). Accordingly, strategic level agency is focused on defining the 'rules of the game' (governing principles): workers negotiate, influence, or adopt shared norms, values, and principles (Kooiman and Jentoft 2009); and they develop shared intent and ambition in the sense of strategically positioning the system in its environment (Mantere 2008). We associate tactical level agency with second order governance. Relating to the strategic principles, tactical level agency is focused on establishing, shaping and deploying organizational structures for facilitating operational level action (Bigley and Roberts 2001). Operational level agency refers to first-order governance (Kooiman 2008) as well as to primary value creation processes that yield benefits for the system's stakeholders (Sirmon *et al.* 2007). Hence, operational agency encompasses personal knowledge and interactions related to primary tasks.

4.3.3 Synthesis: Towards a research approach

In addition to the introduction of TMS theory in Chapter 1, two perspectives have been introduced for studying hybrid enactment of organizations: distributed systems (based on the KBT and KBT), and levels of agency (dissociated from organizational hierarchy). From a distributed system perspective, we note that most theorizing focuses on resource interactions at the operational level (Hutchins 1991; Weick 1993). Bringing in the levels of agency suggests that the nature of interactions differs per level and are connected across levels (Perlow *et al.* 2004). This provides conceptual flexibility when theorizing on hybrid enactment: contributions associated with levels of agency are not necessarily associated with particular resources or formal hierarchical levels. Focusing on hybrid enactment, we assert that agency at and across the levels takes on different patterns. With functional enactment, strategic, tactical and operational agency become oriented towards specialized value creation. Networked enactment, on the other hand, involves resources offering diverse services for ad hoc, complex value creation. Such combinations of resources (and their services) tend to be innovative and

fragile (Brown and Duguid 2001). Transitioning between functional and networked enactment thus poses a challenge to sustain organizational coherence. To answer the question how distributed resources become organized and are able to contribute to both functional and networked enactment, we incorporated TMS as theoretic lens.

As far as we know, TMS literature focuses predominantly on operational level agency. For instance, scholars have studied dyads answering concrete questions, or small groups performing a collective task (e.g. Littlepage *et al.* 2008). Our earlier inclusion of tactical and strategic agency, however, implies that TMS can be analyzed at and across levels of agency. Elaborating on task-expertise-person (TEP) combinations (Brandon and Hollingshead 2004), first, tasks at the strategic level are of a more abstract nature then e.g. a team assignment at the tactical level, or the execution of a task by a particular person at a particular time and place (operational level). Second, the TEP 'expertise' construct is at the strategic level associated with organizational capabilities, at the tactical level it refers to a more specific combination of knowledgeable individuals, and at the operational level expertise concerns personal knowledge and information associated with (physically) situated and evolving agency (Orlikowski 2002). Finally, at the strategic level the TEP 'person'-construct represents abstract organizational entities and partners. At the tactical level, 'person' stands for the tactical combinations of persons or groups. And at the operational level person refers to actual individuals engaging in one or more levels of agency. In the methods' data analysis section we further explain our operationalization.

4.4 Methods: Studying Hybrid Enactment Empirically

4.4.1 Design: interpretive case study research

The objective of this study is to learn how functionally structured organizations engage in networked operations. This required us to gain insight in 1) the operations of functionally structured teams, 2) organizational development efforts enabling these units to engage in networked operations, and 3) the sequencing and operational context of

networked operations. Empirical studies that allow for the collection of such data are broadly defined as interpretive case studies (*cf.* Walsham 1995). The opportunity for this study occurred while we were working on the theoretical foundations of this research. A recent networked operation of the KLPD, involving stealthy eavesdropping on a conversation between two high level criminals, took a dramatic turn when one of the suspects was murdered while being observed. The new situation out-stretched the networked capabilities of the involved police teams. The operation -called operation Frisau-, which was thoroughly evaluated and documented, formed a complex (in terms of dynamics) yet manageable (in terms of number of people involved) exemplar for the study we were conducting. Hence, permission was requested and received to conduct an in-depth case study.

Being employed as a senior advisor at the KLPD and a university-associated researcher, the role of the first author may be described as an involved researcher, while the second author functioned as outside observer (*cf.* Coghian 2001). Measures to ensure the quality of the interpretive case study are being described in the research quality section below (Section 4.4.4). Although the work of Yin (2009) is highly associated with positivist case studies, his work on the design of case studies is unsurpassed and very useful for the design of interpretive case studies as well. Using his terminology, we developed an embedded single case study design, including two supportive units of analysis driving the data collection (functional enactment and networked enactment), and one analytical unit of analysis (hybrid enactment). Yin (2009) provides five arguments for justifying the use of a single-case design. Three of them (revelatory, representative, and extreme) apply to this study. First, this case is revelatory as networked police operations like the one being studied are aimed at high-level criminals; consequently, they are highly confidential. Studying them in a contemporary real-life setting is difficult as researchers need to have high-level access and, as a consequence, case studies like these are very rare. Second, this case is representative as functional teams of public institutions such as the police frequently

engage in networked operations. And finally, this case is extreme as the challenges faced in this operation are very rare.

4.4.2 Research setting and data collection

The Dutch police are organized in 25 regional and one national police force (KLPD). Amongst other tasks the KLPD is responsible for dealing with serious and organized crime. It includes nine semi-autonomous operational departments specialized by functional domain. Next to delivering their functional services (i.e. functional enactment), many of these departments now and then participate in networked operations (i.e. networked enactment). In our results section we further explain the departments involved in Operation Frisau. Table 4.1 provides an overview of the empirical data collected during this study. We provide additional details on some of the data sources.

Ad (1) The police reports of the participating officers have been individually drafted the afternoon after the operation. Three have been supplemented afterwards to include additional details about the event. As police reports have a legal status in court, observations and actions are written down as factually as possible.

Ad (2) Due to legal constraints, video-recording operations is not standard practice. This time, however, it was decided to record the operation for training purposes. The video proved of great value for this study as it provides a highly reliable audio-visual record of the sequence of events

Ad (5) In addition to the materials directly related to our case, one of the senior commanding officers invited the first author to observe a course on operational decision making for tactical commanders. This course provided additional insight in how functional teams engage in networked operations.

Ad (7) The selection of interviewees was based on their role and network position during the operation. Starting from key positions in the network we held interviews until the story was saturated *cf.* Strauss and Corbin 1990). Semi structured interviews lasting from ca. 1 hour to 3 hours were conducted with 5 officers who were operationally involved,

the 3 senior officers responsible for the three functional teams (who were involved in the preparations and on stand-by during the operation), and one interview with 2 commanding officers who became involved during the hot action phase.

	Data Sources	Quantity	Relevant Unit of Analysis
1.	Police reports KLPD	16, plus 3 supplements	Networked enactment
2.	Video recordings KLPD	15 minutes	Networked enactment
3.	Press communiqué KLPD	2 press communiqué items	Networked enactment
4.	Documents KLPD	5 project plans	Networked enactment, hybrid enactment
5.	One-day course operational decision making	Powerpoint and personal notes	Networked enactment
6.	Research feedback session	Powerpoint and minutes of meeting	Functional, networked, and hybrid enactment
7.	Semi-structured interviews	7 transcribed, 2 minuted	Functional, networked, and hybrid enactment
8.	Personal notes and observations of first author related to his regular work at the KLPD	135 pages of notes over a 8 month period	Functional, networked, and hybrid enactment
9.	Parliamentary questions and answers from the Minister of Justice	24 questions, including answers	Networked enactment

Table 4.1: Empirical data sources

The interview protocol was structured as follows. It started with questions directed at describing daily activities in the functional organization (functional enactment). Then, we asked the interviewee for a personal account of the networked operation, including personal observations, interactions, decisions, and actions (networked enactment). And finally, we were interested in the interviewee's thoughts on

transitioning between functional and networked modes, including preparing functional units for future networked enactment (hybrid enactment). The translation from the interview questions to TMS-constructs is explained in the data analysis section below. We recorded 7 interviews on a voice recorder and transcribed these verbatim. During the other 2 interviews, the first author took extensive notes because the interviewee did not allow recording in one case, and because of problems with the dictaphone in the other case.

Ad (8) In his function as senior KLPD advisor, the first author was involved in several organizational development efforts related to hybrid enactment. Notes related to this work were used for triangulation purposes.

The data collection phase was terminated when regularities emerged and accounts of events of the researchers converged with those of the practitioners involved.

4.4.3 Data analysis

In accordance with the interpretive research tradition (*cf.* Walsham 1995), we refined our conceptual framework in interaction with our data analysis processes. The embedded design of our case study implies that we have three units of analysis: functional and networked enactment (used for empirical research), and hybrid enactment as a derivative unit of analysis (which cannot be studied directly in an empirical sense). Our analysis follows this structure. Functional teams are analyzed in terms of differences and commonalities between their TMS. For analyzing the networked operation we studied how the associated TMS evolved throughout the phases of the operation. And finally, for hybrid enactment, we analyzed the differences and commonalities between TMS for functional and networked enactment. To further explain our data analysis, we next explain how we analyzed (1) TMS and (2) relational effects among our units of analysis.

Analyzing TMS

Following Wegner *et al.* (1991) our analysis focuses on knowledge distribution within teams in terms of differentiation (more integrated versus more differentiated). Next, we identify Task-Expertise-Person (TEP) elements and combinations (Brandon and Hollingshead 2004) for each level of agency. Our preliminary empirical results indicated that TEP-combinations at the operational level may systematically be alternated (i.e. reciprocal or team task interdependence, Van de Ven *et al.* 1976). Hence, we are also interested in the state of TEP-combinations (stable versus dynamic). And finally, we included environmental conditions as well: police work is tightly linked with environmental conditions that serve as a context for sensemaking (*cf.* Whiteman and Cooper 2011) and action (*cf.* Peltokorpi 2008),

Analyzing effects across units of analysis

Our interests in transitioning between functional and networked modes of organizing implies that we want to study types of effects between units of analysis[6]. Kozlowski and Klein (2000) distinguish three effects: global, direct, and moderating. Global effects only impact the unit of analysis from which they originate (in our case functional or networked enactment, since our empirical data originates here). Direct effects are effect originating from one unit of analysis (i.e. functional, networked, or hybrid) that conditions other units of analysis. And moderating effects stem from one unit of analysis and affect the relationship between two other units of analysis.

[6] As elaborated in our conceptual framing section, it should be noted that Kozlowski and Klein (2000) refer to levels and units of analysis in terms of aggregation, i.e. individual (representing lower level), team, organization, etc. (higher levels). In contrast, we make a qualitative distinction between different levels of agency (strategic, tactical, and operational); moreover, we use three units of analysis: functional, networked, and hybrid enactment.

Our data analysis resulted in three sections that are combined with case description. First, pertaining to functional enactment, we describe the three teams involved in the networked operation. At this point we are interested in their default mode of operating in accordance with their specialization. We analyze their respective TMS along the three levels of agency (strategic, tactical, and operational). Second, we describe the operational phases of Operation Frisau and analyze these along the levels of agency to analyze networked enactment. We build on these two analyses to examine hybrid enactment and develop a TMS model at organization level, which facilitates hybrid enactment.

4.4.4 Research quality

To ensure research and data quality we followed the principles for conducting and evaluating interpretive studies of Klein and Myers (1999). The principle of the hermeneutic circle was followed by iteratively examining the parts and the whole they form, until the accounts of the researchers of the analyzed events converged with those of the practitioners involved. The principle of contextualization is inherent to an interpretive case study like ours and the multilevel character of the phenomenon being studied. The principle of interaction between the researchers and the practitioners involves ex-ante and informal interactions and a presentation of, and subsequent discussion about our findings. We applied the principle of abstraction and generalization and the principle of dialogical reasoning to data collection and data analysis. We kept in mind that participants involved in the same operation may (and did) have different interpretations of the events (principle of multiple interpretations). During the interviews we were sensitive to possible biases and systematic distortions in the narratives collected from the practitioners (principle of suspicion). Finally, we applied the usual measures recommended by Yin (2009) for thorough case study research, i.e. measures to assure construct validity, internal validity, external validity, and the reliability of our data (protocols and the setup of a case study database), complemented with the principles of analyzing multilevel phenomena (as described earlier). Upfront, a Researcher-Client

Agreement between the researchers and KLPD was drafted, providing the contractual, ethical, and procedural basis for this study.

4.5 Results (1): Functional Enactment

4.5.1 Functional enactment: description of teams

The networked operation analyzed in this study involved 25 members of 3 teams of the following specialized departments of the KLPD:

- an observation team (OT) of the Department of National Criminal Investigations (DNR);
- a tactics team (TT) of the Department of Special Technical Investigations' Methods (DSRT); and
- a helicopter crew (HC) of the Department of Operational Support Services (DOS).

In this section we focus on their functional (default) mode of operating.

Department of National Criminal Investigations (DNR)

DNR is responsible for fighting serious and organized crime. To this end the department has criminal investigations teams (CI) that work on a case-by-case basis, and observation teams (OT). An OT is a team specialized in shadowing suspects and gathering information about geographic-behavioral patterns, meetings, and conversations. OTs provide services for several CIs at the time. An OT may execute two to three operations in one daily shift. To follow and observe suspects OTs have developed a wide range of standardized routines. These routines are used by all national OTs, including the OTs of regional police forces. This enables individual OT members to join other OTs without further training, while multiple OTs can be merged to cater for larger or more complex operations. During an operation the position of an OT member in relation to a suspect constantly changes, and so does his role in the team. With respect to information sharing OTs utilize two principles. The need-to-share principle is used among all involved in the criminal investigation case, because well-informed teams perform better. The need-to-know

principle (i.e. selective, more restricted information sharing) is applied to all those not directly involved in the investigation. Information sharing in this case has a serious connotation with leaking, which compromises action against criminals. OTs provide two types of services: those that OTs deliver on their own (functional enactment), and services that require cooperation with other teams (networked enactment). Networked enactment occurs infrequently.

Department of Special Technical Investigations' Methods (DSRT)

The second participating team is of the DSRT. This department is specialized in collecting data from risky, challenging locations. We focus here on the tactics team (TT) that was involved in our case study. For security reasons the description of the team has to remain limited. A TT provides two types of services, which may both be delivered in functional or networked mode. In 'singular assignments' a client asks for a specific type of evidence, such as the recording of an event, or the placement of eavesdropping equipment. In such assignments DSRT asks no questions since its services are limited to technical contributions. For the second type of service, ´comprehensive assignments´, TT takes responsibility for collecting all evidence and takes on a coordinating role. In general, TTs are assembled in accordance with the requirements of the assignment, so their composition varies. With respect to information sharing TTs only utilize the principle of need-to-know. The reason is that leaking not only compromises action against criminals, but directly affects personal safety of TT members as well, which is an employer responsibility. Most of the time TTs operate on their own (functional mode).

Department of Operational Support Services (DOS)

The third participating team is of DOS, responsible for supportive services such as the provision of police horses, drug-dogs, command and control services, and aerial support. The latter can be provided by planes or helicopters, supporting static (monitoring a single location) or dynamic (following suspects wherever they go) operations. Given their contribution to Operation Frisau, we focus on helicopter support. A

helicopter crew (HC) consists of a pilot and an observer. The division of labor between the pilot and observer is strict, yet their roles are tightly dependent. For instance, based on the evolving situation on the ground, the pilot may request the observer to adjust the flight-plan and clear these plans with air traffic authorities. In case of observing a criminal suspect, a member of an OT or TT often joins the HC to bring in (implicit) knowledge about the suspect (e.g. the way he tends to walk or places he commonly visits). With respect to information sharing HCs emphasize the principle of need-to-share. The more information is available on a subject, the easier it is to recognize and observe him. While the HC can perform some tasks independently without external coordination (e.g. making aerial photos of crime scenes), a substantial part of their work involves aerial support for teams operating on the ground.

4.5.2 TMS for functional enactment: first analysis

In this section we analyze the TMS of the involved departmental functional teams. Our analysis of TMS is structured per level of agency. We interpret departmental TMS in terms of strategic level principles, tactical level structures, and operational level personal knowledge and interactions related to primary tasks (*cf.* Table 4.2).

Differences between TMS elements are described in terms of TMS integration versus differentiation, Task-Expertise-Person (TEP) state (stable or dynamic), and TEP-combinations. Of these combinations, task and expertise are indicated per level of agency, while persons are represented in the form of departmental teams (columns, Table 4.2). For each level, a short description is given of the physical and social environment in which the teams operate. Finally, the right hand column of Table 4.2 shows commonalities of TMS across the functional teams' departments.

	Department DNR Observation Teams (OT)	*Department DSRT Tactical Teams (TT)*	*Department DOC Helicopter Crew (HC)*	*Functional enactment and TMS: commonalities across departments*
Strategic level: emerging and conditioning governing principles				
TMS differentiation	Integrated	Integrated	Integrated	• Police Law • Fighting serious and organized crime • High quality observation skills • Safety principle • Learning through debriefing principle
TEP-state	Stable	Stable	Stable	
Task (T)	Subject observation	Technical observation	Aerial observation	
Expertise (E)	Stealth following skills	Stealth placement skills	Flying skills	
Environment / Context	Mandate to operate in public access spaces Need-to-know and need-to-share	Mandate to enter private spaces Need-to-know	Mandate to operate in the national air space Need-to-share	
Tactical level: emerging and conditioning organizational structures				
TMS differentiation	Integrated	Differentiated	Differentiate	• Hierarchical structure • Police
TEP-state	Stable	Stable	Stable	

[7] C2000 is a shared technical communication infrastructure used by police and other crisis response forces in The Netherlands. In addition, regular GSM phones are used as well.

	Department DNR Observation Teams (OT)	*Department DSRT Tactical Teams (TT)*	*Department DOC Helicopter Crew (HC)*	*Functional enactment and TMS: commonalities across departments*
Task	All team roles	Placement and protection	Visual observation	education • C2000[7]
Expertise	Shared routines	Technology and arrest squad skills	Distance observations	
Environment / Context	Public space-type related repertoires	Private space-type related repertoires	Air space-zone related repertoires	
Operational level: personal knowledge and interactions related to primary tasks				
TMS differentiation	Differentiated	Differentiated	Differentiated	• Policing skills • Knowledge of evolving situation
TEP-state	Dynamic	Stable	Stable	
Task	All team roles alternate	Placement and protection	Visual observation	
Expertise	Unique OT expertise	Unique TT expertise	Unique HC expertise	
Environment / Context	Event related place-time conditions	Event related place-time conditions	Event related place-time conditions	

Table 4.2: Functional enactment: TMS analysis

Strategic level agency and TMS

At the strategic level we found each functional department featuring an integrated TMS and a stable TEP state. When analyzing task

(T) and expertise (E), we found differences between the teams (P), which is reflected in their image and attitude. OTs are known as "the ones with the fast cars", TTs as stealthy "can do´s", and HCs as punctuate and reliable. With respect to attitude, OTs have an urge to never let go and improvise when needed to keep a suspect under control. A dominant value of TTs is to never get seen, and to improvise when required to maintain their stealthy operational presence. The adagio of HCs is to strictly follow aerial (safety) regulations and instructions, while watching the suspect 'like an eagle'. Approaches to information sharing differ: TTs stress the importance of need-to-know (share only information for a given purpose); OTs utilizes the principle of need-to-share for all involved in the criminal investigation case, and the principle of need-to-know for all those who are not; and HCs stress the importance of need-to-share.

Strategic aspects of the physical environment in which the teams operate refer to their respective mandates. OTs are mandated to operate in public access spaces; TTs are mandated to enter private spaces; and HCs are mandated to operate above areas ranging from sea to land and from densely populated to rural areas.

Finally, strategic level TMS elements held in common between the teams include the Police Law and their shared task of fighting serious and organized crime. Moreover, all of their tasks demand high quality observation skills and all three use the same order of priority in relation to safety: safety of own people first, followed by the safety of possible victims, the safety of the criminal(s), and the need to catch them. As a general rule all operations are being debriefed to support learning and organizational development.

Tactical level agency and TMS

Tactical level TEP-elements and combinations among the teams differ in terms of their level of differentiation, while all of them appear stable. Because OT members need to be able to perform all team roles, at a tactical level its TMS is highly integrated. To enable swift allocation and execution of operational tasks a wide range of standards and routines are used. A TT has a more differentiated task-expertise structure: educational

backgrounds of team members responsible for operating technological differ from those responsible for placement or protection. Tasks and expertise in helicopter crews are highly differentiated. Hence, their TMS are differentiated as well.

With respect to the environment in which the teams operate various types may be distinguished, each requiring different expertise to cope with the specific characteristics and dynamics of these environments.

Finally, structural elements which the three teams hold in common include the hierarchical ranking system and their educational background in policing (except for the pilot). This shared background provides the teams with a common elementary knowledge base (expertise), which covers law, mandates, and authority relations. Another common structure is the C2000 communication system. Moreover, members of all the three teams gain knowledge of their colleagues through perceptions based on personal experience and self-disclosure and through knowledge of actors' access to information (*cf.* Wegner *et al.* 1991). This knowledge supports geographically distributed cooperation at the tactical level, which all three teams are familiar with.

Operational level agency and TMS

TMS differentiation and TEP-state of OTs at operational level differ from the tactical level. When an OT is involved in a dynamic pursuit of a subject, tasks related to the pursuit are almost constantly handed over to team members that are in a better position to perform the task, while few to no members are idling. This reciprocal task interdependence (Van de Ven *et al.* 1976) requires the team not only to constantly update and access each other's knowledge. To remain coherent with the evolving operation, the allocation of responsibilities for information storage has to be brought in accord with the division of labor of that particular moment. Operational level TMS differentiation and TEP-state of TTs and HCs, on the other hand, resemble tactical level TMS differentiation and TEP-states.

The operational environment refers to the actual conditions at a particular space and time. These are inherently idiosyncratic for police work.

Finally, operational TMS elements that the teams hold in common are their policing skills. They all know, for example, how and when to use arms, how to make an arrest, what details are important to register, and how to draft a Police Report.

4.6 Results (2): Networked Enactment

4.6.1 Description of phases of 'Operation Frisau'

Operation Frisau, in which the OT, TT, and HC collaborated, moved through the following common phases: initiation, positioning, hot action, and debriefing. These are described next.

Operational phase - initiation

Operation Frisau was part of a larger project of a criminal investigations team of the DNR for which the TT of the DSRT had accepted responsibility (a ´comprehensive assignment´). Two days before the operation it was learned that the two suspects under surveillance would have a meeting next Monday at noon. Since the intended meeting place was quite difficult to secure, the head of the TT-unit contacted the head of the OT-unit for assistance. The concept they agreed on for assembling the network was straightforward (see Figure 1): the TT would take care of the technology to eavesdrop the conversation and form an inner-ring to protect the 'hotspot', i.e. the place from where the technology was operated in the assumed vicinity of the suspects; the OT would form an outer-ring to signal the arrival of the suspects; and to coordinate activities everyone would communicate on C2000 communication channel 2. Thus instructed, the team leader of the TT contacted and briefed the team leader of the OT (by phone), who in turn briefed and prepared her team (also by phone).

Four hours before the operation the question arose within the TT whether the two suspects could be identified beyond legal doubt before

the recording would be started. This is required by law. To eliminate doubt it was decided that the inner-ring would seek additional identification, and that a helicopter would be hired to provide the hotspot with streaming video images of the surroundings. It was decided that one of the TT members would join the helicopter to help identifying the suspects. The HC was strictly instructed that the operation could not be compromised to protect strategic interests of the investigation project. For this reason the helicopter had to operate out of sight and beyond the hearing range of the hotspot. Since for technical reasons the HC could not use C2000 channel 2 it was decided that channel 1 would be used instead. The TT team leader would communicate this change of configuration with the OT. Yet, due to time pressure he failed to inform the OT about the helicopter all together. As a result, communication in the network was organized in two channels (*cf.* Figure 4.1). Most interviewees, including OT members, were only mildly bothered by this omission because the intended role of the helicopter was to provide additional support for the hotspot; it would not interfere with the role of the OT.

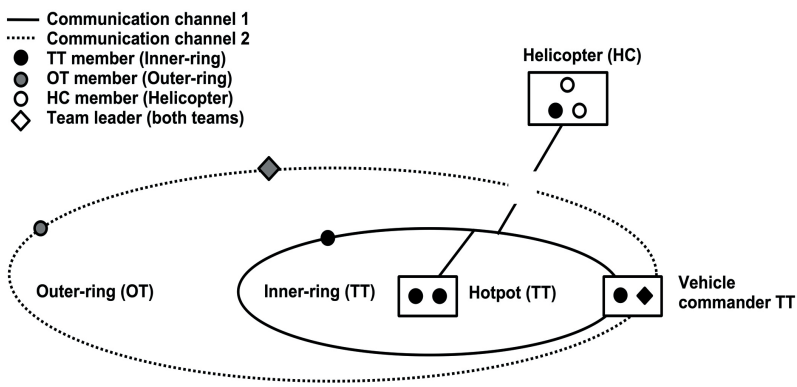

Figure 4.1: Network configuration of Operation Frisau

Operational phase - positioning

While everyone was taking positions, the OT team leader did hear a helicopter. She contacted the TT team leader to verify whether an HC had joined the operation. After his confirmation she helped him guide the helicopter to a spot where it could not be heard or seen. The helicopter

ended up at a suboptimal location because its space to maneuver was restricted due to weather conditions and proximity of a major airport. The OT and TT team leaders discussed alternative communication channels to be used. Because they could not find a secure communication channel to which all three teams had access, it was decided that communication between the helicopter and the OT would be mediated by the TT team leader and his driver (*cf.* Figure 4.1). The boundary-spanning role of the TT team leader and his driver, however, proved ambiguous, as they held different opinions on who would communicate with whom. Shortly after the helicopter was positioned, one of the OT members announced the arrival of the first suspect.

Operational phase - hot action

Within a minute after the suspect had parked his car, an unknown man approached him from behind and emptied his gun. Except for the helicopter no one could see what happened. The officers in the hotspot only heard popping sounds and ticking against the protective layer of the hotspot. They concluded that the ticking was caused by shells and communicated their conclusion over channel 1 (*cf.* Figure 4.1). Combining the sensory input with the message of the hotspot, the co-observer in the helicopter concluded that an assassination had occurred. This conclusion, however, was not communicated. Hence, TT members only knew that there had been a shooting, and the OT, operating on channel 2, was still unaware of the event. They were supposed to be updated by the TT team leader, but he had spotted the van of the shooter and started a pursuit. By following the suspect himself, the TT team leader had become submerged in the operation. This is against one of the governing rules for team leaders, who, according to the functional unit heads of the TT and OT, are responsible for maintaining oversight and preserving team calmness. Shortly after starting the pursuit, the TT team leader realized his responsibilities. He attempted to quickly hand over the pursuit of the shooter to the helicopter, not realizing that the OT was still not informed. As soon as the HC co-observer confirmed he did see a van similar to the one involved in the shooting, the TT team leader assumed

the pursuit was handed-over. He returned, informing the OT team leader that he was returning to the hotspot because – to her surprise – there had been a shooting. By that time the van had passed the outer-ring. At that time the HC realized that the van they followed was not the one involved in the shooting. It had escaped.

Operational phase - debriefing

As soon as responsibility for the crime scene had been handed over to the regional police, the functional teams retreated to their individual units for a debriefing. Such debriefings are standard. Due to the murder, however, the heads of the functional units requested all team members to put their experience in a personal Police Report. This was done because, one of the unit heads explained, 'shared briefings would lead to synchronization of individual memories'. After the Police Reports were written, debriefing sessions were held per functional team. In these sessions it was quickly established that the murder could not have been prevented. All were frustrated, however, by the fact that the murderer had escaped and wondered how this had happened.

Although during the debriefing people agreed that everyone should have been on the same communication channel, during the interviews opinions differed. While some members argued that all network members should share the same channels, others argued that multiple channels were required to ensure silence and the opportunity to speak when needed. Moreover, while being in the heat of the action, they did not want to be distracted by communications taking place in other parts of the network. They did all agree that channel numbers and GSM-numbers should be known by all members of the network. The result of the debriefing was that a thorough evaluation would be organized to learn from what had happened in order to remain in control the next time. In addition, a shared debriefing session was organized to enable the three teams to reestablish trust by explaining their individual situation and discussing their cross-team frustrations.

4.6.2 TMS for networked enactment: second analysis

The first analysis (functional enactment) provided insight in cross-departmental differences and commonalities. Here we focus on networked enactment. For each level of agency a summary is given of our analysis of the evolving network TMS. In addition to the functional commonalities discussed above (not repeated here, *cf.* Table 4.3, first row) we describe TEP-elements and combinations and environmental factors pertaining to networked enactment. Comparison across levels is discussed when relevant for the analysis.

	Strategic level agency and TMS: *emerging and conditioning governing principles*	**Tactical level agency and TMS**: *emerging and conditioning organizational structures*	**Operational level agency and TMS**: *personal knowledge and interactions related to primary tasks*	**Comparison across levels**
Functional enactment and TMS: commonalities (from Table 4.2)	Police Law; Fighting serious and organized crime; High quality observation skills; Safety principle; Learning through debriefing principle;	Hierarchical structure; Police education; C2000	Policing skills; Knowledge of evolving situation	
Phase 1 Initiation	Personal identification needed (legal condition);	Comprehensive assignment, DSRT in the lead;	TL briefing; Briefing of team members by three team	

	Strategic level agency and TMS: *emerging and conditioning governing principles*	**Tactical level agency and TMS**: *emerging and conditioning organizational structures*	**Operational level agency and TMS**: *personal knowledge and interactions related to primary tasks*	**Comparison across levels**
	Operation may not be compromised (compromise principle)	Network configuration; C2000 configuration	leaders (TT, OT, HC); Trust of members in colleagues involved in operation	
Phase 2 Positioning	No additional principles	Positioning helicopter; Adjustment of C2000 configuration; Proximity of major airport and wind direction	Individual position taking	Ambiguous division of responsibilities between team leader and his driver
Phase 3 Hot action	Principle 'Operation may not be compromised' not withdrawn	Tactical team leader role largely absent	Team leader starts acting at operation level; Sharing of various individual observations and conclusions; HC attempts to establish contact with team leader and OT	Dissonance between strategic level (do not compromise) and operational level (follow suspect)

	Strategic level agency and TMS: *emerging and conditioning governing principles*	**Tactical level agency and TMS**: *emerging and conditioning organizational structures*	**Operational level agency and TMS**: *personal knowledge and interactions related to primary tasks*	**Comparison across levels**
Phase 4 Debriefing	Learning through shared debriefing	Instruction to put personal perspectives on paper; Functional team debriefings	Sharing of individual perspectives and lessons learned; Expressions of decreasing trust	

Table 4.3: Networked enactment: TMS analysis

Strategic level agency and TMS

In addition to existing common principles, two conditioning social environmental factors were added during Initiation specifically aimed at Operation Frisau: the legal condition of identifying the subject before switching on the eavesdropping equipment, and the strategic importance of the overall criminal investigation: the investigation was not to be compromised by this operation. During positioning no additional principles were required. Even though the compromise principle became irrelevant after the subject was murdered during the hot action phase, the principle was never explicitly withdrawn. This caused dissonance between strategic level agency (do not come close) and – as will be explained – operational level agency (come closer). Dissonance induces people to change their behavior, change the importance of cognition, or add new cognition (Cooper 2007). In Operation Frisau the co-observer at the HC tried to change the crew's behavior by suggesting the pilot to follow the subject. She could not, however, because she was bounded by aerial regulations and the compromise principle. As a consequence, ambiguity continued. With very limited time available during the operation,

synchronizing tactical and operational agency with strategic principles failed.

During the debriefings it became manifest that the ambiguous situation had led to frustration and trust decay among the teams. Hence, a second, but now shared briefing was organized to learn to understand what had happened, and to reestablish trust. In TMS literature two forms of trust have been studied. First, trust in the form of task credibility (Moreland and Myaskovsky 2000), also known as cognitive-based trust (Kanawattanachai and Yoo 2007). Given the response during interviews, this form of trust had not faltered. The second form of trust is defined as "expectations, assumptions, or beliefs about the likelihood that another's future actions will be beneficial, favorable, or at least not detrimental to one's interests" (Robinson 1996: 576). As the following two quotes illustrate, it was this form of trust that needed to be restored after Operation Frisau:

> We all have an A-status which ensures that we can handle sensitive information … I only do not know up to what extent people have internalized this principle … even when dealing with criminal investigation teams I do not know this, because they too are checked only superficially. And you see what happens when you share information, how much of it leaks … how we work is exposed to the outside world, everyone now knows it. That hotspot was a fantastic means … But now it is gone, tactic lost" (TT member).

> What kind of secrets do I have? We are all in for the same game: catching criminals. And what they (TT) do technically, I do not have to know. But this was crucial … And then I think, why do we agree to work on one channel, while your own team works on another channel? That information (about the shooting) did not come through. And last week this happened again. That piece of trust has to grow again" (OT member).

Restoring trust for future collaboration is important, as research has identified the lack of trust as one of the main barriers of distributed team success (Rosen *et al.* 2007).

Tactical level agency and TMS

For this operation, the TT received a 'comprehensive assignment' (task) for which they sought assistance of the OT and HC. Individuals required for the operation were selected and the network communication infrastructure was configured accordingly (initiation phase). While the functional teams' TMS is based on face-to-face interaction and well-developed (i.e. in a functional sense), cross-team transactions are based on roles, rather than names, and depend on technology mediated communications (C2000 and GSM). During the positioning phase, the configuration of the network and C2000 were adjusted to incorporate the tactical requirements of the helicopter. Its location was dictated by tactical conditions related to aerial control (nearby a major airport) and specific weather conditions (eastern wind). The positioning of the helicopter illustrates Whiteman and Cooper's (2011) notion of ecological sensemaking. Individuals need expertise to cope with local natural and artificial conditions. In this case, natural conditions were complemented with local aerial regulations. These proved inhibiting during the hot action phase. So far, during the positioning phase, the operation was tactically understood as a routine operation in which it was the task of the OT to announce the arrival of the suspects, the HC to provide overview, and the TT to seek additional identification, make the recording, and protect the hotspot. In a predictable environment (external dynamics) with predictable interaction between the various team roles (internal dynamics), this setup had worked -as one of the interviewees said- '99 out of 100 times'. Other interviewees, however, contested that in more dynamic environments, operations had failed before. In this case, the external dynamics were caused by an unexpected event, the assassination. This disrupted the hot action phase and challenged the teams to adapt their networked enactment at all three levels of agency. Immediately after the shooting, the TT team leader became involved at the operational level.

Consequently, he discontinued tactical leadership. Since he was responsible for integrating contributions from OT and the rest of the network, the two parts of the network were deprived of their tactical level resource to synchronize action. This was aggravated by the fact that there were no alternative options for the HC and the OT to communicate with one another. From a TMS perspective, the various teams within the network were minimally coupled and only at tactical level. Failure of the exclusive link that held the teams together (Figure 1) led to disintegration of the network. The disintegration (from a network perspective) continued during the debriefing, which was initially organized per functional team. Preceding the debriefing, all individual officers were asked to put their experience formally on paper in a Police Report. This was aimed at preventing synchronization of memories. During the debriefings, however, it became manifest that a shared briefing was needed to better understand what had happened.

Operational level agency and TMS

Network initiation. During network initiation, the team leader of the TT was briefed (face-to-face) by the head of his unit. The team leader, in turn, briefed the team leaders of the OT and HC about Operation Frisau. He did not know these team leaders in person, but was aware of their intended role in the operation. Due to time pressure and physical distances he briefed them by phone. Subsequent communication, too, was by GSM and C2000. This procedure seems to contradict extant TMS research which holds that technology mediated communication is detrimental to TMS development, if not supplemented by face-to-face communication (*cf.* Lewis 2004). In this case, however, people acted based on task familiarity, rather than team familiarity. Espinosa *et al.* (2007) asserts that these two types of familiarity are substitutive, not complementary, in their effect on team performance. We can nuance this statement. Task familiarity sufficed as long as tasks were predictable. Team familiarity could have limited the extent to which the assassination disrupted the TMS.

Positioning phase. After the briefing each member went to the location from which he/she would operate and communicate personal observations relevant for the task at hand. Until that moment the agreed TMS functioned as designed. Once the OT noted the presence of the helicopter, however, the TMS became ambiguous. Besides the fact that role allocation between the TT team leader and his driver was unclear, the configuration of communication channels (required for updating, accessing, and allocating) became ambivalent. This went well as long as the operation proceeded as predicted. Thus, until the shooting.

Hot action phase. This phase was dominated by two intertwined developments: the shifting role of the TT team leader, and unclarity about the abilities of the helicopter.

First, within the established tactical structure the TT team leader played a pivotal role. By pursuing the shooter, rather than delivering his tactical level services he had shifted to an operational role. The OT and TT/HC teams were connected through one tactical level link only (i.e. the TT team leader). When this link became submerged in the operation, the various parts of the network were incapable of organizing concerted action. In an attempt to fill this tactical level void, the HC tried to establish alternative communication channels with the OT, yet failed. Becoming aware of his role-shift, the TT team leader handed-over the pursuit of the shooter to the helicopter, and returned to the hotspot where he reassumed his tactical role. This time, however, his focus had narrowed down from the entire network to his functional team only. The helicopter resumed its operational role, trying to pursuit the shooter.

Second, lack of awareness of TT members (including the co-observer that had joined the HC) of the environmental factors that conditioned the functioning of the helicopter resulted in misperceptions of its operational capabilities. That is, potential services of this resource for the network were constrained by the environment (*cf.* Whiteman and Cooper 2011). Contributing to network collapse was the fact that TT members assumed (but never verified) that the helicopter would switch from a static mode of operating (providing sight to hotspot) to a dynamic one (pursuing the escaping shooter). Yet the helicopter could not

materialize this switch due to tactical level environmental conditions and strategic level instructions and regulations. Due to the extreme situation and unfamiliarity with the functioning of the helicopter, the TMS of the network was no longer backed by task familiarity. In absence of team familiarity and alternatives to coordinate action (communicate), networked enactment had broken down in three functional teams working in isolation.

Debriefing phase. In the aftermath of the operation officers made individual Police Reports and participated in the two briefing sessions, contributing their personal perspectives and reflecting on the lessons learned. From these sessions insights emerged that fueled tactical and strategic level agency.

4.7 Results (3): Hybrid Enactment

4.7.1 TMS for hybrid enactment: third analysis

In this section we revisit our analysis of functional (F) and networked (N) enactment to obtain insight in hybrid enactment. To this end we take an analytical step (this section) and a theory development step (next section). Our previous two analyses resulted in constructs associated with functional and networked enactment: principles at the strategic level, structures at the tactical level, and personal knowledge and interactions at the operational level. As explained in our data analysis, we use Kozlowski and Klein's (2000) distinction of global, direct and moderating effects to relate the results of our three units of analysis –functional, networked, and hybrid enactment (*cf.* Table 4.4). Global effects concern only functional or networked enactment since our data collection concerned these units of analysis. Direct effects occurred between all three units of analysis. Following this step we construct a model of hybrid enactment based on these relations and effects, and thus address our main research objective.

	Global effects	*Direct effects*	*Moderating effects*
Strategic level: emerging and conditioning governing principles			
TMS for functional enactment of diverse departments (ex Table 4.2):			
Subject, technical, aerial observation		Complementary effect (F→N)	
Skills, attitude related to following, placement, flying		Complementary effect (F→N)	
Legal mandates for specialized tasks			√
Information sharing principles		Conflicting effect (F→N)	
TMS commonalities across departments for functional enactment (ex Table 4.2):			
Police Law			√
Fighting serious and organized crime			√
High quality observation skills			√
Safety			√
TMS for networked enactment (ex Table 4.3):			
Identification			√
Compromise	√		
Learning through shared debriefing		Learning effect (N→H)	

	Global effects	*Direct effects*	*Moderating effects*
Tactical level: emerging and conditioning organizational structures			
TMS for functional enactment of diverse departments (ex Table 4.2):			
Team roles		Complementary effect (F→N)	
Routines		Complementary effect (F→N)	
Environment related repertoires		Complementary effect (F→N)	
TMS commonalities across departments for functional enactment (ex Table 4.2):			
Hierarchical structure			√
Police education			√
C2000			√
TMS for networked enactment (ex Table 4.3):			
Comprehensive assignment		Initiating effect (F→N)	
Network configuration	√		
C2000 configuration	√		
Positioning HC	√		
Proximity airport and wind direction	√		
Role of TL			√
Reporting instructions			√

	Global effects	*Direct effects*	*Moderating effects*
Functional teams debriefings	√		
Operational level: personal knowledge and interactions related to primary tasks			
TMS for functional enactment of diverse departments (ex Table 4.2):			
Unique OT, TT, and HC skills		Complementary effect (F→N)	
TMS commonalities across departments for functional enactment (ex Table 4.2):			
Policing skills			√
Knowledge of evolving situation	√		
TMS for networked enactment (ex Table 4.3):			
TL briefing	√		
Team briefings	√		
Individual trust-levels			√
Individual position taking	√		
TL goes operational	√		
Sharing of observations (transactions)	√		
HC attempt to contact OT	√		
Shared debriefing		Learning effect (N→H)	

Table 4.4: Hybrid enactment: TMS analysis

Strategic level agency and TMS

TMS for functional enactment of diverse departments. Specialized strategic tasks and expertise related to observation (i.e. subject, technological, and aerial observation) can potentially be combined in networked operations and, thus, have a direct, complementary effect: functional services can be compiled to create networked services. Legal mandates and regulations related to tasks are independent of the mode of enactment. Hence, these mandates have a moderating effect. Finally, the functional teams used different principles with respect to information sharing. This had a direct, conflicting effect on the networked operation. Expectations with respect to information sharing were not explicated and brought in line with one another before the operation commenced. The contributing functional teams did stick to their own principles. During the operation this resulted in ambiguity and decay of trust.

TMS commonalities across departments for functional enactment. These include the Police Law, principles of fighting serious and organized crime, delivering high-quality observation services, the safety principle, and the principle of learning through shared debriefings. These principles do not remain limited to functional enactment and hence, have a moderating effect. All organizational members know these principles, and know that other members know these principles. They thus serve as a common body of knowledge underpinning collaboration processes (*cf.* Cramton 2001).

TMS for networked enactment. First, the identification principle is related to the legal mandate to record conversations and, thus, applies to both functional and networked modes of enactment. During the networked operation it had two direct conditioning effects: at the tactical level it influenced the configuration of the network (inclusion of helicopter, and additional task for TT inner-ring), and at the operational level it inspired the OT to collect additional video evidence by parking one of its video equipped cars such that it offered an overview of the hotspot. Thus, by knowing what the network needed, the OT could boost its functional contribution. Second, the compromise principle applied only to the networked operation (global effect). And third, the principle of learning

through shared debriefings (i.e. involving multiple functional units) originated from the networked enactment. It had a direct effect on the knowledge base that the functional teams hold in common. In turn, this common knowledge has a moderating effect on future networked enactment.

Tactical level agency and TMS

TMS for functional enactment of diverse departments. The roles among the three teams showed little overlap and as such were complementary. The same holds for the routines of the teams and repertoires related to the environments in which they operate. For example, the HC complements the OT by providing aerial oversight. To provide this service they assume the role of observer. Routines are developed to handle specific aspects of tasks, such as static and dynamic operations, camera techniques (visual or infra-red), and transport modalities (plane or helicopter). In turn, sets of routines are combined in repertoires. The services the HC provides are complementing the capabilities of the OT, which is operating on the ground and has its own set of roles, routines, and repertoires.

TMS commonalities across departments for functional enactment. The constructs we found include the hierarchical structure, general police education, and C2000 communication infrastructure. These have a moderating effect: teams operating in both functional and networked modes benefit from these tactical level structures. Their common knowledge of these structures has a moderating effect in the sense of reducing communication needs and enriching the professional meaningfulness of collaboration processes (Rico *et al.* 2008).

TMS for networked enactment. The networked operation was initiated by the DSRT when it received a comprehensive assignment of the DNR to collect evidence. Seeking to combine capabilities of the OT, TT, and HC, the DSRT TT unit head initiated a networked operation. Most of the tactical structures that followed were global in effect; their relevance remained limited to Operation Frisau. For example, structuring the network (based on the experience of the unit heads in previous

collaborations) and the configuration the C2000 communication channels was idiosyncratic to this operation. Likewise, the proximity of airport and prevailing wind direction influenced the actual position of the HC in the network configuration. We found two tactical level constructs that influenced network enactment yet not uniquely related to either mode of enactment. These moderating constructs include the role of the team leader, and the instruction to all contributors to the operation to draft personal Police Reports. Finally, functional team debriefings after the networked operation remain limited to the team, and hence are global in effect.

Operational level agency and TMS

TMS for functional enactment of diverse departments. The operational skills of the various teams (OT, TT, and HC) cover diverse aspects of observation. Hence, they are complementary. Network operations rely on combinations of these operational capabilities that originate in the functional realm of the organization (Sirmon *et al.* 2007).

TMS commonalities across departments for functional enactment. In this category we found two constructs: common policing skills and knowledge of the evolving situation. Policing skills are applied in both modes of organizing. Hence, these skills have a moderating effect. Second, individual knowledge of the evolving situation in its physical context is of utmost importance for the meaningfulness of networked enactment (Whiteman and Cooper 2011), but is global in effect.

TMS for networked enactment. Team briefings are standard routines that are used for both modes of organizing. This construct thus moderates operational level agency. Enacting the routine at the operational level, however, implies a global effect: the briefing is geared at preparing for a specific networked operation. Trust influences the willingness to cooperate and share information (Mishra *et al.* 2010). Specifically, initial trust among network members is critical for performance (Rosen *et al.* 2007). Inter-team trust was a given at the beginning of the operation. It resulted from previous experiences, or perceptions of persons or (types of) teams, in previous collaborations.

Operational constructs associated with Operation Frisau and with a global effect included: position taking, the role shift of the TT team leader, the sharing of observations, and the attempt of the HC to contact the OT. Finally, due to the dramatic turning of events the networked operation a shared debriefing was organized. Shared debriefings have a direct effect on hybrid enactment, as lessons learned are used to inform future operations (in either mode of enactment).

4.7.2 Developing an Organizational TMS Model for Hybrid Enactment

We can now synthesize our results to construct a multilevel model for hybrid enactment (Figure 4.2). The model depicted in Figure 4.2 allows us to address our research objective by providing insight in the structure of TMS for hybrid enactment, its development, and in mechanisms for increasing organizational resilience. We distinguish four types of TMS involved in hybrid enactment, depicted as rectangles in Figure 4.2.

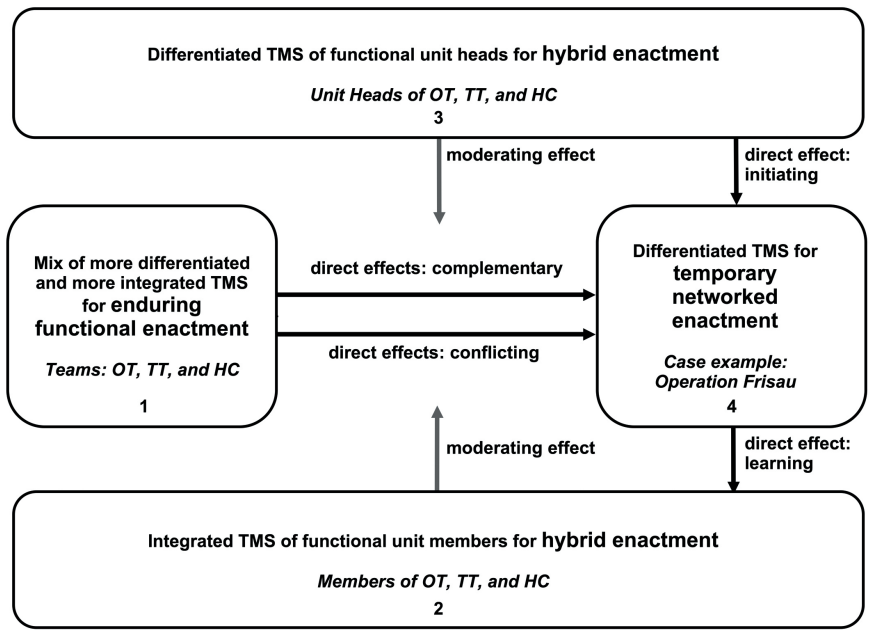

Figure 4.2: Organizational TMS model of hybrid enactment

First, functional units (including their heads and members) develop enduring TMS supporting their functional services. Depending on the requirements of each functional department, their TMS varies in terms of differentiation across strategic, tactical and operational levels. Departmental TMS are characterized by unique mandates, knowledge, routines, and repertoires underpinning functional enactment.

Second, based on common elements of functional and networked TMS, unit heads and members hold TMS elements in common. These include shared or overlapping legal frameworks and strategic intent, educational backgrounds and experience, and organizational and technical structures. We call this integrated TMS for hybrid enactment. The integrated TMS moderates functional and networked enactment as it provides the participating teams with a common basis for understanding (Wegner 1986).

Third, while each unit head is responsible for his specialized unit, he knows what the other unit heads could contribute and how these contributions can be activated (Kor and Mahoney 2004). This TMS thus consists of a group of unit heads enabling unit-crossing services and innovations (Kor and Mahoney 2004). It is differentiated since the unit heads bring in unique, non-overlapping expertise, while they depend on each other for delivering networked services. Hence, this TMS has a direct initiating effect on networked operations, in addition to a moderating effect on the relationship between functional and networked enactment.

And fourth, the organization develops a temporary TMS for networked enactment. It is initiated by the differentiated TMS for hybrid enactment (rectangle 3) and it is linked by direct effects originating from the TMS for functional enactment (rectangle 1). These include complementary and conflicting effects, originating at the strategic, tactical, or operational level of functional enactment. Differences between functional teams contribute to the potential of combinative capabilities during networked operations, but may also fuel conflicts if conflicting differences between contributing functional teams are not recognized and solved during network initiation. And finally, networked TMS contribute

to the integrated TMS for hybrid enactment (rectangle 2) through explicating lessons learned during shared debriefings (*cf.* Ron *et al.* 2006).

4.8 Contributions

The objective of this chapter was to analyze how organizations can organize for hybrid enactment. We framed organizations as collections of knowledge resources providing services (i.e. organizational agency) in a strategic, tactical, and operational sense. TMS play a role in the organization of resources (Wegner *et al.* 1991). Particularly, we assumed that organizations develop different TMS patterns to enable functional or networked enactment (*cf.* Gupta and Hollingshead 2010), and to transition between these modes. Conducting case study research at a national police organization, we were interested in how TMS patterns are interrelated, and how its resilience could be increased.

4.8.1 TMS for hybrid enactment

Although Wegner stated that 'the structuring of an organization is clearly an exercise in structuring transactive memory' (Wegner 1986: 204), there are only two conceptual studies (Anand et al 1998; Nevo and Wand 2005) and one empirical study (Jackson and Klobas 2008) exist at the organizational level (Ren and Argote 2011). These three studies depict organizational TMS as a patchwork of multiple group TMS. They illustrate that people may be member of multiple groups, and show how information systems can be used to share information with members outside their group. These three studies hold in common an aggregative perspective of organizational TMS. In contrast, we found that TMS for hybrid enactment consist of four different types of TMS with unique contributions (Figure 4.2). At the organization level, these four TMS are interrelated through direct and moderating effects.

First, specialized units have developed TMS for functional enactment, which in effect did not have bearing relevance to other units' TMS, i.e. global effects (*cf.* Kozlowski and Klein 2000).

Second, heads of these specialized units regularly collaborate with each other to solve problems they cannot solve with their own units, thus

requiring networked enactment. Through experiences with networked enactment they develop a differentiated TMS, which plays a critical role in identifying partners for collaborative networked operations (*cf.* Jackson and Klobas 2008).

Third, following the initiative of functional unit heads, a networked operation is assembled for which a temporary TMS is being developed. We learned that multiple TMS for functional enactment are potentially not just complementary, but may be conflicting as well. Moreover, the need for harmonization of strategic principles at the organizational level may conflict with the functional orientation of the unit (Kogut and Zander 1992).

Finally, lessons learned during networked enactment can enrich the common knowledge base of the participating organizational units. Following Wegner (1986), we refer to this base as an integrated TMS for hybrid enactment, providing a basis for mutual understanding and minimizing the need for explicit coordination (*cf.* Cramton 2001).

4.8.2 Qualitative approach to multilevel theorizing

The aggregative perspective of organizational TMS falls short in properly explaining the composite structure of TMS at the organizational level, and how they emerge. We introduced the concept of agency (Emirbayer and Mische 1998) and explained how people (irrespective of hierarchical position) engage in three distinct levels of agency, i.e. strategic (creating or adjusting principles, norms, values), tactical (creating or adjusting supporting structures, routines, configuration of technology), and operational (execution of primary processes). Thus dissociating these levels of agency from the formal vertical division of work, we used the levels to structure our analysis of functional and networked enactment. This agency-based perspective to multilevel TMS provides insights that remain hidden when using an aggregative perspective by explaining how operational agency contributes to the emergence of tactical structures and strategic level principles, which in turn condition operational level agency.

4.8.3 Resilience, control and potentiality

In organizations capable of hybrid enactment, functional enactment represents their comfort zone with deeply engrained organizing architectures, control processes and expertise coordination (*cf.* Feldman and Pentland 2003; Faraj and Xiao 2006). Networked enactment, on the other hand, represents a 'zone of potentiality' in tactical-operational terms. It provides the organization with opportunities to deliver services exceeding functional teams' capabilities (*cf.* Bosch *et al.* 1999). In this zone of potentiality the organization stretches its capabilities with the palpable risk of over-stretching and losing control (*cf.* Brown and Eisenhardt 1997). Combining unit services may change the strategic, tactical, and operational coherence of their stand-alone functional services since it disrupts established TMS patterns at and across these levels. For networked enactment, the TMS gains an ad hoc operational logic that gives new organizational meaning to unit services (*cf.* Maitlis and Lawrence 2007). This ad hoc logic is fragile as many studies on crisis response illustrate. Where these studies mainly focus on system breakdown (e.g. Weick 1993), our study considers networked operations as opportunities for creating new value through the combination of services of functional units. Moreover, our study indicates that dissonance within networked operations can be understood when analyzing TMS developed for networked enactment in relation to the TMS for functional and hybrid enactment (Figure 4.2). While the pool of functional capabilities provides opportunities to respond in exceptional situations, we showed how organizations may strengthen their TMS in support of hybrid enactment. In particular, our study sheds light on enablers of swift networked response, and switching between modalities (functional or networked) and network configurations (combinations made).

4.9 Implications for Research

4.9.1 Combinative capabilities

The KBT starts with the notion of Grant that 'if the strategically most important resource of the firm is knowledge ... then the essence of

organizational capability is the integration of individuals' specialized knowledge' (Grant 1996: 375). Subsequent research (e.g. Bosch *et al.* 1999; Wang and Peng 2008) has emphasized internal organizational structures and processes that enable organizations to develop new capabilities for increasing competitive advantage. Heeding calls for building micro foundations of the capability perspective (Foss 2011), our research extends the literature on combinative capabilities. This may inspire further research in this area.

First, where literature on combinative capabilities emphasizes the adaptation of organizations to changing markets (e.g. Barney *et al.* 2001), we studied combinative capabilities as a special mode of networked enactment that complements an organization's default functional mode of operating. As such, hybrid enactment enables an organization to develop highly specialized services and to combine these services into temporary configurations for delivering value beyond functional enactment.

Second, contemporary KBT research emphasizes the positive aspects of making new combinations, as heterogeneously specialized resources would add value through innovation (Busquets 2010). We nuance this view. Taking a multilevel TMS perspective brings to light complementary as well as conflicting knowledge patterns. Further research could examine how organizations committed to hybrid enactment identify and manage these contradictions in a sustainable manner (*cf.* Smith and Lewis 2011).

Third, from the perspective of our study, current literature on combinative capabilities is predominantly focused on organizational structures. For example, scholars study combinative capabilities in terms of platforms (Ciborra 1996), modularization of organizations (Sanchez and Mahoney 1996), and the configuration of networks and components (Busquets 2010). Our study encourages researchers to describe the emergence of these structures in terms of strategic, tactical, and operational levels of agency.

And finally, we have limited ourselves deliberately to intra-organizational hybrid enactment. Further research could examine hybrid enactment in inter-organizational relationships (e.g. alliances) and

networks (Kleindorfer and Wind 2009; Provan and Kenis 2008). Moreover, while inter-organizational cooperation is often framed in terms of mechanisms and phases, the TMS perspective highlights sharing of knowledge and resources. This appears relevant for creating value across organizational boundaries. Such value creation is characterized by scale, innovation and the politics of dealing with organization-specific interests (*cf.* Child and Rodrigues 2011). The types of TMS we distinguished in organizational TMS could transcend organizational boundaries. For instance, potential partners in crisis response could organize reconnaissance meetings for developing a differentiated TMS that supports hybrid enactment. Further research could examine how strategic and tactical level TMS constructs of potential partners interrelate, and which approaches could be developed to deal with potential conflicting differences and constraints.

4.9.2 Organizational TMS and learning

First, contemporary TMS research predominantly focuses on operational level agency and emphasizes TMS as systems that may vary in terms of convergence (Brandon and Hollingshead 2004). The compound and multi-level structure of TMS for hybrid enactment suggests that new methods are needed to measure its stage of development and the degree of complementarity and conflict between functional units' TMS, and incorporate all three levels agency.

Second, in addition to current literature, which depicts TMS as emergent (Kozlowski and Klein 2000), we observed that knowledge patterns may be very dynamic, especially when the team is engaged in a particular task. Analyzing knowledge patterns of functional teams in terms of TMS differentiation and TEP-state (stable or dynamic) reveals that differentiation and state may differ for each level of agency. Future research may explore whether counter-balancing relationships occur across the levels.

Third, in addition to TEP-combinations, the environment in which organizational resources act represents an important additional parameter influencing the configuration of (temporary) combinations. This applies in

particular to networked operations which tend to be more complex than functional enactment. As shown in Operation Frisau, the environment conditioned the forming of TEP-combinations, requiring the network members to engage in ecological sense making (Whiteman and Cooper 2011).

Finally, Wegner *et al.* (1991) identify three progressively sophisticated learning methods through which distributed expertise becomes known: stereotyping, self-disclosure, and experience. One question that this study raises is whether these learning methods are necessarily sequential. Where in enduring functional teams this may be the case, because members move through for instance regular training programs, in operations such as Frisau, teams worked together based on role-perceptions. More research is needed to better understand how TMS for networked enactment can be strengthened in relation to functional enactment. This could support the allocation of organizations' knowledge investments.

4.9.3 The psychology of hybrid enactment: stress and trust

With hybrid enactment central to our analysis, our results pointed at the interrelatedness of organizational phenomenon like principles and structures, and human agency. Stress and trust were not included in our initial model (*cf.* Lin *et al.* 2008), yet, as has been found in other studies, they had an important moderating effect on Operation Frisau (e.g. Ellis 2006; Ellis and Pearsall 2011; Pearsall *et al.* 2009; Rau 2005).

First, where Ellis (2006) found that stress reduces TMS related communication, we found that stress impacted the level of agency and reduced the network horizon (van Liere 2007) of its members (defined as awareness and perception of who is part of the team). It is well known that people under stress tend to redraw to their comfort zone, i.e. fall back on older learned routines (Staw *et al.* 1981). Likewise, after the shooting the TT team leader became operationally involved, disregarding the tactical level services he was providing for the network. As one of the functional unit heads explained, this is very common:

> In stressful situations strategic leaders tend to interfere with tactical level leaders, while tactical leaders tend to interfere with the operational level. In general everyone tends to regress one level (Functional Unit Head OT).

Besides this level of agency descending effect, we noticed a narrowing network horizon effect. The moment the TT team leader reestablished his tactical role his horizon had reduced from the entire network to TT-members at the crime scene (his functional team), and from the entire operation to securing the crime scene and handing it over to the local police authorities. The consequence for the network TMS was that it ceased to exist (Figure 4.3, rectangle 4). As the network broke up, the three teams retreated to their functional mode. Future research may explore how team leaders can recognize narrowing network-horizon and descending level of agency (i.e. from tactical to operational), and how unit heads may dynamically alter or add strategic principles, or tactical level structures to increase resilience.

Second, trust has been studied within the context of TMS development in the form of cognitive-based trust and task credibility (Kanawattanachai and Yoo 2007; Moreland and Myaskovsky 2000; Rau 2005). In our study we found that although trust in each others´ capabilities was high, during Operation Frisau trust in each others´ willingness to collaborate was negatively affected. The latter category of trust sheds light on TMS validity, which is defined as the degree to which group members actually make use of each other during problem solving (Brandon and Hollingshead 2004). Because members originating from different functional teams maintained different values with respect to information sharing, trust among the members diminished. This affected the development of the temporary networked TMS and the integrated TMS for hybrid enactment. Lack of trust hinders open communication, asking questions, and explicitly verifying facts (Jarvenpaa and Leidner 1999). The DSRT unit head exercised strategic level agency to restore trust, enforcing the principle of shared briefings). The latter act could extend current work on semi-structures at the tactical and operational

level. Semi-structures are defined as ‘simple or minimalist rules that help members of a group organize their knowledge integration processes, yet remain exible enough to adapt to an evolving situation’ (Jarvenpaa and Majchrzak 2008: 262). Examples include dialogic practices (conversation rules), clarity of knowledge ownership (ensuring the right and responsibility to act on that knowledge), and knowledge dissemination protocols (what to share). In relation to strategic level principles, these semi-structures at the tactical level may contribute to more transparent decisions making that sustains trust among the teams.

4.10 Implications for Practice

4.10.1 Developing TMS for hybrid enactment

TMS for hybrid enactment constitutes multiple group TMS. Each may have its own structure (more integrated or differentiated) and may differ in terms of convergence (*cf.* Brandon and Hollingshead 2004). Moreover, principles, organizational structures and processes), and personal knowledge and interactions that emerge in the various TMS may differ to suite the requirements of the respective tasks and task contexts (environment). From the perspective that specialist services are at the core of the organization and networked services form their derivative, these differences have to be managed. First, among functional teams these differences signify more specialization. Second, for additional value adding through networked operations these differences have to be bridged. Interventions aimed at developing TMS for hybrid enactment have to respect both values. Based on the model presented in Figure 4.2 this may be achieved by 1) intervening in differentiated TMS for hybrid enactment, e.g. through strengthening meta-knowledge of other functional units, 2) intervening in the integrated TMS for hybrid enactment, e.g. through developing shared principles, structures, or skills, 3) establishing mechanisms to ensure feed back of lessons learned during networked enactment to further strengthen the integrated TMS for hybrid enactment, and 4) by increasing awareness of potential conflicting direct effects, and developing strategic level principles, tactical level methods or semi-

structures (*cf.* Jarvenpaa and Majchrzak 2008), or operational level personal skills to deal with them.

4.10.2 Cross-unit cooperation and preparation

In the evaluation report, practitioners advice to organize frequent shared training sessions, and to approach preparations more systematically, i.e. to use check-lists, standard formats and schemas to help configuring the network, and shared (where possible face-to-face) briefings. To start with the first, training is known to help to increase team performance through developing a shared TMS (Liang *et al.* 1995; Moreland *et al.* 1996). This is due to the fact that members of groups with highly developed TMS declare domains of knowledge in earlier periods of interaction then groups with less developed TMS, while the frequency with which members evaluate other's expertise and competence increases over time (Ren and Argote 2011; Rulke and Rau 2000). With regard to more systematic preparations, these are aimed at strengthening strategic and tactical level structures, while shared face to face briefings are known to strengthen TMS (Lewis 2004).

Making the recommendation more specific, we recommend to develop more integrated TMS (increasing redundancy), develop meta-routines (*cf.* Zollo and Winter 2002) to assemble multiple functional teams for networked operations, invest in interdepartmental trust, and develop semi-structures for knowledge sharing. The latter is of utmost importance to stimulate explicit communication, required to remain in control (Argote 1982; Larson and Schaumman 1993). Finally, we recommend to cross-check for potential vertical (among levels of agency) and horizontal (among teams) dissonance, make direct conflicting effects explicit, and make known to all participating members how these conflicts are solved for the duration of the networked operation.

4.10.3 Enablers and leadership

Like was the case in Operation Frisau, during some tasks absolute concentration and silence is required, while for other tasks events in the rest of the network may have to be monitored as well. Temporary

networked operations by default are used to conduct less predictable tasks. In such setting explicit communication is of utmost importance for shared sense making (Van De Ven *et al.* 1976; Kraut 1987). This need is aggravated by the fact that TMS for networked enactment is temporary too, which increases its reliance on explicit communication (*cf.* Littlepage *et al.* 2008). We therefore recommend to work -by default- on one channel and redraw to multiple channels only when and for as long as needed. In that case, at least one alternative connection should be maintained to prevent the creation of a (potentially vulnerable) exclusive link.

While enabling strategic and tactical constructs may be negotiated by the functional unit-heads, and briefed to team members just before the actual operation, during the hot action phase new strategic and tactical constructs may be needed (e.g. new strategic objective: pursuit shooter) and old ones may become redundant (e.g. compromise-principle). These changes require the team leaders to maintain oversight at all times. As some of the interviewees contested, however, 'team leaders are first and foremost police officers … action driven … and hate to stand by doing nothing'. Thus, the urge to jump into action (provide operational level services) may interfere with the task of providing tactical level services. Three types of measures could be used to make tactical level services more robust. First, organize redundancy. In Operation Frisau the team-leader functioned as an exclusive link between the participating teams, rendering the network susceptible for team collapse due to link failure. Second, make team-leaders aware of level of agency transcendence. And third, review whether team-leaders can participate virtually. Leading the team from a distance frees them of local stressors (Larsson 1989), forces them to remain overview, and prevents them from being drawn into action, thus providing a context in which full concentration can be paid to the networked operation. Moreover, such central position (e.g. in a command and coordination center) enables swift scaling of operations.

4.11 Conclusion

We formulated hybrid enactment as the capability of distributed functionally specialized units to engage in networked operations. Being

able to assemble networked operations increases the potential value of an organization's resources, as through the creation of new combinations the organization can engage in services that none of its functional units can deliver on its own (*cf.* Zammuto *et al.* 2007). We studied hybrid enactment empirically at a policing organization. To this end we developed a theoretic lens. Through this lens we analyze the organization as a collection of distributed (knowledgeable) resources that become organized through the development of a multilevel TMS. Contrary to social science practices, which usually use an aggregative perspective to multilevel theory, we adopted a multilevel agency perspective.

We found that TMS in combination with multiple levels of agency provides a micro-foundation for KBT, as it provides insight in how capabilities are being developed (Foss 2011). We found that, next to multiple TMS for functional enactment and temporary TMS for networked enactment, integrated TMS and differentiated TMS for hybrid enactment are being developed. Relations among these TMS are characterized by moderating and direct effects, which, if managed well, may constitute an organizational learning cycle. These moderating and direct effects provide pointers for interventions aimed at strengthening hybrid enactment, which increases operational resilience. Moreover, we found that environmental factors, as well as psychological factors (trust and stress) play an important conditioning role on TMS and team performance.

5 CONCLUDING REFLECTIONS

5.1 Setup of this Chapter

This concluding chapter is organized as follows. First, the answers to the three research questions are being summarized, followed by an explanation of how these answers contribute to the two research objectives that have been formulated in Chapter 1. Third, the implications for TMS theory are being discussed followed by implications for a few related theories. Fifth, the implications for practice are being treated, i.e. in terms of implications for system design and system governance. In the sixth section the limitations of the conducted studies are being discussed, followed in the final section by suggestions for future organizational TMS research.

5.2 Answers to the Research Questions

5.2.1 Research question 1

The first research question has been formulated as follows: how can knowledge transfer among (different types of) knowledge resources in an organizational TMS be strengthened to support temporary and geographically distributed collaborations? Knowledge management literature was used to formally describe three ideal types of knowledge resources that play a role in TMS at organization level, i.e. personalized, encoded, and embedded knowledge resources. Based on conceptual work and field experiments, three types of interventions have been identified that can be used to strengthen knowledge transfer in organizational TMS.

First, knowledge transfer may be strengthened by increasing potential transactivity among knowledge resources. For example, in addition to traditional face to face communication, alternative communication channels may be created. Moreover, opportunities for automated matching and alerting may be increased by enabling the linkage between encoded knowledge resources, such as distributed sensors, registers, and knowledge rules.

Second, tasks may be reassigned to other knowledge resource types. For example, where people are well equipped to interactively assess an idiosyncratic situation, automated routines are better equipped to systematically observe intensive traffic flows on e.g. highways.

Third, knowledge transfer in organizational TMS may be strengthened by organizing differently. An example from the AR is the set up of a virtual team in order to provide local officers with distant expert support. Likewise, sensor networks were being used to increase the sentience of the virtual team, e.g. by making available geographically distributed observations that are related in time and space, and which may be used to initiate local action.

5.2.2 Research question 2

The second research question has been formulated as follows: how are different types of knowledge resources related to TMS, which develops for supporting temporary collaborative action in a geographically distributed setting? Because TMS are cognitive systems people develop to divide responsibilities for interdependent tasks (Ren and Argote 2011), insights were being used from organizational routines theory (*cf.* Pentland and Feldman 2003; 2008). Indeed, TMS theory and organizational routines theory explain different aspects of collaborative work. Where the first elicits the distribution of expertise in a group, including the processes of specialization and integration, the second is primarily focused on the task. Both theories recognize that knowledge resources other than people do play a role. Where the function of different types of knowledge resources in organizational routines is clearly described, however, in TMS theory the function of knowledge resources other than people is still in debate. Oshri *et al.* (2008), for example, argue that codified directories (i.e. explicit knowledge, shared through e.g. databases or documents) and personalized directories (i.e. tacit knowledge, shared through personal interaction) should be viewed as complementary. Others suggest that knowledge resources other than people may substitute (parts of) TMS, but only if they can emulate and facilitate transactive processes (Lewis and Herndon 2011).

In answer to calls for research to study what the role and function is of IT (e.g. Choi *et al.* 2010) and other types knowledge resources in TMS (e.g. Yuan *et al.* 2011), in this dissertation I suggest to describe the structure and functioning of TMS in the same way as the structure and functioning of organizational routines theory is being described (Pentland and Feldman 2003; 2008) (see Figure 5.1).

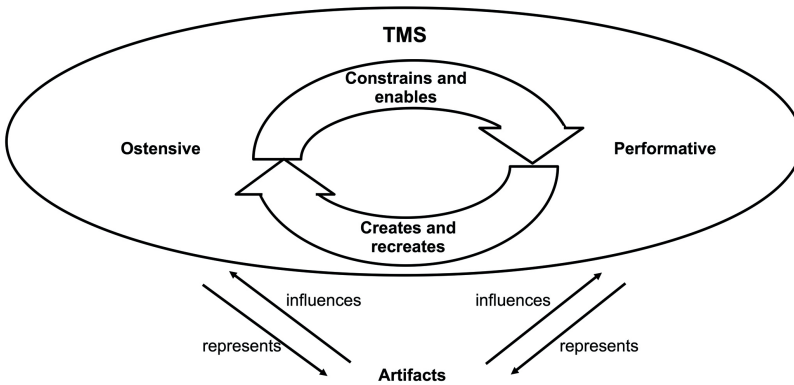

Figure 5.1: TMS as generative system (adapted from: Pentland and Feldman 2008: 241)

Consequently, TMS consist of ostensive and performative aspects which are (possibly, but not necessarily) influenced and represented by artifacts. These three elements are explained next.

First, the ostensive aspects of TMS constitute the collection of shared mental representations of how work is being divided and what the capabilities are of the participating actors. As discussed in Chapter 1, this meta-knowledge includes at least the labels and locations of the involved knowledge resources (Wegner 1986). It further may include meta-knowledge of allocation, updating, and retrieval coordination (Brandon and Hollingshead 2004), emergent behavioral knowledge (Moreland and Myaskovsky 2000; Moreland *et al.* 1996), soft knowledge, such as belief structures, judgment, intuition (Anand *et al.* 1998), capability and motivation (Majchrzak *et al.* 2007), and affect (Huang 2009). Moreover, the shared mental representations of organizational rules that serve as resource for information storage and retrieval (*cf.* Kieser and Koch 2008)

form ostensive aspects of TMS and may include the shared mental representations of routines or e.g. hierarchical organizational structures (*cf.* Chapter 4).

Second, like in organizational routines (*cf.* Pentland and Feldman 2008), the ostensive aspects enable and constrain the actual functioning of a TMS, i.e. the performative aspects of the TMS, which in turn create and recreate the ostensive aspects of the TMS. Thus, the ostensive and performative aspects of TMS are mutually constitutive and form a generative system.

Third, like in organizational routines (*cf.* Pentland and Feldman 2008), the ostensive and performative aspects may be represented by artifacts (Figure 5.1, downward arrows) or influenced by them (Figure 5.1, upward arrows), and hence, are not part of the TMS.

Besides these findings, analysis of the case material suggests that multiple TMS may be interrelated in two ways. First, a special case of artifacts are so called 'dead TMS', which are fully automated TMS (or subsystems thereof) which are not capable of learning or improvisation (*cf.* Pentland and Feldman 2008). Second, analysis of the TMS that developed in support of Operation Vigilance showed that actually two TMS had developed, i.e. one in support of the action planning phase, and one in support of the action phase. Moreover, further analysis revealed that five types of overlap could be identified, i.e. overlap in actors, artifacts, relationships among these, and type and content of informational interactions.

5.2.3 Research question 3

The third research question has been formulated as follows: how can functionally structured organizations develop their ability to engage in networked operations, in addition to their functional mode of organizing?

To answer this question the TMS of three collaborating teams have been analyzed. To this end two extensions to TMS theory have been made, i.e. concerning the nature of TMS building blocks, and the qualification of actor agency (i.e. strategic, tactical, and operational).

Before turning to the answer to the third research question, these two additions are explained.

Concerning the nature of TMS building blocks

Current TMS literature describe the building blocks of TMS as combinations of Task-Expertise-People (TEP) (Brandon and Hollingshead 2004; Yuan *et al.* 2007). To cater for the dynamic contexts in which many tasks are being executed, however, the concept of TEP-combinations has to be extended. This concerns two additions. First, in the analysis of the observation team (*cf.* Section 4.5.3) it was observed that while working on a task, TEP-combinations may dynamically be altered. Hence, in addition to TEP-combinations, its State should be taken into consideration. Second, external conditions may influence the TEP-combinations that are made. As Whiteman and Cooper (2011) analyzed, the environment may demand special sense making skills. This finding is confirmed by the empirical study of Operation Frisau (Chapter 4). In that operation, people working on the ground were not aware of the restrictions of the helicopter induced by the vicinity of a major airport. One of the reasons the operation failed was that context was not considered as factor when forming the TEP-combinations needed to switch from a stealth observation mission to a hot pursuit. Based on this observation, and supported by the work of Whiteman and Cooper (2011), I propose to extend TEP-combinations to Task-Context-Expertise-People combinations (TCEP-combinations) as building blocks of TMS.

Qualifying actor agency in TMS

Resources contribute to organized action through their capacity to act, i.e. their agency. Following Mantere (2008) and others (Mintzberg 1980; Simon 1962), a distinction can be made between strategic, tactical, and operational levels of agency, each representing functionally different capabilities. Strategic level agency concerns third order (or meta) governance (Sorensen and Torfing 2009). It is focused on defining the 'rules of the game' (in short: governing principles) in two ways. First, workers negotiate, influence, or adopt shared norms, values, and

principles (*cf.* Kooiman and Jentoft 2009; Oliver and Holzinger 2008). And second, they develop shared intent and ambition in the sense of strategically positioning the system in its environment (Mantere 2008; Volberda and Lewin 2003). Tactical level agency is associated with second order (or meso) governance. As such it is focused on establishing, shaping and deploying organizational structures and routines to facilitate operational level action (Bigley and Roberts 2001; Burgelman 1996; Rouleau 2005). Operational level agency refers to first-order (of micro) governance (Kooiman 2008), i.e. the primary value creation processes that yield benefits for the system's stakeholders (Mintzberg 1979; Porter-Liebeskind 1996; Sirmon *et al.* 2007). In less abstract terms: engaging in day-to-day problem solving and the creation of new opportunities.

Thus, rather than associating strategic, tactical, and operational levels of agency with the vertical division of work in hierarchical organizations, levels of agency are being used to refer to functional aspects of work. That is, at each level in the organization people may engage in activities that are strategic (e.g. establishing principles), tactical (e.g. establishing routines or structures), or operational in nature (e.g. carrying out value-adding or problem-solving tasks), the latter being the dominant perspective in extant TMS research. Because each level of agency has its on unique function, they are reflected in both the ostensive and performative aspects of the TMS, as well as in the artifacts used to represent or influence the TMS. Moreover, with respect to the multilevel nature of TMS (*cf.* Kozlowski and Klein 2000), levels of agency form an additional perspective, rather than an alternative perspective to social aggregate perspectives of multilevel TMS (e.g. individual, group, organization).

Answer to the third research question

The answer to the research question how functionally structured organizations can develop their ability to engage in networked operations in addition to their functional mode of organizing, consists of two parts, i.e. the structure of organizational TMS, and the learning processes that interlink the components of organizational TMS.

The structure of organizational TMS is shown in Figure 5.2. As illustrated in Figure 5.2, in addition to TMS in support of functionally specialized organizational units (functional enactment), and TMS in support of temporary collaborative networks (networked enactment), two types of TMS develop to enable cross-unit collaboration, in addition to their routine (functional) mode of enactment, i.e. a differentiated and an integrated TMS for hybrid enactment.

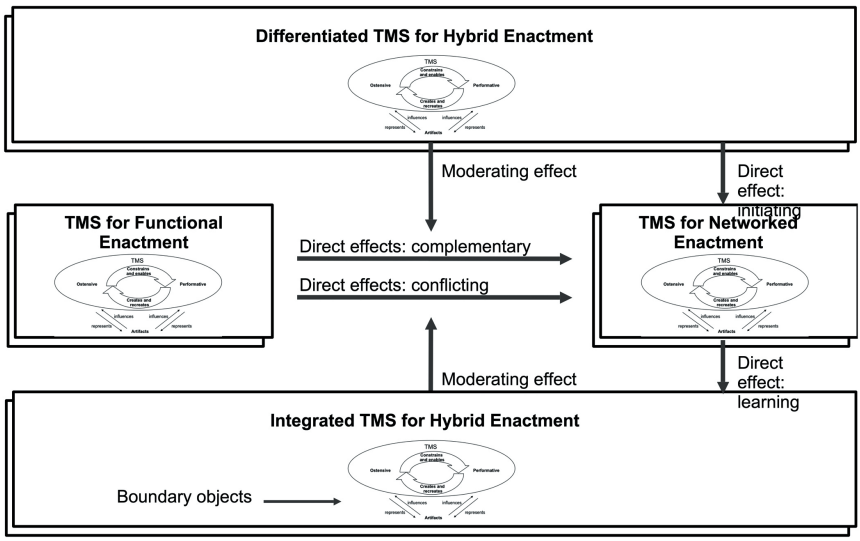

Figure 5.2: The structure of organizational TMS

The differentiated TMS for hybrid enactment is being developed by representatives of organizational units. In Operation Frisau these representatives were managers of the collaborating departments, but in other cases they may include less formal groups such as communities of practice (*cf.* Jarvenpaa and Majchrzak 2008; Hargadon 2002). The differentiated TMS for hybrid enactment is prerequisite for initiating collaborative action (networked enactment) in which distributed capabilities of functionally specialized organizational units are being integrated (*cf.* Jansen *et al.* 2009). The integrated TMS for hybrid enactment serves as a common knowledge-base to enable cross-knowledge domain understanding and coordination (*cf.* Cramton 2001)

and thus moderates the success of functional units to engage in temporary collaborations. In large organizations, consisting of e.g. divisions and departments, I hypothesize that multiple differentiated TMS for hybrid enactment may be found, e.g. dominated by hierarchical levels or disciplines. Within the police, for example, law enforcement departments and criminal investigations departments do work together, but more often they work together with other departments within their own domain (i.e. public order and emergency response, law enforcement, or criminal investigations). It may be presumed they develop a broader or more fine-grained common knowledge-base with those partners with whom they collaborate more frequently. Likewise, multiple integrated TMS for hybrid enactment may be found for collections of groups with more or less frequent collaboration patterns. These TMS, which may be functionally nested, are indicated by the white-shaded boxes behind the four types of TMS (see Figure 5.2).

The learning processes that interlink the components of organizational TMS are represented by the arrows in Figure 5.2. The learning effects can be either direct or moderating and together form a complex organizational learning 'cycle'. Starting from the differentiated TMS for hybrid enactment, opportunities for combining capabilities are identified at management level (*cf.* Jansen *et al.* 2009), or any other group in which representatives of divers organizational units convene for current or future collaboration purposes. Thus, this differentiated TMS for hybrid enactment has a direct effect (i.e. initiating) on networked enactment. The temporary networked collaboration is influenced by direct effects stemming from the TMS that develop in support of the respective participating organizational units. These effects can both be complementary and conflicting. In case of the first, combinative capabilities are being developed. In case of the second, combinative capabilities are frustrated by conflicting knowledge patterns, which may originate from, and affect strategic, tactical, or operational levels of agency. During networked enactment lessons may be learned at any of the three levels of agency and used to strengthen the integrated TMS for hybrid enactment. In the second AR, these lessons were drawn by

organizing observants, shared debriefings, and shared reflection sessions. Both integrated and differentiated TMS for hybrid enactment moderate the relation between organizational units and the temporary collaborative actions in which they engage. These moderating effects may originate from and affect strategic, tactical, and operational levels of agency.

Of particular value for hybrid enactment and organizational learning are boundary objects, which are defined as artifacts that have meaning across practices and as such have the potential to improve coordination and synthesis across heterogeneous disciplines (Bechky 2003; Carlile 2004). Within the context of hybrid enactment the boundary objects that influence or represent aspects of the integrated TMS for hybrid enactment are likely the most important for hybrid enactment as they not only have a function across heterogeneous disciplines within a functional organizational unit, but across functional organizational units as well.

5.3 Research Results in Relation to Research Objectives

The theoretic objective of this research was to:

1) to develop organizational TMS theory as a lens to study how distributed knowledge resources may be involved in collaborations, which are temporary and geographically distributed, to head tasks that none of the participants can head (as easily) on its own, and

2) to identify which features of organizational TMS contribute to the robustness and resilience of these collaborations.

In Table 5.1, which is explained below, an overview is given of the contributions of the three empirical studies to the two research objectives.

The first study contributed to the first research objective (develop organizational TMS theory as a lens to study how distributed knowledge resources may be involved in collaborations, which are temporary and geographically distributed, to head tasks that none of the participants can head -as easily- on its own) by introducing the distinction of three knowledge resource ideal types that can be identified at organization level.

Study	Research Objective 1	Research Objective 2
1	Inclusion of three knowledge resource ideal types.	Increasing potential transactivity; Transforming knowledge resource types; Organizing differently.
2	Formal inclusion of different knowledge resource types in TMS theory (Fig. 5.1); Understanding overlap of TMS in terms of actors, artifacts, relationships, and type and content of informational transactions.	Strengthening ostensive aspects of organizational TMS; Use of artifacts to represent or influence the ostensive or performative aspects of organizational TMS; Locking-in (aspects of) critical TMS.
3	Subsystems of organizational TMS (Fig. 5.2); Distinguishing between levels of agency; Inclusion of Context as element in TMS building blocks, and State as dynamic characteristic of overall building blocks.	Strengthening differentiated TMS for hybrid enactment in order to find alternative collaborative solutions; Strengthening integrated TMS for hybrid enactment in order to increase mutual understanding and coordination; Organizational learning processes (direct and moderating effects among organizational TMS-subsystems); Identifying complementary and conflicting direct effects between TMS for functional enactment and TMS for networked enactment; Identification of exclusive links; Investing in affective-based trust; Increasing awareness of effects of stress.

Table 5.1: Contributions of empirical studies to research objectives

This extension to TMS theory yielded three insights that contribute to the second research objective of this dissertation (identify which features of

organizational TMS contribute to the robustness and resilience of these collaborations), i.e. increasing potential transactivity; transforming knowledge resource types; and introducing alternative modes of organizing.

The second study contributed to the first research objective by describing the formal role of different knowledge resource types in TMS (*cf.* Fig 5.1), and by identifying overlap of TMS in terms of actors, artifacts, relationships, and type and content of informational transactions. These extensions to TMS theory yielded three insights that contribute to the second research objective of this dissertation, i.e. organizational TMS may be strengthened through investing in the ostensive aspects of organizational TMS; by using artifacts to represent or influence the ostensive or performative aspects of organizational TMS; and by locking-in (aspects of) critical TMS.

The third study contributed to the first research objective by identifying four subsystems of organizational TMS (*cf.* Fig. 5.2), by distinguishing between distinct contributions per level of agency, and by the inclusion of Context as an element in TMS building blocks and State as dynamic characteristic of these building blocks. These extensions to TMS theory yielded four insights that contribute to the second research objective of this dissertation, i.e. strengthening differentiated TMS for hybrid enactment in order to find alternative collaborative solutions; strengthening integrated TMS for hybrid enactment in order to increase mutual understanding and coordination; organizational learning processes (direct and moderating effects among organizational TMS-subsystems); and the identifying complementary and conflicting direct effects between TMS for functional enactment and TMS for networked enactment.

In addition to these findings, the third study yielded three findings that overarch its research question but which nonetheless contribute to the second research objective, i.e. the identification of exclusive links (which should be avoided because they threaten the robustness of the team); the effect of (a lack of) affective-based trust (which should be avoided because it hampers explicit communication and fact checking); and the identification of two effects induced by stress (i.e. network horizon

regression effect and the level of agency regression effect). The effects related to trust and stress are shortly elaborated upon next.

On the effects of trust in TMS development

In TMS trust is usually studied in the form of cognitive-based trust (e.g. Kanawattanachai and Yoo 2007). This form of trust is also known as task credibility (Moreland and Myaskovsky 2000) and is being described in terms of source credibility and trustworthiness (Nevo and Wand 2005). The analysis of Operation Frisau revealed that next to cognitive-based trust, affective-based trust needs to be taken into consideration. The latter may be defined as the "expectations, assumptions, or beliefs about the likelihood that another's future actions will be beneficial, favorable, or at least not detrimental to one's interests" (Robinson 1996: 576). Although in Operation Frisau cognitive-based trust was high, affective-based trust was low. This was caused by unresolved conflicting principles with respect to information sharing.

On the effects of stress on TMS development

As has been found in other studies (e.g. Ellis 2006; Ellis and Pearsall 2011; Pearsall *et al.* 2009; Rau 2005), the analysis of Operation Frisau illustrates that stress has an important moderating effect on TMS development. Where Ellis (2006) found that stress reduces TMS related communication, in the Frisau case study two additional effects related to stress were found. First, it is well known that people under stress tend to redraw to their comfort zone, i.e. fall back on older learned routines (*cf.* Staw *et al.* 1981). In Operation Frisau this resulted in a 'network horizon regression effect', defined as a reduced awareness and perception of who is part of the team (*cf.* van Liere 2007). Second, an 'agency regression effect' was found, which was defined as the tendency of people under stress to decent one level of agency: strategic leaders start to concern themselves with tactics, and tactical leaders become operationally involved. The first effect may be corrected if tactical level agency remains organized, i.e. the capacity to create and recreate the structures and routines needed by the group. The empirical study presented in Chapter 4

suggests that if tactical level agency is not effective, the network disintegrates.

5.4 Implications for TMS Theory

The theoretical contributions made have several implications for theory, i.e. for group TMS, organizational TMS, organizational TMS development, and the development of organizational TMS assessment methods. In the following paragraphs each of these research themes is being addressed.

5.4.1 Implications for group TMS research

Based on the theoretical contributions described in section 5.2 and 5.3, in this paragraph a summary is given of aspects that should be accounted for in future (single) group TMS research.

TMS development may take place at strategic, tactical, and operational level. Although this notion is highly relevant when cross-team TMS are being developed, in which complementary and conflicting principles, or structures of routines may have to be unified, it is also relevant in TMS that develop in single groups. That is, it is important in the development phase of group TMS (*cf.* Littlepage *et al.* 2008), when the group may have to form, for example, its norms and values. It may also be important during the utilization phase (*cf.* Littlepage *et al.* 2008), when disruptions may require new principles, or when actors routinely switch operational task responsibilities among themselves. Hence, when a group TMS is being studied, its development and utilization should be qualified in terms of levels of agency.

In additional to Task-Expertise-People-combinations, Context should be addressed. Moreover, researchers should be aware that TCEP-combinations may be stable at e.g. strategic and tactical level, while they are dynamic at operational level, like was the case with the observation teams in the Frisau case (*cf.* Chapter 4). Hence, in case TCEP-combinations are dynamic during the execution of a task, TCEP-state should be addressed, too.

When artificial repositories for information storage and retrieval are being studied, their relation to TMS should be expressed in terms of influencing the ostensive aspects of TMS (see e.g. the study of Moreland and Myaskovsky 2000) or the performative aspects of TMS (e.g. Faraj and Sproull 2000); or in terms of representing the ostensive aspects of TMS (e.g. Nevo and Wand 2005), or the performative aspects of TMS (e.g. iFunnel technology used during Operation Vigilance).

Finally, TMS researchers should be aware of the effects on TMS of stress (i.e. network horizon regression and level of agency regression) and trust. With respect to the latter, in addition to cognitive-based trust, researchers should be aware of the influence of affective-based trust.

5.4.2 Implications for organizational TMS research

Current views on organizational TMS hold that they resemble the (hierarchical) structure of the organization (e.g. Anand *et al.* 1998; Nevo and Wand 2005; Wegner 1986), or that they are composed of a collection of overlapping ego-centered networks complemented with facilitative ICT (e.g. Jackson and Klobas 2008; Jarvenpaa and Majchrzak 2008). Using the perspective of organizational TMS as presented in Figure 5.3 these studies can be related to one another.

First, the work of Anand *et al.* (1998) and Nevo and Wand (2005) covers the collection of (functionally specialized) organizational units and the differentiated TMS for hybrid enactment. In their work, however, the latter is depicted as a higher hierarchical level in support of TMS at lower hierarchical levels and does not explain the function of these TMS at higher management level in relation to networked enactment. Second, the work of Jackson and Klobas (2008) emphasizes the ability of individuals in organizations to establish cross-unit contacts. As such their work concentrates on what I conceptualize as differentiated TMS for hybrid enactment, although they remain silent about the structural nature of these collaborations. Finally, the work of Jarvenpaa and Majchrzak (2008), which is focused on temporary (inter-) organizational networks, concentrates on what I conceptualize as temporary TMS for networked enactment.

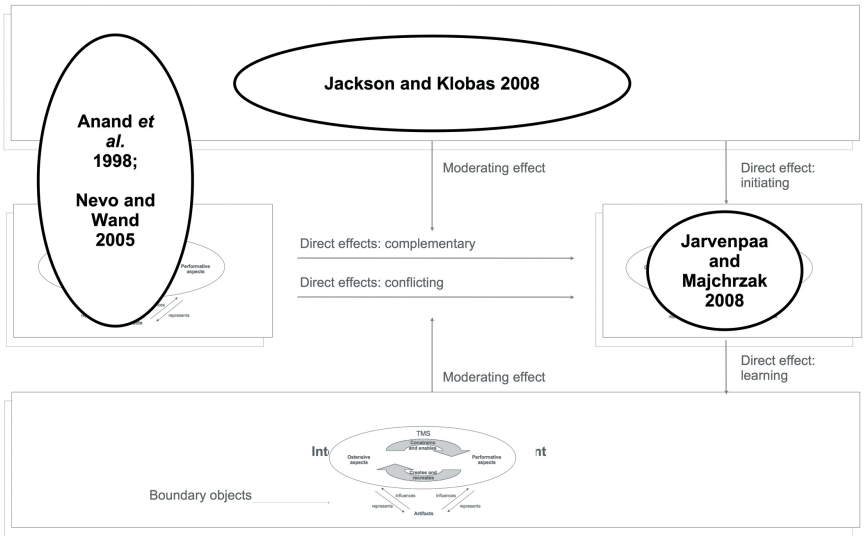

Figure 5.3: Positioning of extant organization-level TMS research

Thus, as depicted in Figure 5.3, existing TMS studies address different aspects of TMS in organizations that engage in temporary collaborations, but nonetheless, are related. It also shows that important areas of organizational TMS are not being covered, including the integrated TMS for hybrid enactment and the organizational learning processes among the TMS-subsystems in organizations. Hence, future TMS research at (inter) organization level should explicate which subsystems are being studied and how these are affected by other TMS through moderating and direct effects.

5.4.3 Organizational TMS development

The notion that TMS cannot be designed, but can be designed for (*cf.* Wenger 1998) exceeds the development of semi-structures to help understand how knowledge is disseminated, owned, and discussed in ego-centered networks (*cf.* Jarvenpaa and Majchrzak 2008). Although TMS are emergent, the interventions discussed in this dissertation illustrate Wegner's early notion that 'the structuring of an organization is clearly an exercise in structuring transactive memory' (1986: 204), and are

supported by the work of Gittell and Weiss (2004), who indicate that organizational design may be used to shape networks. Examples in this dissertation include organizing for transactivity among knowledge resources of the same type, transforming knowledge from one type of knowledge resource to another, and locking-in critical routines. Such organizational TMS development efforts should be aimed at providing for stable structures to enable future temporary and geographically distributed collaborations (*cf.* Moreland and Argote 2003; Powell *et al.* 2004) and, hence, are aimed at strategic (e.g. guiding principles) and tactical level (e.g. organizational structures and routines).

5.4.4 Organizational TMS assessment

In the TMS literature several methods have been developed to assess the state of TMS development (e.g. Kanawattanachai and Yoo 2007; Lewis 2003; Littlepage *et al.* 2008). All of them are defined at the team level of analysis (including dyads and triads). While all distinguish between a development phase and a utilization phase, they also acknowledge that the two are mutually constitutive, i.e. TMS develop through utilization while at the same time its utilization is limited by its state of development. With respect to measuring the TMS state of development, Brandon and Hollingshead (2004) hold that in its optimal state of development (called Convergence) a TMS reflects high levels of accuracy (degree to which perceptions about group members are accurate), sharedness (degree to which perceptions of group members are shared by all group members), and validity (degree to which group members actually make use of group members' expertise). To be able to assess TMS at organization level, at least three issues have to be addressed.

First, while existing team-TMS assessment methods predominantly focus on operational level constructs, i.e. related to individual knowledge or others, at organization level strategic and tactical level constructs may be more meaningful to assess organizational TMS, as these have to enable future collaborations. Such assessment may include assessing the presence and effectiveness of artifacts that are created to

influence or represent strategic and tactical ostensive or performative aspects of TMS (*cf.* Fig. 5.1).

Second, while existing team-TMS assessment methods may be used to assess organizational TMS-subsystems (i.e. functional and networked TMS, and integrated and differentiated TMS for hybrid enactment) (*cf.* Fig 5.2), they do lack constructs and methods to assess the interlinking learning processes which tie the TMS-subsystems into a functioning organizational TMS.

Third, supporting the work of Majchrzak *et al*. (2007), who studied TMS development among emergent response groups (thus, at inter-organizational level), the three empirical studies of this dissertation (at organization level) illustrate that for the execution of a complex task not all members do have to know each other equally well: although all contribute and none of these contributions can be missed, the contributions are complexly related, not linearly. To perform well, actors need to (get to) know the actors with whom they directly interact, but may not need to know as well actors further away in the network.

The consequence of these three observations is that at organization level the construct of convergence is of limited value. Hence, future research should be aimed at developing new constructs and assessment methods to assess the state of development of organizational TMS.

5.5 Implications for Related Theories

The extensions made in this dissertation to TMS theory draw attention to a number of theories. In the following paragraphs the relations between organizational TMS theory and these adjacent theories are being explained, which results in additional directions for future research.

5.5.1 Hybrid enactment versus ambidexterity

In the Frisau study, hybrid enactment has been defined as the capability of an organization to engage in temporary networked mode of operating, in addition to their regular functional mode of operating. Similarly, ambidextrous organizations are defined as organizations

capable of simultaneously engaging in both routine and non-routine tasks (Adler *et al.* 1999; Raish *et al*. 2009). Raish and Birkinshaw (2008) distinguish five types of routine versus non-routine tasks, i.e. modes of organizational learning (single vs double loop), technological innovation (incremental vs radical), organizational adaptation (stability vs transformation), strategic management (autonomous vs induced), and organizational design (efficiency vs effectivity). Each of these streams of research shares a tension between exploiting and exploring. To better understand the nature of ambidexterity it is useful to note that ambidexterity is a form of dynamic capabilities (*cf*. Jansen *et al.* 2009; O'Reilly Tushman 2008). The latter concept is defined as: 'The firm's processes that use resources [...] to match and even create market change. Dynamic capabilities thus are the organizational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve, and die' (Eisenhardt and Martin 2000: 1107). This definition elicits the distinction with hybrid enactment. In contrast to engaging in two modes of enactment to adapt to the changing environment of the organization, and thus, increase the lifespan of the organization, both modes of hybrid enactment (functional and networked) are aimed at solving here and now problems (or capitalize on opportunities). In addition, a hybrid organization may develop ambidextrous capabilities such as described by Raish and Birkinshaw (2008). Thus, hybrid enactment as presented in this dissertation represents a new theoretic perspective on ambidextrous modes of organizing, i.e. enabling an organization to switch (here and now) between modes of organizing to suit the problem or opportunities at hand. The consequence for theory is that ambidexterity should not only be approached from a dynamic capabilities perspective, but also from the perspective of the capability of organizations' to temporary combine its resources (i.e. combinative capabilities perspective) (*cf.* Bosch *et al.* 1999; Matthews and Cho 2001).

5.5.2 Structural holes: competitive advantage **and** *threat*

Structural-hole theory holds that connections between groups, if few in number, are a source of (competitive) value because these connections are able to control the flow of information between them (Burt 2005). Thus, the one occupying the privileged position of the structural-hole functions as information broker between the otherwise detached groups.

Analysis of the Frisau-case illustrates that structural holes not only represent opportunities to link independent sections of collaborative network. They also threaten the robustness of collaborating teams in case the success of the collaboration depends on such structure hole position. In the Frisau-case, for example, the position of the overall team leader was compromised while no one was able to reestablish contact with members of other collaborating teams without him.

The consequence for structural hole theory is that the function of structural holes should not only be studied from the perspective of opportunities to interlink disparate units and control the flow of information between them, but also from the perspective of threats due to potential disintegration of cross-team collaboration.

5.5.3 Patterns of actions versus patterns of actors: orchestration

Just as organizational TMS theory is enriched by organizational routines theory, organizational routines theory can learn from organizational TMS theory. Where the latter describes patterns of actors, the former describes patterns of action. Both are part and parcel of organizational tasks. Further integration of the two theories may help organizations to learn to switch not only between patterns of actions (i.e. alternative action repertoires) but to switch between actors capable of delivering these services as well. Such switching, known in the management literature as orchestration (*cf.* Busquets 2010; Rethemeyer and Hatmaker 2007; Sirmon *et al.* 2010), may contribute to the robustness and resilience of networked operations.

5.5.4 Organizational TMS as micro-foundation for KBT

In theoretical terms the strategic management perspective behind exploring and exploiting distributed knowledge resources for collaborative action is known as the resource based theory of the firm (RBT) (Barney 1991; Penrose 1959), or more specific, by its derivative, the knowledge-based theory of the firm (KBT) (Barney 2001; Spender and Grant 1996). The services that (knowledgeable) resources can provide are known as capabilities or competences (Sanchez and Heene 1997; Tsoukas 2000). Capabilities of an organization to integrate differentiated capabilities into (novel) services are known as combinative capabilities (Bosch *et al.* 1999; Matthews and Cho 2001). These combinations may result in new knowledge and new capabilities (McEvily and Zaheer 1999). Capabilities of an organization to adjust to its changing environment are known as dynamic capabilities (Wang and Ahmed 2007). Where KBT describe how the development of capabilities contributes to the strategic positioning of an organization, it remains salient about how resources, processes, and interactions among these resources and processes contribute to the development of capabilities (Foss 2011). That is, how do organizations develop specialized resources (differentiation) and prepare for the combination of these resources to deliver services (integration)?

To cater for this shortcoming, calls for micro-foundations for KBT are being made (Abell *et al.* 2008; Foss 2011). According to Felin *et al.* (2012) these micro-foundations should at least include three categories of micro-level components that underlay organizational capabilities, i.e. individuals, social processes, and structure. Although Kogut and Zander (1992: 398) note that a 'transaction is an insufficient vehicle by which to examine organizational capabilities, because these capabilities are a composite of individual knowledge and social knowledge', TMS theory covers both, as well as the three categories of micro-level components that underlay organizational capabilities. Thus, organizational TMS theory as being developed in this dissertation explains how distributed knowledge resources become organized at organization level, i.e. how capabilities of distributed knowledge resources may be combined to deliver valuable services, which is the core contention of KBT.

5.5.5 TMS and shared mental models

The literature on shared mental models (SMM) is still in its infancy (Mohammed and Dunville 2001) and how SMM relate to TMS is still in debate. In this section a contribution is made to this discussion by projecting SMM as content of more integrated TMS for functional enactment, or as content of the integrated TMS for hybrid enactment when the models are shared across organizational (unit) boundaries.

Ellis describes a mental model as a 'psychological map, or organized structure of knowledge', which across individuals may differ in accuracy and similarity (Ellis 2006: 577). Mental models that are similar across individuals are known by a variety of constructs, including social cognition (Larson and Christensen 1993), collective mind (Weick and Roberts 1993), shared mental models (Orasanu and Salas 1993), and team mental models (Klimoski and Mohammed 1994). These various concepts only differ in their description of what is being shared and what is held in common, and 'exist to the extent that they are apprehended by team members' (Klimoski and Mohammed 1994: 426). From this perspective, 'transactive memory is a team mental model about the distribution of knowledge in a group' (Austin 2003: 867), and as such represents a subcategory of team mental models (Peltokorpi 2008). The latter is in line with the work of Ellis (2006), who studied team interaction mental models. Ellis (2006) suggests that team interaction mental models and TM are conceptually and theoretically distinct yet complementary, and positively related: where transactive memory has a differentiating function, team interaction mental models have an integrative function, as they provide the necessary common perceptions and language to enable differentiation. This claim, however, is also made by TMS theory, as it gives explicit recognition to the fact that shared knowledge and differentiated knowledge are integral to TM (Huber and Lewis 2010; Wegner 1986). In fact, Wegner used the phrase 'integrated transactive memory' to represent those items of information that are held by all team members, while the team members 'are aware of the overlap as they do share label and location information as well' (Wegner 1986: 204) .

Based on the findings of this dissertation, two contributions to this discussion can be made. First, rather then conceptualizing TM as a subcategory of SMM (Peltokorpi 2008), or explaining the conceptual and theoretical distinction between the two in terms of their complementary function (integrative versus differentiating) (Ellis 2006), SMM should be put on par with integrated transactive memory. That is, SMM are a form of integrated memory, which through the three TMS processes of information allocation, updating, and access coordination, become transactive. As such, integrated transactive memory make communication more efficient (Carlson and Zmud 1999) as it increases the likelihood of comprehension (Cramton 2001), decreases the need for knowledge exchange (Grant 1996), and allows participants 'to formulate their contributions with an awareness of what their addressee does and does not know' (Krauss and Fussell 1990: 112). Through these functions it permits actors 'to share and integrate aspects of knowledge which are not common between them' (Grant 1996: 115). From the perspective of SMM, putting SMM and integrated transactive memory on par helps to explain the emergence of SMM.

Second, integrated transactive memory (and thus SMM) may be restricted to a group TMS, but may also be developed among groups, i.e. through the development of an integrated TMS for hybrid enactment (*cf.* Figure 5.2). The construct of an integrated TMS for hybrid enactment lifts the concept of SMM from team level (i.e. the traditional unit of analysis in SMM research) to organization level.

5.5.6 TMS development versus task- and team-familiarity

Within the contexts of team mental models (*cf.* previous paragraph), Espinosa *et al.* (2007) found that task-familiarity and team-familiarity are substitutive, but not complementary. These findings are highly relevant for TMS theory, as Task-Context-Expertise-Person (TCEP) combinations form the basic building blocks of TMS. The findings of Espinosa *et al.* (2007) suggest that TMS may be based on either knowledge of the task or knowledge of expertise-person distribution

in the group. This conclusion, however, is not entirely consistent with extant TMS research.

Studying the role of communication in TMS development, Kanawattanachai and Yoo (2007) found that during the initial and developing phase of TMS development, task-oriented communication has a positive impact on virtual team performance. In well-developed TMS, however, communication related to task-knowledge coordination does positively influence virtual team performance. Thus, where in the early phases of TMS development task-familiarity is being developed, in well-developed TMS the focus shifts to team-familiarity. This finding is in line with the three successive meta-knowledge learning methods identified by Wegner (1987), i.e. learning through stereotyping, perception and self-disclosure, and through gaining first-hand knowledge of actors' access to information, thus, gradually replacing task-familiarity with team-familiarity.

In the Frisau-case, team-familiarity was restricted to the members of the same team. Hence, collaboration with the other teams was based on task-familiarity, while the other teams were only known in terms of stereotypes and perceptions. As long as the operation continued in a routine fashion, task-familiarity was sufficient – confirming the findings of Espinosa *et al.* (2007). When the planned routine operation shifted to an unexpected non-routine operation, however, cross-team team-familiarity could not compensate for the lost task-familiarity, because the cross-team TMS (TMS for networked enactment) had not been developed that far. Thus, analysis of the Frisau-case suggests that the two types of familiarity may be complementary in situations in which one of the two collapses.

5.6 Implications for Practice

The findings of this dissertation have several managerial consequences. In the following paragraphs they have been categorized in interventions related to organizational design, and interventions related to system governance.

5.6.1 Organizational design

The main finding with consequences for practice concern the composite structure and functioning of organizational TMS, summarized in Figure 5.1 and 5.2, and the finding that organizational TMS are susceptible for interventions which should be aimed at strategic and tactical level. Four consequences for organizational design are being identified, i.e. related to potential switching capabilities, dissonance reduction, differentiated and integrated TMS for hybrid enactment, increasing potential transactivity among knowledge resources.

Potential switching capabilities

Hybrid enactment describes how an organization can switch dynamically between functional and networked enactment, depending on the problem situation at hand. When strategic level principles sufficiently overlap (i.e. are present in the integrated TMS for hybrid enactment), organizational units may be able to divide responsibilities, but work more or less separately (e.g. fire brigade and police: the former fights the fire, the latter secures the area). When in addition tactical level organizational structures and routines sufficiently overlap, tasks may be more integrated (e.g. surgeon and assistant: the former operates, the latter hands on the instruments). Both examples are compositional in effect: the joint efforts result in new capabilities (*cf.* Kozlowski and Klein 2000). If in addition operational level knowledge and skills overlap, compilational forms of collaboration are possible. One example is provided by the observation team (OT) studied in Chapter 4: tasks are dynamically switched among team members, depending on the position and behavior of the suspect being observed and e.g. the position of the various team members. Thus, overlap at various levels of agency determine the nature of the combinations that can be made between task, context, expertise, and persons.

As shown in Operation Vigilance and Operation Frisau temporary strategic and tactical level constructs may be added ex ante the operation, and even during the operation. Moreover, before a collaborative operation starts, Task-Context-Expertise-People (TCEP) combinations should be

checked on overlapping, complementary or conflicting TMS components in order to avoid vertical and horizontal dissonance.

Dissonance reduction

Knowing in practice within collaborative networks does not only concern operational and tactical cross-team sense making and understanding (e.g. Orlikowski 2002), but may also include the (conscious or unconscious) integration of strategic level governing principles. Strategic, tactical, and operational level TMS-constructs together form knowledge patterns, which emerge in support of patterns of action. During action, however, dissonance may occur among these levels of agency (Bacharach *et al.* 1996) (which I typified as vertical dissonance). In case of hybrid enactment it may be expected that enduring TMS for functional enactment are well established, and that consequently vertical dissonance in these teams is low. The patterns that developed, however, may need adjustment for networked enactment (i.e. temporary collaboration). This may induce dissonance within (vertical dissonance) and among the collaborating teams (horizontal dissonance). Hence, contrary to the perspective of organizational TMS as a collection of group TMS (Jackson and Klobas 2008), measures may be needed to solve conflicting strategic or tactical elements that may hinder effective collaboration. Organizational designers may facilitate dissonance reduction by developing meta-routines for integrating cross-team strategic and tactical TMS-elements.

Differentiated and integrated TMS for hybrid enactment

Hybrid enactment is served by a well-developed differentiated TMS for hybrid enactment and a well-developed integrated TMS for hybrid enactment (*cf.* Figure 5.2). Differentiated TMS for hybrid enactment may regularly develop during management (and specialist) meetings in which shared problems and opportunities are being discussed, and during collaborative actions in which capabilities of others can be experienced out of first hand. Its development may be stimulated by introducing boundary-crossing practices (e.g. paying field visits to

participating units or organizing opportunities to learn to know each other) (*cf.* Jansen *et al.* 2009, and Chapter 3). Integrated TMS for hybrid enactment are more costly, as they involve larger numbers of participants. Next to general selection criteria for new organizational members, such as educational background, the development of integrated TMS for hybrid enactment can be stimulated by e.g. creating shared explicit coordination mechanisms, such as task organization and team communication (*cf.* Espinosa *et al.* 2007). In addition, boundary objects such as the iFunnel (*cf.* Chapter 2 and 3) can be used to improve coordination and synthesis across heterogeneous disciplines (*cf.* Bechky 2003; Carlile 2004).

Increasing potential transactivity among knowledge resources

TMS develop through informational interactions (or transactions) related to the cognitive division of labor (Ellis 2006; Wegner 1986). Opportunities to engage in informational interactions, however, may be limited. As shown in Operation Frisau (*cf.* Chapter 4), alternative communication channels and means were sought to compensate the problem of exclusive link failure. Transactivity, however, does not only refer to informational interactions among people (personalized knowledge resources). In an organizational setting, transactivity may be increased among various types of knowledge resources. Transactivity among artifacts (e.g. iFunnel, Chapter 2 and 3) and people, for example, may be increased by providing access alternatives and formats. In this respect it should be noted that artifacts are not part of the organizational TMS, but may be used to influence or represent the ostensive or performative aspects of organizational TMS. People may choose to use it, but may equally well decide to use the artifacts in unintended ways, totally ignore it, or use alternative methods or means to achieve their goal. When needed, critical TMS processes may be locked-in, in fully automated routines, thus creating 'dead TMS'. These artifacts may serve as boundary object and as such may compensate for lost flexibility.

5.6.2 System governance

System governance exceeds interventions in the organizational design, which represent second order problem solving (Boonstra 2004; Kooiman 2008). In addition, system governance is concerned with first order (day to day problem solving) and third order problem solving (establishing the governing rules by which the system is governed) (Kooiman 2003, 2008). Kooiman stresses the socially constructed and ongoing nature of governance by defining the verb governing:

> *Governing can be considered as the totality of interactions, in which public as well as private actors participate, aimed at solving societal problems or creating societal opportunities, attending to the institutions as contexts for these governing interactions, and establishing a normative foundation for all those activities (Kooiman 2003: 4).*

Following this definition he continuous by saying that '[g]overnance can be seen as the totality of theoretical conceptions on governing' (Kooiman 2003: 4). Although Kooiman addresses governance at governmental level, it may also be applied at organization level. The establishment of a normative foundation represents strategic level agency, while the institutions that serve as contexts are represented by tactical level organizational structures and routines, are established through tactical level agency. Both levels of agency serve two purposes, i.e. providing a platform for 'solving societal problems or creating societal opportunities'. As these problems and opportunities are ongoing, so is system governance. In the following sections the types of interventions uncovered in this dissertation are being addressed. First interventions aimed at strengthening the ostensive aspects of organizational TMS are being discussed, followed by interventions aimed at strengthening the performative aspects of organizational TMS.

5.6.3 Governing the ostensive aspects of organizational TMS

In the following paragraphs five findings are discussed with respect to the strengthening of the ostensive aspects of organizational TMS (which in turn enable and constrain the performative aspects of organizational TMS).

First, like was done in Operation Vigilance (Chapter 3) the ostensive aspects of organizational TMS may be strengthened by creating opportunities to practice (*cf.* Moreland *et al.* 1998), which may be complemented with priming, defined as providing network actors with a description of the capabilities of others in the network (Moreland and Myaskovsky 2000). Temporary networked operations, too, contribute to the development of organizational TMS, one, because individual members develop their personal meta-knowledge of 'who knows what', and two, because both differentiated and integrated TMS for hybrid enactment are being developed, which moderate the success of assembling future temporary collaborations.

Second, where Espinosa *et al.* (2007) found that team-familiarity and task-familiarity are substitutive in their effect on team performance, but not complementary, the analysis of Operation Frisau revealed that in situations in which one of the two shared mental models collapses, the other could compensate and thus, could be complementary. The implication for practice is that collaborative networks may be strengthened by investing in both team-familiarity and task-familiarity related to interdependent tasks.

Third, in addition to cognitive-based trust, affective-based trust (used to represent what Robinson (1996) describes as “expectations, assumptions, or beliefs about the likelihood that another’s future actions will be beneficial, favorable, or at least not detrimental to one’s interests”) is an important moderator influencing team success. In a hierarchical command-driven environment, such as the police, fire-brigades, or the army, this may seem trifling, but these professionals regularly engage in high-risk assignments. Supported by the work of Rosen *et al.* (2007), who found that lack of trust is one of the main barriers for distributed team

success, organizations engaging in hybrid enactment should pro-actively invest in both cognitive-based trust and affective-based trust.

Fourth, based on the research findings of the third empirical study I hypothesize that awareness about the nature and dynamics of virtual team settings and temporary collaborative action will strengthen the ostensive aspects of the organizational TMS, and thus collective performance. In particular awareness should be increased about:

1. differences in strategic, tactical, and operational level knowledge patterns associated with functional enactment (representing their comfort zone) and networked enactment (representing a potentially fragile zone of potentiality);
2. contextual strategic and tactical realities of the teams involved;
3. potential sources of dissonance (within and among the participating teams) and instructions how to handle them;
4. the network horizon regression effect, when under stress; and
5. the level of agency regression effect, when under stress.

Finally, as shown in Figure 5.1, the ostensive aspects of organizational TMS may be influenced through the design of artifacts. Especially in the case of hybrid enactment boundary objects may be used to increase familiarity of tools or methods used in networked operations.

5.6.4 Governing the performative aspects of organizational TMS

Like the ostensive aspects of organizational TMS, the performative aspects may be influenced through the design of artifacts (after which the performative aspects in turn create and recreate the ostensive aspects of organizational TMS). Based on the empirical data collected in this dissertation I discuss three examples. The first artifact that was developed to influence the performative aspects of the organizational TMS was the iFunnel (*cf.* Chapter 2 and 3). In fact, part of the TMS system and the substantive knowledge required to identify drug traffickers on highways was fully automated. This division of labor (process of allocating), complemented with automated processes of

accessing other data sources (e.g. RDW) and updating people (through screen messages and SMS) to direct interception, did have a significant effect on collective performance. The second artifact concerned an explicated method, ILP+, which was used to structure the process from explicating implicit knowledge to indicators which could be shared with officers along the road and of which some could be processed by tools such as the iFunnel. Finally, in the AR reported in Chapter 3 a method was developed to analyze formal and informal relational networks (Figure 3.3). These diagrams may be used to identify risky exclusive links and alternative patterns of actors ex ante the collaborative operation, and thus influence the course of action.

5.7 Limitations

Several limitations of the dissertation may provide opportunities for future research. They can be divided in limitations related to the applied research methods, and limitation related to research context.

5.7.1 Limitations related to the applied research methods

In this section I discuss two limitations related to the applied research method. First, there is the known limitation of generalizability in qualitative research. Each of the three empirical studies was aimed at understanding a problem situation and draw theoretic and managerial lessons from it – not to study the full range of variety of such problem situations. Hence, although some of the findings of this dissertation may be generalizable, more research is needed to broaden the base of empirical evidence. Second, in absence of organizational TMS assessment methods, organizational TMS in this dissertation is being assessed based on observations related to task-interdependence and performance, and in the third empirical study based on TEP-combinations and context (TCEP) and TCEP-state at the various levels of agency. More research should be conducted to develop an organizational TMS assessment method which includes not only the ostensive and performative aspects of the organizational TMS and its subsystems, but also the artifacts that are in

use to influence or represent the related ostensive and performative aspects.

5.7.2 Limitations related to the research context

All three studies were explorative in nature and conducted within one organization. And although project initiatives and operations studied in this dissertation are quite representative for project initiatives and operations within the KLPD, variety is certainly much higher. This variety includes three aspects, i.e. types of knowledge resources, organizational context, and types of interventions to strengthen the organizational TMS. First, in this dissertation circa 10 types of teams and organizational subunits have been studied, a limited number of structures and routines, and among other IS, one system which has been developed to process complex geographically distributed events (iFunnel). The KLPD, however, is home to over a 100 different types of expertise, while within the field of public safety and security, work is often executed in collaborative networks that encompass an extensive range of public and private partners. Likewise, 100s of information systems and registers, structures and routines are being used, which in one way or another play a role in the 'information ecology' of the organization (*cf.* Davenport and Prusak 1997; Jones *et al.* 2005). Hence, variation in knowledge patterns covered by organizational TMS is many times higher than studied in this dissertation. Studying these diverse patterns is a promising area for better understanding the functioning of organizational TMS, and for identifying opportunities to strengthen them. Second, more research is needed to study organizational TMS in different contexts. Examples within the police included crisis response situations or large scale public order events. Examples of different partners include other types of specialist teams, organizational units such as collaborative control and command centers, and external partners. Finally, within this dissertations interventions are being discussed as taken – not as a range of potentially effective interventions. Hence, the range of alternative interventions is many times larger then has been studied.

5.8 Future Research Directions

Besides future research directions stemming from the limitations of this dissertation, five leads have been identified that are discussed below.

5.8.1 Archetypes of interdependence

With the inclusion of levels of agency, the concept of TMS structure has been refined. For example, while TMS may be more integrated at strategic and tactical level, a TMS may be more differentiated at operational level, meaning that allocation of roles may be more flexible. Using these two characteristics (TCEP-state and TMS structure (differentiated vs integrated)), archetypes of interdependence within teams may be identified (see Table 5.2). These are explained next.

Static TCEP-state: all roles are fixed	**Homogeneous teams** everyone knows and does the same. E.g. ME peloton	**Predictable interdependence teams** everyone is specialized and knows how their work relates to that of others. E.g. Operation Frisau
Dynamic TCEP-state: all roles are flexible	**High redundancy teams** everyone knows the same but attends different aspects of the shared task. E.g. Observation teams	**Unpredictable interdependence teams** everyone brings in expertise, but does not know how this relates to that of others. E.g. improvisation, major crisis
	←More integrated TMS	More differentiated TMS→

Table 5.2: Archetypes of interdependence within teams

First, teams with a more integrated TMS (left column of Table 5.2) are characterized by overlap in knowledge. In high redundancy teams, such as observation teams studied in Chapter 4, the integrated TMS at strategic and tactical level enables the team to dynamically rotate tasks

at operational level. Homogeneous teams, such as ME pelotons, are characterized by similarity of all three levels of agency. The integrated nature of the supporting TMS of high redundancy teams and homogeneous teams enables them to scale the size of the operation/team with the (evolving) task at hand. Teams with a more differentiated TMS may start from the situation in which interdependence is known (i.e. predictable interdependence teams), while the team is challenged to maintain coherent (which failed during Operation Frisau). They may also start from a situation in which interdependence is unpredictable (unpredictable interdependence teams), thus challenging the team to make sense of their interdependencies (as was the case in Operation Vigilance).

Based on these exemplars, I hypothesize that different principles (strategic level agency) and coordination mechanisms (tactical level agency) may be used to enable and sustain collaboration within these different types of teams. These may include, but are not limited, to mechanisms used to reduce vertical and horizontal dissonance. For example, the national forensic investigations team (LTFO)[8] consists of a small permanent team of circa 5 officers, which may be complemented with members of regional forensic investigations teams in case of larger, or multiple crisis situations (i.e. a high redundancy team). To prepare for collaborative action bi-annual collective trainings are organized, while tactical level structures and routines of the LTFO overrule the tactical level structures and routines of the regional teams. These overruling structures and routines are explicitly communicated during these trainings, and ex-ante every actual operation. Future research should uncover what kind of other synchronizing and coordinating mechanisms in these inter-organizational TMS are being used, or may be used to strengthen temporary distributed collaborations.

5.8.2 Gaps in organizational TMS literature

The positioning of TMS studies in relation to organizational TMS as depicted in Figure 5.3 brings to light areas of research which have not

[8] Source: interview teamleader LTFO

been addressed yet. This includes the initiating effects between differentiated TMS for hybrid enactment and TMS for networked enactment, the direct effects between TMS for functional versus TMS for networked enactment, and the moderating effects of differentiated and integrated TMS for hybrid enactment on the forming and functioning of temporary collaborations. Moreover, it brings to mind questions about TMS processes at organization level. Apparently functional differentiation exists between different types of TMS within organizations (i.e. TMS for functional enactment, for networked enactment, and differentiated and integrated TMS for hybrid enactment). More research is needed to understand how the processes of information allocation, updating, and access coordination at organization level differ from those at lower levels of analysis. These questions, together with the model of organizational TMS as developed in this dissertation (Figure 5.2), represent angles to study how multi-activity tasks affect organizational TMS, which coincides calls for research made by Lewis and Herndon (2011).

5.8.3 Organizational TMS and learning

Second, and in addition to the first, when approached from a TMS learning perspective, the implied sequential relation between the TMS learning methods identified by Wegner and his colleagues (1991) may have to be reexamined. Wegner *et al.* (1991) identify three progressively sophisticated learning methods through which distributed expertise becomes known. People gain almost instant knowledge about someones capabilities through stereotyping, such as inferences from roles, uniforms, posture, age, or sexe (Hollingshead and Fraidin 2003). Perceptions are further developed by self-disclosure of traits, skills, past activities, preferences, and emotions. In the third method knowledge about the actor's access to information includes facts, like knowing who accessed a source and who has accessed it for the longest period of time or most recently. One question that the interpretive case study of operation Frisau raises, is whether these learning methods are necessarily sequential. Where in enduring functional teams this may be the case, in Operation Frisau the teams at the tactical level worked together based on role-

perceptions, while at the operational level it was clear to everyone who had access to which information. To better understand how TMS for networked enactment can be strengthened effectively, without requiring high investments associated with the most sophisticated learning method, more research is needed. This could support the allocation of organizations' knowledge investments.

5.8.4 Taxonomy for organizational TMS development

Third, where this dissertation furthered our understanding of how the various types of knowledge resources are related to organizational TMS, more research is needed to better understand how within various contexts various types of knowledge resources can be used to strengthen organizational TMS (e.g. by transforming personalized knowledge to encoded knowledge) (*cf.* Chapter 2). During the course of this dissertation I made a first attempt to develop a taxonomy for organizational TMS development (see Appendix 2). Research is needed, however, to study the relevance of this taxonomy for organizational TMS development.

5.8.5 Organizational TMS in relation to divergent epistemologies

Fourth, in a paper about knowledge-based policing (Schakel *et al.* 2012), in which the iFunnel (*cf.* Chapter 2 and 3) is being discussed from a juridical and ethical perspective, the problem of divergent epistemological perspectives between officers in the field (predominant interpretive-constructivist perspective) and information analysts at the office (predominant positivist perspective) is being addressed. It is concluded by Schakel *et al.* (2012) that these different epistemological perspectives hinder the integration of distributed knowledge resources. Following this observation the integration of knowledge resources which are founded on divergent epistemological perspectives forms an interesting area of research with respect to the coherent functioning of organizational TMS.

5.8.6 System governance

Finally, the introduction of levels of agency draws attention to system governance. System governance is generally aimed at two aspects, i.e. performance and control (Weill and Ross 2004). In this dissertation the focus was on increasing performance, while control was used in the sense of increasing operational robustness and resilience. The interventions discussed in this dissertation show that organizational TMS are in principle governable (*cf.* Kooiman 2008). Following Kooiman (2008), this involves three elements, i.e.: organizational TMS may be viewed a system-to-be-governed for which an organization may develop a governance system, while the two are interrelated through governing interactions. While Figure 5.1 and 5.2 present the elements of the system-to-be-governed, future research attention should be given to outlining the contours of a governance system and the types of governing interactions that can be applied to improve the system's performance and control, i.e. guide the exploration and exploitation of distributed organizational knowledge resources in collaborative action.

APPENDIX 1. TMS ANTECEDENTS, MODERATORS, AND EFFECTS

Although findings of one unit of analysis may not be applicable to other units of analysis, many insights of TMS studies at dyad, tryad, and team level have been referred to in the three empirical research projects of this dissertation. At the same time, an extensive overview of these details has not been included in the introductory chapter (Chapter 1), as it would distract the reader too much from the core interest of this dissertation, which is at the organization level. Hence, these details are provided in this appendix. The appendix is structured as follows:

Section 1: Emergent characteristics of TMS

Section 2: Higher order contextual features and effects

Emergent Characteristics

In Table 1 an overview is presented of emergent characteristics that have been identified in the literature. In the following text each row is being discussed.

As Hollingshead (1998) noted, a TMS will only develop if actors perceive cognitive interdependence with others. This characteristic, which may change in time, may be expressed by the level of specialization found in the network (Moreland and Myaskovsky 2000). Whether the TMS is effective depends on the level of task credibility and task coordination (Moreland and Myaskovsky 2000). Using slightly adjusted constructs, Kanawattanachai and Yoo (2007) who studied TMS in virtual teams, found that expertise location and task cognition-based trust (task credibility) both increase task-knowledge coordination.

Distinguishing between initial, developing, and well developed TMS, Kanawattanachai and Yoo (2007) found that in the first two phases task-oriented communication has a positive impact on virtual team performance. In well-developed TMS task-knowledge coordination, defined as “the team’s ability to develop overlapping mental representations of how the task can be divided and the relationships

between subtasks and team members" (Kanawattanachai and Yoo 2007:786), does positively influence virtual team performance.

Emergent characteristic	Definition	Reference
Specialization Expertise location	the level of memory differentiation within a team,or, differently formulated; the extent to which team members know who on the team knows what	Moreland and Myaskovsky '00; Lewis '03; Kanawattanachai and Yoo '07
Task credibility; Cognition-based trust	team members' beliefs about the reliability of other members' knowledge and their ability to carry out the task	Moreland and Myaskovsky '00 Kanawattanachai and Yoo '07
Task coordination; Task-knowledge coordination	the ability of team members to work together efficiently; the team's ability to develop overlapping mental representations of how the task can be divided and the relationships between subtasks and team members	Moreland and Myaskovsky '00; Kanawattanachai and Yoo '07
Accuracy	the degree to which group members' perceptions about others' task-related expertise are accurate	Brandon and Hollingshead '04
Sharedness	the degree to which members have a shared representation of the TMS	Brandon and Hollingshead '04
Validation	the degree to which group members participate in the TMS	Brandon and Hollingshead '04

Table 1: Emergent characteristics of TMS in the literature

Depicting the development of a TMS on a continuum ranging from highly divergent to highly convergent, convergence is the optimal state of TMS development, reflecting high levels of accuracy (degree to which perceptions about group members are accurate), sharedness (degree to which perceptions of group members are shared by all group members), and validity (degree to which group members actually make use of group members' expertise) (Brandon and Hollingshead 2004).

Emergent social phenomena are highly complex and influenced by contextual factors at higher societal levels (Klein and Kozlowski 2000). Following one of the principles of Klein and Kozlowski for studying multi-level phenomena, 'the relevant contextual features and effects from higher order levels should be incorporated into the theoretical models', as they do have 'either direct or moderating effects on lower-level processes and outcomes' (Klein and Kozlowski 2000:15).

Introduction to Higher Order Contextual Features and Effects

In this section an overview is given of higher order contextual features that have been identified in the literature. To this end I extend the work of Ren and Argote (2011) and Lewis and Herndon (2011), who both conducted an extensive TMS literature review. Following the work of Ren and Argote (2011) a distinction is made between antecedents (table 2) and moderators (table 3). Antecedents are factors that condition the development of TMS. Moderating factors condition its outcome and performance.

Ren and Argote (2011) identify three types of antecedents, i.e. antecedents related to individual members (who participate in the team), related to the team, or related to the organization. Building on this classification I add three classes. First, following Brandon and Hollingshead (2004), who stipulated the importance to identify task as a factor next to people and expertise, I include a class of contextual features related to task. Second, I include a miscellaneous class for features not specifically related to one of the former categories. And third, as the level of TMS development is the only contextual feature that is recursively related to TMS development, I include this TMS characteristic as a special class.

TMS Antecedents and Effects

In Table 2 an overview is presented of emergent characteristics that have been identified in the literature. In the following text each row is being discussed.

Contextual feature type	Contextual features	Effects	References
Individual member characteristics	Surface, or diffuse cues (e.g. gender, age, ethnicity) and specific cues (e.g. experience, certificates)	Both are related to perceived experience. Only specific cues have intra-group influence	Bunderson and Sutcliff 2003; Wegner *et al.* 1991
	Critical team member dispositional assertiveness	positively affect team performance and satisfaction. Both effects are mediated by TMS.	Pearsall and Ellis 2006
	With increasing expertise mental representations become increasingly abstract and decreasingly reliant on superficial features of a task	This procedural knowledge allows individuals to recognize structural similarities across tasks that are different in content or context	Lewis *et al.* 2005
Task characteristics	Cognitive interdependence	Most critical prerequisite for TMS development.	Brandon and Hollingshead 2004; Wegner *et al.* 1985
	Task and goal interdependence	Both positively affect team performance. Both effects are mediated by TMS	Zhang *et al.* 2007
Team characteristics	Virtuality expressed in distances in terms of space, time, organizational boundaries, and culture; Use of technology mediated communication	May hinder ability to communicate cues and coordinate actions; lack of mutual knowledge; may be larger and more divers, and have less opportunity to train together	Bell and Kozlowski 2002; Bjorn and Ngwenyama 2008; Cramton 2001; Griffith and Neale 2001
	Group training	Members of groups with highly developed TMS declare domains of	Moreland *et al.* 1996; Ren and Argote 2011; Rulke

Contextual feature type	Contextual features	Effects	References
		expertise during earlier periods of group interaction, while the frequency with which members evaluated others' expertise and competence increases over time; TMS mediates the relationship between training and performance;	and Rau 2000;
	Team member familiarity; group experience	Team member familiarity related to task may or may not result in higher expert recognition and utilization (if not related to task it does not). Ren and Argote (2011) speculate that the effect may depend on whether TMS processes are affected as well.	Akgün *et al.* 2005; Jackson and Moreland 2009; Littlepage *et al.* 1997; Michinov and Michinov 2009; Rulke and Rau 2000;
	Task experiences	Direct task experience leads to higher creativity then indirect task experience. The effect is mediated by TMS; Task experience leads to higher ability;	Gino *et al.* 2010; Littlepage *et al.* 1997
	Communication	Volume and frequency are both positively related to TMS development	Jackson and Moreland 2009, Kanawattanachai and Yoo 2007, Lewis 2004, Peltokorpi and

Contextual feature type	Contextual features	Effects	References
			Manka 2008
		ICT mediated communication can be detrimental to TMS development if not accompanied with frequent face-to-face communication	Lewis 2004
Organizational characteristics	Goal interdependence (mixed motives);	need to share or withhold information	Jarvenpaa and Majchrzak 2008; Zhang *et al.* 2007
	Reward interdependence	shared rewards lead to improvements in information allocation and reductions in social loafing	Pearsall and Ellis 2010
	ineffectiveness of ICT, lack of common ground, and breakdowns in information flow	Less effective coordination	Reddy *et al.* 2009
Miscellaneous characteristics	Acute stress due to time pressure or danger	reduced TMS related communication	Ellis 2006
	Stress due to challenge or hindrance	challenge stressors positively affect team performance and transactive memory, while hindrance stressors affect them negatively. In combination they lead to the lowest levels of performance and TMS	Pearsall *et al.* 2009
TMS development level	Level of convergence, specialization,	Different stages require different forms and accents of	Brandon and Hollingshead 2004; Littlepage *et al.*

Contextual feature type	Contextual features	Effects	References
	cognitive-based trust, and task-knowledge coordination	communication	2008; Kanawattanachai and Yoo 2007
	Imposed knowledge structure	In integrative knowledge structure knowledge overlap is larger than in differentiated knowledge structures; Explicit encoding schemes may negatively infer with existing implicit encoding schemes	Ren and Argote 2011; Wegner 1986

Table 2: TMS antecedents and effects in the literature

Antecedents related to individual member characteristics.

Wegner *et al.* (1991) identify three learning methods through which distributed expertise may become known, i.e. through stereotyping, perception and self-disclosure, and through knowledge of actors' access to information. In their work they describe how people gain almost instant knowledge about someone's capabilities through stereotyping, such as inferences from uniforms, posture, age, or sexe (Hollingshead and Fraidin 2003). Perceptions are further developed by self-disclosure of traits, skills, past activities, preferences, and emotions. The final method, knowledge about the actor's access to information, includes facts like knowing who accessed the source, accessed it the longest time, or most recently. This type of knowledge is then used to infer which actor may have more, or more recent knowledge then oneself (Wegner *et al.* 1991). Where stereotyping is based on what Bunderson (2003) calls 'diffuse cues', perception and self-disclosure, and knowledge of actors' access to information rely more on specific cues, such as experience and certificates.

One of the personality characteristics that does positively influence the development of TMS, and thus performance, is critical team member dispositional assertiveness (Pearsall and Ellis 2006). Critical team members are those with access to information that is vital for task completion (Brass 1984). It is perceived that dispositional assertiveness of critical members aids to team performance, as these persons 'tend to be decisive, outspoken, forceful, and direct (Deluga 1988) and share ideas and information in a clear, confident manner (Hayes 1991).

Lewis *et al.* (2005) found that with specialization, individual representations of tasks become increasingly abstract and procedural (rather than declarative) in nature. This allows experts to recognize the structural qualities of tasks and contexts that are similar to the ones they have experience with. Thus, TMS developed within one context may positively impact TMS development in other (task) settings.

Antecedents related to task characteristics

One of the most critical prerequisites of TMS development is cognitive interdependence for completing a shared task (Hollingshead 1998; Wegner *et al.* 1985). Other researchers have examined the related concepts of task and goal interdependence (Zhang *et al.* 2007) and found that these, too, positively contribute to TMS development, and thus team performance.

Antecedents related to team characteristics

One important contextual feature influencing TMS development is the degree of virtualness, which may be defined as the degree of distribution of group members in time or space (Griffith and Neale 2001). To overcome these distances teams rely on technologically mediated forms of communication to coordinate their activities (Bell and Kozlowski 2002; Cordery and Soo 2008). Thus, virtual teams are defined as 'groups of geographically and/or organizationally distributed participants who collaborate towards a shared goal using a combination of information and communication technologies (ICT) to accomplish a task' (Bjorn and Ngwenyama 2008:2). Technologically mediated forms of communication

may impede communication cues (intonation and paralanguage), and visual cues, such as style of dress, gender, age, and behavior (Griffith and Neale 2001; Hollingshead 1998). Moreover, geographically distributed teams may experience a lack of mutual knowledge, which may render information retrieval coordination problematic (Cramton 2001). Other reasons why virtual teams may experience more difficulty to coordinate knowledge include the facts that they are often more diverse in nature, may be larger in size, making it more difficult to know who knows what, and there may be less opportunity to train together (Griffith and Neale 2001). Alavi and Tiwani (2002) and others (e.g. Griffith *et al.* 2003) assert that these difficulties may be mitigated by technology or organizational systems that support the development of TMS. Concrete examples include the fostering of a psychological safe communication climate (Cordery and Soo 2008); the use of 'yellow pages' and searchable repositories, such as bulletin boards where actors can pose and answer questions; and the construction of feed back mechanisms (Alavi and Tiwana 2002). Moreover, Moreland *et al.* (1998) found that training together aids tackling the problem of fleeting membership in virtual teams, which is found to be as effective as priming, defined as providing actors in the network with a description of the capabilities of new actors (Moreland and Myaskovsky 2000). Other measures include the standardization of templates and methodologies across the network and the use of rich communication media, such as teleconferencing, complemented with occasional face-to-face contact (Oshri *et al.* 2008). The latter two are especially useful for moderating the difficulties in integrating information in virtual teams, by allowing actors to 'develop a shared understanding of the task goals and the current state of accomplishment', and which provide them with opportunities to organize monitoring, feed back, and evaluation (Curşeu *et al.* 2007:645).

Training may help to increase team performance through developing its TMS (Liang *et al.* 1995; Moreland *et al.* 1996). This is due to the fact that members of groups with highly developed TMS declare domains of knowledge in earlier periods of interaction then groups with less developed TMS, while the frequency with which members evaluate

other's expertise and competence increases over time (Ren and Argote 2011; Rulke and Rau 2000).

Research findings with respect to the effect of team familiarity are mixed. In their analysis of TMS literature Ren and Argote speculate that familiarity may only have a positive influence on TMS development if TMS processes are affected as well (Ren and Argote 2011). Experience with the task, however, always has a positive effect on TMS development (Littlepage *et al.* 1997), and direct experience more so than indirect (through the experience of others) (Gino *et al.* 2010).

Frequency and volume of communication are positively related to TMS development (Lewis 2004; Peltokorpi and Manka 2008), as it provides members with the opportunity to demonstrate what they know and to learn to know what others know (Jackson and Moreland 2009). Moreover, communication is important in the early phases of TMS development when it is task oriented, and in mature TMS when it is oriented at task-knowledge coordination (Kanawattanachai and Yoo 2007). Frequent face-to-face communication is important in the initial TMS development phase, as well as for TMS to become more mature (Lewis 2004). ICT mediated communication did not influence TMS development during the initial TMS development phase, but it was found to be detrimental for TMS maturing if not accompanied with frequent face-to-face communication (Lewis 2004). Jackson and Moreland (2009) nuanced this finding. They found that face-to-face communication was particularly important in the early phases of TMS development, but less so in the later development phases. In contrast with these studies, Kanawattanachai and Yoo (2007) found that TMS may develop in virtual teams that solely rely on ICT mediated communication. The difference between these two findings may be explained by the differences in study context (Ren and Argote 2011). Where students involved in the first study had the opportunity to meet face-to-face, the students involved in the study of Kanawattanachai and Yoo could not.

Where Lewis *et al.* (2005) found that individual specialization facilitates knowledge transfer to new TMS settings, the ordering of individual contributions to organizational tasks in organizational routines

serves a similar purpose. That is, TMS developed in relation to one routine may aid the development of TMS in other settings, as long as the individual expert domains are recognized across task domains.

Antecedents related to organizational context

People work together in all kinds of organizational contexts, ranging from stable business units to temporal projects, and from startups to aged organizations. Such characteristics condition TMS development. Hence, in empirical studies these conditioning factors may be found as control variables (e.g. Jarvenpaa and Majchrzak 2008) or archetypes (e.g Fiol and O'Connor 2005). In cooperation between (non) profit organizations, or organizations with convergent yet different motives, for example, the need to share information is balanced with the need to withhold information, because it may cause harm, or because its possession or access is restricted by law (Jarvenpaa and Majchrzak 2008). As a consequence, (informal) TMS structure is likely to reflect (formal) organizational structure (Wegner 1986).

Pearsall and Ellis (2010) studied the impact of reward interdependence on TMS development. Where individual reward systems may reduce individual information sharing (Johnson *et al.* 2006), shared reward systems reduce personal accountability (Karau and Williams 1993). Pearsall and Ellis found that hybrid reward systems outperformed individual and shared reward systems, by minimizing the risks of reduced information allocation (individual) and social loafing (shared reward systems).

Reddy *et al.* (2009), who studied coordination among teams in crisis situations, found that coordination is negatively affected by the ineffectiveness of information and communication technologies, the lack of common ground, and breakdowns in information flow.

Miscellaneous antecedents

Psychological stress may be related to personal factors, team factors, organizational factors, or environmental or other external factors. Psychological stress related to job-demand and control is often additive

(and sometimes quadratic) (Häusser *et al.* 2010). Teams under stress, caused for example by time pressure of danger, tend to become more cohesive (Drabek and McEntire 2003), but also more closed, as the cost of coordinating new actors may be higher than their potential contribution (Moynihan 2009; Provan and Kenis 2008). In his study about the vulnerability of transient teams during crisis, Weick (1990; 1993) found that stress may result in several tendencies, which together may result in a functional breakdown of the team. That is, actors tend to regress to simpler mental models, become more self-centered, centralize command, and ignore data, which is not consistent with the conditions as perceived. Ellis (2006), who studied the relation between acute stress and the role of TMS and mental models, found that acute stress affects the levels of communication, especially those related to the processes of directory updating, information allocation, and retrieval coordination, thus disrupting transactive memory. The literature proposes several measures to mitigate the problems related to stress in transient teams, all aimed at increasing control. Measures include: previous working relationships (Moynihan 2009); cross-functional training (Ellis 2006); the development of shared mental models; the stimulation of active communication aimed at sense making; the cultivation of interpersonal skills and norms of trust and openness about stress and doubt; the over-learning of newly required skills (to reduce the likelihood of regression); by increasing the awareness of the conditions under which actors are vulnerable for false hypotheses (i.e. when they expect, want, or finish something, or when they are preoccupied); the generous distribution of discretion (Weick 1990); and the restructuring of teams towards more divisional structures (broad and independent) rather than functional structures (narrow and specialized) (Hollenbeck *et al.* 2002).

Antecedents related to TMS development level

With respect to stage of TMS development, Wegner *et al.* (1991) identify three progressively sophisticated learning methods through which distributed expertise may become known, i.e. through stereotyping, perception and self-disclosure, and through actual knowledge of actors'

access to information. In their work they describe how people gain almost instant knowledge about someones capabilities through stereotyping, such as inferences from uniforms, posture, age, or sexe (Hollingshead and Fraidin 2003). Perceptions are further developed by self-disclosure of traits, skills, past activities, preferences, and emotions. The final method, knowledge about the actor's access to information, includes facts like knowing who accessed the source, accessed it the longest time, or most recently. This type of knowledge is then used to infer which actor may have more, or more recent knowledge then oneself (Wegner *et al.* 1991). These increasingly sophisticated learning methods suggest that TMS mature in an iterative manner. Within these cycles Brandon and Hollingshead (2004) identify three returning phases, i.e, construction, evaluation, and utilization. Through these phases useful links among task (T), expertise (E), and persons (P) emerge. During the iterations TEP-combinations are being ordered in useful hierarchies of nested knowledge domains that structure the TMS (Brandon and Hollingshead 2004:638). Kanawattanachai and Yoo (2007), who studied TMS development in MBA-student project teams, distinguish between before midpoint (of early phase), midpoint, and after midpoint of project life. Looking at expertise location, task-knowledge coordination, and cognition-based trust, they found that the impact of these behavioral dimensions of TMS on team performance change over time. In the early stages of a project, task-oriented communication played an important role in the development of expertise location and cognitive-based trust, thus laying the foundation for team performance. Once expertise location and cognition-based trust have been formed, however, communication related to task-knowledge coordination becomes more important, mediating the development of expertise location and cognitive-based trust, and performance. This finding is consistent with the work of Littlepage *et al.* (2008). In their attempt to better understand the role of communication, they too, distinguish between a development and utilization of a TMS. Based on an experiment with collocated pairs of coworkers, they suggest that ´for intact work groups with a history of working together, additional communication at the time of task allocation [i.e. task-oriented

communication] over and above the background level of communication that naturally occurs does not improve performance´ (Littlepage *et al.* 2008:234-235).

Wegner (1986) describes knowledge structures as ranging from highly integrated to highly differentiated. Integrated knowledge structures are those in which 'the same items of information are held in different individual memory stores and the individuals are aware of the overlap because they share label and location information as well' (Wegner, 1986:204). Differentiated knowledge structures are those in which 'different items of information are stored in different individual memory stores but the individuals know the general labels and locations of the items they do not hold personally' (Wegner, 1986:204). Hence, as differentiated TMS allow for more specialization and provide access to a larger pool of knowledge, differentiated TMS are more beneficial to groups operating on complex tasks (Akgün *et al.* 2005). Knowledge structures in TMS, including forms of coordination, may be both tacit and explicit. Where the first is based on expectations, the latter is based on explicit communication (Vaughan 1996; Wittenbaum *et al.* 1998). With respect to the latter Wegner (1991) suggests that (new) explicit encoding schemes may negatively infer with implicit encoding schemes that exist in established TMS (Ren and Argote 2011).

TMS Moderators and Effects

In Table 3 an overview is presented of emergent characteristics that have been identified in the literature. In the following text each row is being discussed.

Moderators related to task characteristics

One of the task characteristic that is identified in TMS literature that moderates the relation between the existing TMS and its performance, is task complexity (Ren and Argote 2011). Akgün *et al.* (2005) describe task complexity in terms of routine (routine or non-routine) and knowledge (existing or novel solutions). They conclude that non-routine work and work involving novel bodies of knowledge benefits more from

TMS than routine work or work that can be executed using existing bodies of knowledge. The reason is that novelness and variation may require the involvement of more people to deal with new information and knowledge, thus requiring more cooperation and coordination between team members.

Moderator type	Moderators	Effects	References
task characteristics	Task complexity; task type	Non-routine work benefits more from TMS than routine work, because more variation may require the involvement of more people to deal with new information and knowledge;	Akgün *et al.* 2005; Gupta and Hollingshead 2010
team characteristics	Team composition; diversity	need for TMS	Moreland *et al.* 1996; Wegner 1986
	Fleeting membership (stability)	fragmented memory;	Cordery and Soo 2008; Lewis *et al.* 2007; Moreland *et al.* 1996; Wegner 1986
	Group size	larger pool of knowledge	Ren *et al.* 2006
	Task and knowledge volatility	TMS are more beneficial in environments with high task volatility and knowledge volatility	Ren *et al.* 2006;
Miscellaneous characteristics	New product technologies; customers preferences;	Weakening relationship between TMS and team learning as well as lower speed-to-market;	Akgün *et al.* 2006; Ren *et al.* 2006;

Table 3: TMS moderators and effects in the literature

Gupta and Hollingshead (2010), who studied two types of task, i.e. recall and intellective, found that task type does moderate the relationship between TMS knowledge structure and group performance. Where most TMS researchers studied the effect of differentiated

knowledge structures compared to the absence of knowledge structures, Gupta and Hollingshead (2010) are among the first to compare differentiated knowledge structures with integrated knowledge structures. Studying performance of (very) small work groups (3 members) they found that teams with more integrated TMS performed intellectual tasks faster and more accurate than groups with more differentiated TMS.

Recall tasks were performed faster by groups with differentiated TMS, yet less accurate, thus evidencing a decreased cognitive load. The conclusion Gupta and Hollingshead (2010) draw is that the advantage of a reduced cognitive load in differentiated TMS has to be weighted against the advantage of correcting errors in integrated TMS. Another argument to weigh these two alternatives stems from the work of Rau (2005). In her study on the moderating role of conflict and trust on TMS performance in top management teams, she cautiously concludes that too much diversity in top management teams operating in relatively stable environments may cause conflict, resulting in lower team performance. As a consequence she advices that 'teams may need to trade off between the positive and negative effects of having different types of expertise on the team' (Rau 2005:766-767).

Lewis and Herndon (2011) use two dimensions to categorize tasks. First, they distinguish between three procedural task characteristics, i.e. produce, choose, and execute. Second, they distinguish between three structural characteristics, i.e. task demands (divisible vs unitary), underlying goal structure (cooperative vs conflictual), and evaluative specificity of group outcomes (intellective vs subjective). Based on these dimensions they draft a number of propositions. They speculate that TMS relevance will be higher for execute tasks than for choose and produce tasks; when tasks are divisible rather then unitary; when the goal structure is cooperative rather than conflictual; and when task output is intellective rather than subjective. Moreover, they speculate that TMS development (thus, not moderating, but antecedently) will be higher when activities involve choose and produce tasks, rather then execute tasks, when tasks are divisible rather then unitary; when the goal structure is cooperative

rather than conflictual; and when task output is intellective rather than subjective.

Moderators related to team characteristics

A high levels of specialization may not only indicate the presence of a TMS (Moreland and Myaskovsky 2000), it also signifies that the team may benefit more from the development of a TMS by facilitating specialization and access to a larger pool of knowledge (Hollingshead 1998; Wegner, 1997).

Fluctuating team membership may impede TMS in two ways (Cordery and Soo 2008). First, it takes time to incorporate new members. Moreover, new members tend to adapt their specialization to substitute for members that have left. Although as a consequence TMS structure remains largely the same, TMS processes may be affected negatively (Lewis *et al.* 2007). This may be mitigated by asking old group members to "formally consider ways in which their collective knowledge structures might be leveraged, and even more importantly, how their own and others' roles might be adapted prior to task execution" (Lewis *et al.* 2007:175). Second, access to leaving members may be restricted, rendering the related meta-knowledge fragmented (Moreland *et al.* 1996; Wegner 1986).

Team size in most TMS-related studies focus on dyads and small groups (up to 5) (e.g. Hollingshead 1998, 1998a, 2000, 2001; Michinov and Michinov 2009; Jackson and Moreland 2009) to groups up to 20 members (Palazzolo *et al.* 2006). Ren *et al.* (2006) forms an exception, studying groups ranging from 3 to 35 members. They found that although groups of all sizes benefit from established TMS, TMS were more beneficial to larger groups in terms of efficiency and speed, while TMS in smaller groups tend to be more beneficial in terms of decision quality. This finding is confirmed by the work of Palazzolo and colleagues (2005, 2006). They found that network size is negatively related to the average number of communications within the network, which negatively affects both the process of differentiation and the accuracy of expertise recognition.

Task volatility (frequency at which tasks change) and knowledge volatility (speed at which knowledge decays) render some individual knowledge obsolete and force individuals to search for knowledge in the rest of the team. Consequently, TMS become more valuable with high task or knowledge volatility (Ren *et al.* 2006).

Miscellaneous moderators

A final class of features that moderate the performance of TMS is environmental turbulence. Akgün *et al.* (2006) distinguish between turbulence caused by market dynamics and turbulence caused by technological development. High turbulence renders some team knowledge obsolete, old-fashioned, and misleading, and forces the team to search for new knowledge to address the change. As a consequence Akgün *et al.* (2006) conclude that TMS are less useful within high turbulent environments. This finding seems inconsistent with the conclusion Ren *et al.* (2006) with respect to task volatility. According to Ren and Argote (2011) the explanation can be found in the level at which the knowledge becomes obsolete. Where in environmental turbulence team knowledge may be affected, in task volatile environments individual knowledge may become obsolete.

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.

Taxonomy	Main classes	References
Aggregate level	Component; architecture	Henderson and Clark 1990; Matusik and Hill 1998;
Aggregate level	Individual; collective; team; organization; network	Nissen 2006; Matusik and Hill 1998; Spender 1996
Context	Situated; context independent	Nelson and Winter 1982, 2002; Walsh and Ungson 1991
Firm knowledge dimensions	Articulable; observable; complexity; dependence (rich, schematic); teachability; articulated; documented	Davenport and Prusak 1998; Zander and Kogut 1995
Life cycle	Creation; distribution; utilization; feed-back loop	Nissen 2006
Organizational knowledge types	Conscious; automatic; objectified; collective	Spender 1996
Repository type	Embrained; embodied; embedded (structures and transformations); encoded; encultured; ecology	Blackler 1995; Collins 1993; Huber 1991;Walsh and Ungson 1991
Tacit-explicit continuum	Explicit; implicit; tacit; deep tacit	Leonard and Sensiper 1998; Nonaka and Takeuchi 1995; Polanyi 1983
The 6 journalist questions	Declarative (know what); procedural (know how); causal (know why); relational (know who); spatial (know where); temporal knowledge (know when).	Alavi and Leidner 2001; Borgatti and Cross 2003; Mokyr 2002; Lundvall and Johnson 1994; Fu 2006; Walsh and Ungson 1991
Tightness	Reliability; complexity; uncertainty; ambiguity; equivocality	Mokyr 2002; Spender 1996; Zach 2007
TMS knowledge	Role; instance; transactive	Nevo and Wand 2005

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.

Author	Classes					
Alavi and Leidner 2001	Individual		Social			
Spender 1996	Individual		Social			
	Conscious	Automatic	Objectified		Collective	
Collins 1993	Individual		Social			
	Embrained	Embodied	Encoded		Encultured	
Blackler 1995	Individual		Social			
	Embrained	Embodied	Encoded	Embedded		Encul -tured
Proposed ideal types	Individual		Social			
			Encoded	Embedded		Encul -tured
				Structu-res	Rou-tines	

Table 2: Relation between knowledge resource ideal types

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).

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).

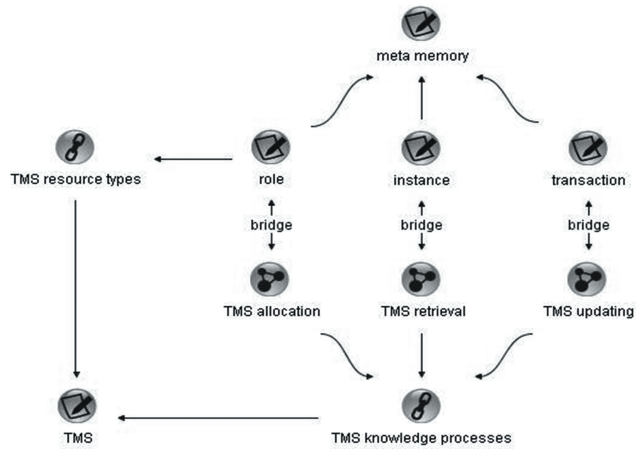

Figure 1: TMS as bridge between knowledge resources and knowledge processes

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.

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EXECUTIVE SUMMARY

In the domain of safety and security (such as e.g. organizing a response after a crisis, or fighting organized forms of crime) specialized organizations often have to collaborate on an occasional basis with other specialized organizations to head challenges that none of the participants can head (as easily) on its own (*cf.* Agranoff and McGuire 2001; Wastell *et al.* 2004). Such collaborations are assembled and dissembled per assignment, while the situation at hand mandates them to perform almost instantly. Another characteristic of such temporary collaborations is that they are often more or less virtual in nature, i.e. participants are distributed in time and space and depend on technology to communicate (Cramton 2001; Griffith *et al.* 2003).

In the literature temporary collaborations are being addressed from many different perspectives, including leadership (e.g. Jones and Hinds 2002), knowledge management (e.g. Rosenberg 2000), coordination (e.g. Bechky 2006; Faraj and Xiao 2006; Majchrzak *et al.* 2007), communication (e.g. McKinney *et al.* 2004), sensemaking processes (e.g. Weick 1990; 1993), and in terms of virtualness (e.g. Saunders and Ahuja 2006). One emerging theme is that of transactive memory systems (TMS). TMS are cognitive systems collaborating people develop to facilitate knowledge transfer and to contribute to people's abilities to coordinate specialized knowledge (Ren and Argote 2011). As such TMS support and are antecedent to the capabilities of an organization to combine its resources (Jarvenpaa and Majchrzak 2008). Developing an effective TMS may result in (new) organizational capabilities and services (Wang and Peng 2008), while failure to develop an effective TMS is known to be one of the most common barriers to distributed team success (Rosen *et al*. 2007).

Since the initial construction of TMS theory by Wegner and his colleagues (Wegner 1986; Wegner *et al*. 1991), TMS studies have flourished. There are, however, two important and repeated calls for research, which still received little attention. The first call for research concerns the level of analysis at which TMS are being studied. The

majority of TMS research takes dyads, triads, and (small) teams as their level of analysis – few studies are conducted at organization level. This hinders organizational TMS development efforts, because TMS-related findings at one level of analysis are often not applicable to other levels of analysis (Peltokorpi 2008). Consequently, several scholars call for TMS research at organization level (e.g. Jackson and Klobas 2008; Peltokorpi 2008; Ren and Argote 2011). The second call for research concerns the study of TMS in geographically distributed collaborations, because still little is known about short-term collaborations in real-life settings, how experiences in temporary collaborations impact future collaborations, what the effects are of management structures (as most studied collaborations were highly self-directing), and how technologies can help the group to develop a shared cognitive division of labour (*cf*. Cordery and Soo 2008; Kanawattanachai and Yoo 2007; Lewis *et al*. 2007; Powell *et al*. 2004; Ren and Argote 2011). In this dissertation these two calls for research are brought together based on the notion of Powell *et al.* (2004) and others (Moreland and Argote 2003) that organizational development efforts (read: organizational TMS development efforts) should provide for stable structures to enable future temporary and geographically distributed collaborations. Thus, the scientific motive of this dissertation is to increase our understanding of the structure, functioning, and emergence of organizational TMS, and understand its relation with the TMS of temporary and geographically distributed collaborations. Following this motive, the objective of this dissertation has been formulated as:

1. to develop organizational TMS theory as a lens to study how distributed knowledge resources may be involved in collaborations, which are temporary and geographically distributed, to head tasks that none of the participants can head (as easily) on its own, and
2. to identify which features of organizational TMS contribute to the robustness and resilience of these collaborations.

To reach this objective, three consecutive research projects were conducted, each guided by its own research question.

First, recognizing that knowledge in organizations may take on different forms, the first research question was how knowledge transfer

among (different types of) knowledge resources in an organizational TMS can be strengthened to support temporary and geographically distributed collaborations. Based on knowledge management literature three ideal types of knowledge resources were formulated at organization level: personalized, encoded, and embedded. The latter includes amongst others knowledge embedded in organizational structures, routines, processes, and technology. This explorative question was being studied using an action research approach. The results of the first study show that one way to develop organizational TMS is to organize for transactivity among resources of the same type, a second way is to transform resources from one type to another type, and a third way is to organize differently. Moreover, the first study illustrates how ICT and information-related methodologies provide opportunities to intervene in organizational TMS.

Second, because TMS are cognitive systems in the second study the question is examined how different types of knowledge resources, such as organizational structures and routines and technological information systems, should conceptually be related to TMS. To address the question TMS theory is extended by borrowing insights from organizational routines theory (*cf.* Pentland and Feldman 2008). Using this theory a mutually enabling and restricting relation can be distinguished between the shared mental representations of how the collaboration should function (called: the ostensive aspects of TMS) and the actual performances by specific people at a specific time and place (called: the performative aspects of TMS), while artifacts are represented as external factors which may influence or represent either of these aspects. Using an AR-approach the resulting theoretical lens is used to study and strengthen TMS in a large-scale policing operation. Next to formally including different types of knowledge resources in TMS theory, this study demonstrates that where TMS in organizations are interrelated, these relations can be described in terms of actors, artifacts, relationships, and type and content of interactions. With respect to strengthening organizational TMS the study illustrates that one way to intervene is to strengthen the ostensive aspects of organizational TMS, a second way is to develop artifacts to represent or influence the ostensive or performative

aspects of the organizational TMS, while a third way is to lock-in (i.e. automate) critical TMS components. The consequence of the latter, however, is that it reduces the ability of the organization to adapt and improvise. This effect may partly be compensated by increased efficiency.

The third research project is focused on the question how functionally structured organizations can develop their ability to occasionally engage in networked operations, in addition to their functional mode of organizing. Hybrid enactment is introduced to conceptualize the ability of an organization to switch dynamically between functional and networked enactment. These collaborations may be infrequent and brief, yet they are very common in e.g. law enforcement, crisis response, and the military. To develop a theoretical lens to study hybrid enactment the knowledge based theory of the firm (KBT) is combined with the concept of strategic, tactical, and operational levels of agency to develop a multilevel distributed systems perspective, while TMS-theory is used (and extended) to conceptualize mechanisms for achieving coherence. Using an interpretive case study approach a failed case of networked enactment is analyzed. Studying the TMS of the involved teams and that of the networked operation revealed (underdeveloped) TMS components and relations among these components. These elements are used to construct an organizational TMS model. This model reveals TMS-subsystems and direct and moderating effects among them. The model provides cues for strengthening organizational TMS (i.e. organizational learning), which contributes to increased opportunities for exploration and exploitation of distributed organizational knowledge resources, in order to head challenges that none of these resources can head on its own.

DANKWOORD

Isaac Newton schreef in 1677 aan zijn collega, ‘Als ik verder heb gezien dan anderen, komt dat doordat ik op de schouders van reuzen stond’. Naast de wetenschappers op wiens inzichten ik heb voortgebouwd, bevonden zich onder die reuzen veel dierbare collegae. In talloze bijeenkomsten, gesprekken en acties, zijn ideeën en inzichten ontstaan, verrijkt, vertaald naar de praktijk, of na toetsing weer verworpen. Zonder hun nieuwsgierige, kritische, eigen-wijze en humorrijke inbreng was dit proefschrift er niet geweest. Enkele mensen noem ik.

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Tot slot, traditioneel maar oprecht, mijn laatste woorden voor mijn grootste liefde. Je bent mijn trots, mijn rots, mijn zon, mijn warmte.

CURRICULUM VITAE

Jan-Kees Schakel was born on the 16th of October of 1968 in Leusden, the Netherlands. His career can be characterized by two periods. The first period started with his study 'Management of International Land, Water, and Environmental Resources' (B.Sc.), at Larenstein (now part of Van Hall Larenstein, Wageningen University), which he completed in 1994. In part-time he gained his M.Sc. (completed in 1998). At the same time he was working as international consultant on projects such as the establishment of an irrigation and drainage compendium to combat salinization in Northern India, the creation of a national cadaster system to enhance the investment climate in El Salvador, the development of a national forest management system to align forest exploitation with sustainability and biodiversity goals in Malaysia, and the set up of a natural resources information exchange network to improve collaboration among (mostly) governmental institutions in Ethiopia.

Returning to the Netherlands in 2002 he sought to align his education with his practice, which had shifted from the management of natural resources to the management of information within and across organizations. While working for the Dutch National Policing Services Agency (KLPD) as senior advisor information and organization he completed his master degree in Information Science (cum laude) at the University of Amsterdam. His master thesis, titled 'bridging the knowledge gap in a distributed action oriented environment', was graded with a 10 (excellent) and formed the stepping-stone to this dissertation. As the thesis title suggests, his professional and academic interests had further developed in the direction of organizing distributed knowledge for real-time action by carrying through organizational, methodological, and technological innovations. The academic results of this journey are presented in this doctoral dissertation.

In the domain of safety and security specialized organizations often have to collaborate on an occasional basis with other organizations to head challenges that none of the partners can head (as easily) on its own. Such collaborations are temporal and often virtual in nature. One emerging perspective to study such collaborations is that of transactive memory systems (TMS). TMS are cognitive systems collaborating people develop to facilitate knowledge transfer and to contribute to people's abilities to coordinate specialized knowledge. Developing an effective TMS may result in new organizational capabilities and services, while failure to do so is a known barrier to distributed team success. Addressing several gaps in TMS literature, in this dissertation the structure, functioning, and emergence of TMS are being explored of temporary and geographically distributed collaborations at intra-organizational level.

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