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

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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).

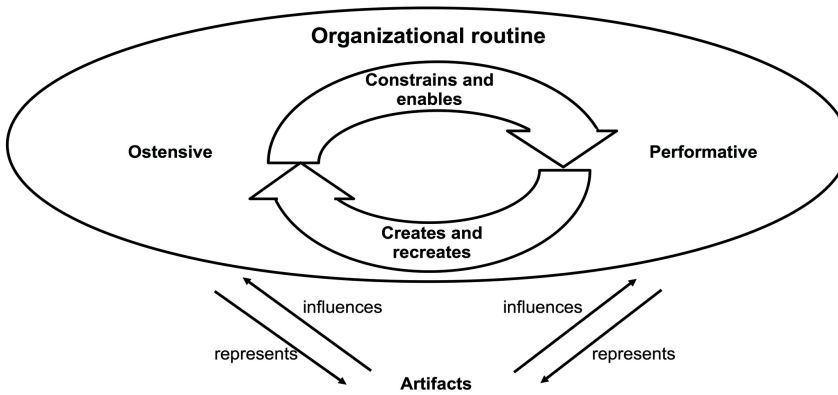

Figure 3.1: Organizational routines as generative systems *(adapted from Pentland and Feldman 2008)*

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.

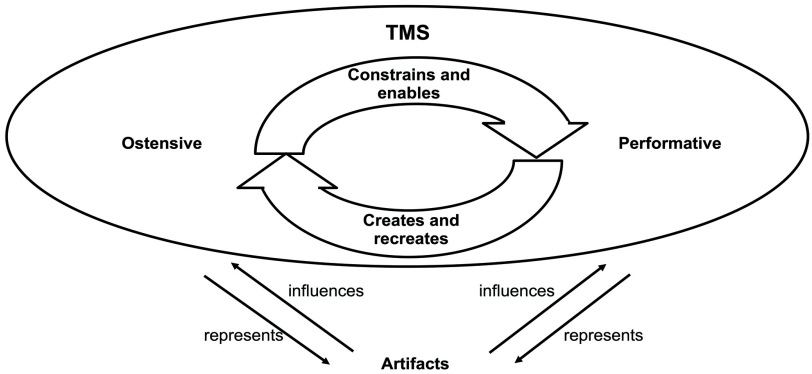

Figure 3.2: TMS as generative system *(adapted from: Pentland and Feldman 2008: 241)*

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.).

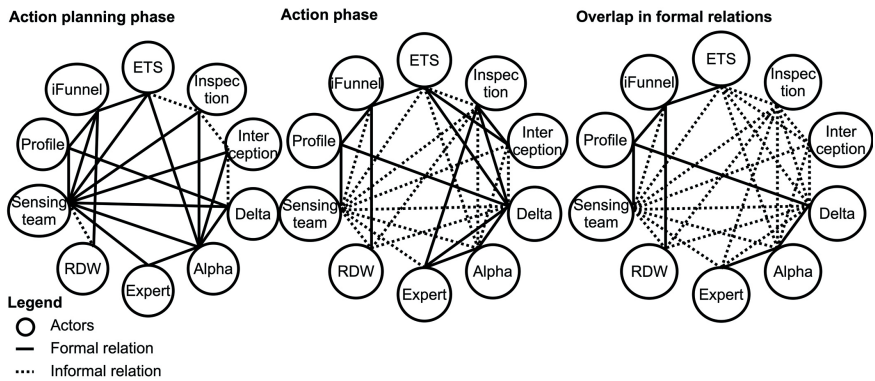

Figure 3.3: Relational patterns during the action planning phase and the action phase

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.