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# Transactive memory in distributed organizations

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# TRANSACTIVE MEMORY IN DISTRIBUTED ORGANIZATIONS

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## Abstract

*Transactive memory systems (TMS) are systems of directories that are used to locate and use knowledge in groups. Previous research indicates that, by supporting group cognitive activities, TMS are important determinants of group performance. This paper applies the concept of TMS to knowledge sharing in organizations. The three process dimensions of TMS – directory maintenance, information storage and information retrieval – were used to identify the characteristics of TMS in a case study organization. TMS directories are stored in several types of media, and the processes for maintaining and using these directories varies. The authors conclude that organizational knowledge sharing may be assisted by information systems developed to support TMS, and suggest how an understanding of the nature of an organization's TMS might be used to design information systems and management interventions to improve knowledge sharing.*

*Keywords: Transactive memory systems, knowledge management, virtual organizations, global organizations.*

# 1 INTRODUCTION

In this research we seek to gain insight into the behavior of knowledge retrieval processes over distance in organizations. We focus on the concept of organizational memory, that knowledge distributed throughout an organization which can be brought to bear on present activities to improve (or change) work effectiveness (Stein 1995, Walsh and Ungson 1991). It can apply not only to instrumental knowledge, but also to forms of knowledge which give structure and meaning to events, allowing shared interpretation to emerge within organizations (Krippendorf 1975). Several forms of repository have been proposed for organizational memory, including people, culture, routines, technology and software, organizational structure and workplace ecology (Argote 1999, Walsh and Ungson 1991). The concept of organizational memory has been applied to improving information and knowledge management within organizations. The notion of transactive memory systems (Wegner 1987, Wegner, Guiliano and Hertel 1985) has recently been proposed as a model for understanding how information can be more effectively managed in organizations (Anand, Manz and Glick 1998, Nevo and Wand 2005) and how intellectual resources can be better utilized (Moreland 1999). Transactive memory systems essentially consist of sets of directories containing metadata which point to knowledge locations, and the processes that maintain and utilize those directories. In this paper, we apply TMS constructs to explore knowledge sharing at an organizational rather than a group level.

# 2 LITERATURE REVIEW

## 2.1 Transactive Memory Systems

Transactive memory is a system for encoding, storing, and retrieving information in groups: it is a set of individual memory systems in combination with the communications that takes place between individuals (Wegner 1987, Wegner et al. 1985). The notion of transactive memory systems (TMS) was developed by Wegner and his colleagues, who separated the knowledge which members of a group have from the directories which the members have about the knowledge of others in the group. These directories indicate the existence, location and form of retrieval required to obtain and use the knowledge of others. The effective knowledge of an individual in a group consists of internal knowledge (held in the mind of the individual) and external knowledge (which the individual can effectively access using the directory). Originally the TMS construct was used to describe the ways in which dyads (such as married couples) who are close to one another share knowledge and allocate responsibilities for knowing. Wegner (1987) observed three processes which supported couples' communication: directory maintenance, information storage and retrieval of information.

Directory maintenance is the ongoing upgrading of the mental maps held by people in a group to reflect the knowledge of other members of the group. Directories can be maintained in several ways, the basic default being through the assumed roles (job titles or family position for example) and characteristics (gender or age for example) of others, which indicate their likely domain of expertise or interest.

Information allocation and storage is the allocation of knowledge responsibilities and retention of knowledge by the allocated responsible member of the group, such that future access by other group members is possible via the directories. This involves transactive encoding of information and deciding where and how in a group information is to be directed or stored.

Retrieval is the process of determining the location and accessing the knowledge of a group using the directory. Retrieval may require the use of multiple, linked individual directories before the required information is actually found and accessed.

Well-developed TMS are believed to improve group functioning. Moreland, Argote & Krishnan (1998) found that a TMS developed through group training improved group performance more than individual training with team building exercises. Lewis (2004) found a positive correlation between strength of TMS and knowledge worker team performance. Group performance is believed to reflect the ability of a group with a well functioning TMS to store and recall more knowledge than any individual (Hollingshead and Brandon 2003), to use the knowledge of others better (Moreland et al. 1998, Stasser, Stewart and Wittenbaum 1995), to match problems with the person most likely to resolve them (Moreland and Levine 1992), to coordinate activities more effectively because of better anticipation of capabilities of others and appropriate allocation of roles and tasks (Wittenbaum, Vaughan and Stasser 1998), to make better decisions through the recognition and evaluation of the expertise contributed by group members (Stasser et al. 1995), and to reduce cognitive overload where others to act as external memory stores and allow greater specialization (Hollingshead and Brandon 2003, Wegner 1987).

More recently, several authors have speculated on how organizations might function as TMS. Anand, Manz and Glick (1998) formulated a model which shows how organizations can be perceived as collections of TMS. They proposed that certain forms of information systems, such as intranets, search engines, standardized concepts and vocabularies, could be used to enhance the functioning of TMS. Nevo and Wand (2005) examine how an organization may function as a single TMS and propose a conceptual model upon which to base the design of an information system for supporting an organizational TMS. Moreland (1999) suggests that organizational TMS may have different characteristics to pairs and groups. Larger groups are less cohesive and willing to share, for example. He speculates that TMS might be constructed along technological or interpersonal dimensions, where the former is oriented towards the use of computers to create and maintain an organizational TMS and the latter is based upon those things that bring people together, such as a matrix structure and personal relationships in which knowledge about each other is shared.

So until now, the work on organizational TMS has been conceptual rather than empirical. Empirical data is needed to understand the degree of "fit" with which the notion of TMS can be applied to organizations. Our first research question is therefore, do organizations exhibit the characteristics of TMS (directory maintenance, knowledge storage and knowledge retrieval systems) observed by Wegner (1987) and others in smaller groups?

## 2.2 Transactive memory systems and virtual work

Virtual work is a term which commonly describes an approach to managing and configuring organizational human resources and work activities beyond the spatial, temporal and legal boundaries of the firm. Recent research in the information systems literature suggests that TMS will be constrained for groups that are distributed or virtual (Alavi and Tiwana 2002, Griffith, Sawyer and Neale 2003).

Alavi and Tiwani (2002) argue that constraints on transactive memory are a substantial inhibitor of the effectiveness of virtual teams to integrate their knowledge resources and that knowledge management systems (KMS) could be used to improve the functioning of group TMS. In examining the particular knowledge management problems encountered by virtual teams, Griffith et al (2003) also posit TMS as a significant factor in group effectiveness. Based on recent TMS literature, they propose that:

"the transfer of potential team knowledge to usable team knowledge will be positively moderated by team transactive memory" and that "more virtual teams will have lower transactive memory development than less virtual teams", whereby this "will be mitigated to the extent that technologies or organizational systems are used to support transactive memory development" (p277-278) .

Lewis (2004) found that frequent, early face to face meetings were correlated with the development of transactive memory systems of groups. This supports Hollingsheads' (1998) findings, in which even familiar couples required face to face contact to exchange the non-verbal cues required to access their

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TMS effectively. Shared task training (Moreland 1999, Moreland et al. 1998), shared mental models (Moreland 1999), spending time together (Argote 1993) and intimacy (Moreland 1999, Wegner, Erber and Raymond 1991) are all factors which improve TMS function but which are degraded by physical separation.

If we assume that TMS can be observed at the organizational level, it would seem from this literature that the TMS will be constrained by distribution of members of the organization, but that certain activities may ameliorate the affect of distance. Our second research objective is therefore to examine the impact of distribution on organizational TMS.

# 3 METHOD

In this initial empirical study of organizational TMS, we applied a qualitative and interpretive research approach to a single case study organization. The parent organization has a centralized head office (HO) in northern Europe and a large number of distributed staff, all knowledge workers working in teams on highly sophisticated engineering and institution-building projects. Our case study was conducted within the development planning division of the organization.

**The case study organization**

We began our research with an examination of the structure, objectives and characteristics of the organization. The sources of the data were annual reports, the corporate intranet and Internet portals, and interviews with the management team. The division under study differs from the rest of the organization in its emphasis on engineering projects in developing regions of the world, the high proportion of social scientists and natural scientists employed, and the geographical dispersal of staff. The division has 83 permanent staff, of whom 22 (26%) were based in the field at the beginning of our study and 13 (16%) at the end of it. Organizational records indicate that, any one time, 49% of the permanent staff are working outside of head office. All contractors are based in the field. Of the division's 250 staff (including contractors), around 74% are permanently based outside head office and 91% are outside HO at any one time, a high degree of dispersal. Many staff working in the field are the only representative of the organization in their location, and thus they are also isolated from other staff.

The division has a matrix structure, with one director and two department managers in charge of resources and organizational development (including knowledge management) respectively. The 'rows' of the matrix are functional areas (water resources, urban development, agriculture, and social and institutional development) run by market area managers, each of whom has the oversight of a number of projects. The market area managers are coordinated by the Department Manager (Resources). The director, department managers, and market area managers are all based in head office. The 'columns' of the matrix are projects run by project managers, who report to the market area managers. Project managers and consultants may be based either in HO or outside (OS) and may be permanent or contract staff. The rest of the staff are administrative support staff and specialist subject-matter consultants who report to one of the functional managers.

The work performed by most staff within the division requires a high level of education (many staff have a masters degree or doctorate) and long years of experience. It often creates unstructured, unique problems requiring novel approaches and solutions. Except for rigorous project management procedures and careful storage of consulting reports, materials and outcomes, knowledge codification is low. Knowledge exchange between staff is highly personalized and conversational and the work atmosphere is non-threatening and collegial.

**Data collection**

To address the two research objectives, we conducted 16 semi-structured interviews with the staff of the division. The interviews were conducted in two rounds over six months. In each round, interviews were conducted in HO with staff who were either permanently in HO or visiting from the field, and by

telephone with staff who were outside HO. This approach allowed us to speak with at least two staff from each of the defined roles in the division.

We did not use notions of TMS to impose an *a priori* structure on the questions, rather we used generic questions about knowledge sharing to generate data that we could analyze for evidence of how TMS might work in the organization. The questions addressed the way knowledge was shared, where it was kept, and what inhibitors existed for the sharing of knowledge and accessing organizational memory systems. Participants were also asked about the forms and location of knowledge in their division and the modes by which knowledge was created, stored and shared.

**Data analysis**

All interviews were transcribed shortly after completion. In order to answer the research questions, the transcripts were analyzed for evidence of remarks that could be classified using Wegner's (1987) dimensions of TMS (maintenance of directories, knowledge storage and retrieval of knowledge). All remarks that could be classified using each of these dimensions were gathered together and interpreted in relation to the two research objectives. In the first instance, they were used to outline the characteristics of knowledge management in the division – if the three dimensions of TMS could be observed, then we would have evidence that TMS do exist in organizations. Information about the location (HO or OS) of the participants was then used to examine any differences between the remarks made by the two groups of knowledge worker.

# 4      RESULTS

**Directory maintenance**

Directory maintenance was clearly observed in the case study organization. Staff actively update their personal knowledge of what others in the division know, in meetings, at lunch and in corridor conversations. The roles of manager and administrator function as a locus of directories and their central role facilitates the ongoing maintenance of their personal directories. Both managers and administrators are based in HO and there were few reports of staff having difficulty to access them. Two information systems support directories: a portal where staff from all locations are encouraged to report to others on what they are doing and a searchable curriculum vitae (CV) database. We also observed personal transactive memories built up over time, and not related to the formal organizational structure. Staff recognized the importance of directory systems and lamented the loss of a lunch time forum in HO at which not only was knowledge shared, but directory systems were updated.

Managers continually update their directories through interactions with their subordinates and management colleagues. This is consistent with the "gatekeeper" function described by Allen (1977) and Klobas and McGill (1995). There are processes in place where project debriefs are performed with managers, reports are sent to managers, and managers physically travel to overseas projects to conduct reviews and audits. In this way they refresh their understanding of the location of capabilities and knowledge in the organization, both locally and remotely. References to managers' directory maintenance role include:

> *It's pot luck to find the right person: but usually it's the manager who is asked…There are a lot of maps in my head* (HO-based Department Manager)
> *The market area managers are the main way of learning – they have time and the overview and learn from each project and provide information in future when needed* (HO-based Administrator)

Administrative assistants and coordinators are also a major locus of directories. Although permanently based at head office, their role as a communications hub means that they develop extensive maps of the experience and skills of a range of staff and become known as gatekeepers:

> *I'm always here and reachable: that's why all people come to me. And I know who to ask* (HO-based Administrator)

However, accessing the right person for knowledge in the division is not always a function of the role formally defined by the organizational structure. Personal transactive memories are built up over time "*through trial and error*", says one OS-based Project Manager:

> *I have been in the organization for over 20 years and have a clear map in my head of where to find what I need, a real network* (HO-based Department Manager.)

Poor knowledge sharing inhibits the development of directories regarding what other people know. In particular, the absence of a forum for sharing what each person knows was regretted by many of the staff:

> *It's about keeping maps in heads…it needs a small presentation to the group to let them know what you know* (OS-based Project Manager)
>
> *We are not rewarded for sharing. There is also no forum for it. The lunch meetings were very important. It is frustrating that it has to be in your own time.* (HO-based Consultant)

The HO-based face-to-face forums were replaced with information systems, and in particular a divisional knowledge portal designed to encourage communication that reached international staff as well as staff in HO. Staff have been reluctant to contribute to the written forums for reasons which are attributed to a national culture of modesty and anti-self promotion described as the *Law of Jante*, a Scandinavian cultural trait in which standing out in a crowd through high-performance or self-promotion is seen as unseemly, pushy or disloyal:

> *people don't like having names mentioned on the website, as this gives the impression of somehow publicizing them and raising them above others* (HO-based Department Manager)

Another information system designed to support directory maintenance is the CV database. CV's and professional resumes are an important codified set of maps to locate expertise, as well as a key asset for marketing and acquiring work. They are updated in a formal process at the completion of each project and are available using keyword search from within the corporate CV management system:

> *The skills and expertise are in people's heads and the CV system is a crucial map in locating this for subsequent projects.* (HO-based Market Area Manager)

The CV system was seen to have some limitations:

> *At least everything goes into the CV: but the keywords are not really relevant.* (HO-based Project Manager)
>
> *Using externals [outside staff] based upon their CV is risky and can go wrong: anyone can put anything in a CV* (HO-based Administrator).

Because of the strategic value of the CV management system, and the fact that project teams are put together by HO-based staff, the system is available only inside the corporate firewall. Access to CV's by staff outside HO is limited to those few who can create a VPN connection from the location in which they are working, so the system is of little value as a directory system for outside staff.

Despite the existence of the portal and CV management system, even some HO staff felt that they did not know enough about the expertise of international staff, both permanent and on contract:

> *I don't think people here realize how much good professional regional knowledge is sitting in this organization...they don't draw enough on it.* (HO-based Consultant)
>
> *There might be knowledge hidden from us, definitely...the problem is that these people are in other countries…"* (HO-based Administrator)

Distance does not seem to be the only factor here. There are also limitations in the directories of collocated staff:

> *You are amazed by some people...their knowledge about what other colleagues sitting down the corridor - they don't know. Again, people are different* (HO-based Department Manager)
>
> *Curiosity is required to seek knowledge that could be applied* (HO-based Department Manager)

Personal directories in the division build up through involvement in projects, but degrade as people move onto new projects with different project teams over time. This degradation is observed by both

HO-based and international staff, but international staff appear to suffer more because they are not able to speak informally with colleagues 'over the lunch table':

> *The 'knowing who' is very important…But after a long time abroad, my old group has been moved, so I know few in the current setup* (OS-based Project Manager)
>
> *Earlier, when our division was small, induction was good…But for people working abroad is where the chain breaks. You are sitting on your own, there is no debriefing, no opportunity to share knowledge with colleagues. Colleagues have been complaining about this.* (OS-based Project Manager)

Therefore organizational TMS directory maintenance may have the following general characteristics:

Directories to knowledge can be stored in a number of places, including the heads of managers and administrative staff who have directory maintenance roles defined by organizational structure.

Staff with long company experience have more extensive directories than newer staff.

Maintenance of personal directories requires a forum for knowledge sharing and finding out who knows what.

Personal and cultural factors such as curiosity and modesty influence the active updating of personal directories.

Physical separation hinders the update of personal directories about those who are remote.

## Knowledge Allocation and Storage

In TMS, the storage of knowledge is shared among people who recognize that each person has their own domain of expertise (as identified in the directory). Allocation and movement of knowledge to the appropriate repositories is essential to TMS maintenance.

Each domain of expertise observed in the case study organization was generally associated with a formal organizational group or a formal role; for example, managers are responsible for strategic management and project managers for specific projects. Certain directions are encoded in organizational structure and procedures: the proposal secretariat gets requests for tender sent to it because it is their job to process them; market area managers receive information about changes to bidding procedures because they must act on this and so on. Technical knowledge and knowledge related to specific projects appears, however, to be gained and stored by the person assigned to complete the project or task to which the knowledge is relevant:

> *Within projects, especially multidisciplinary, there is a lot of learning. It happens on the job from association with other staff and external consultants, and is tremendous* (OS-based Project Manager)
>
> *Learning through doing is the main way. When I start new projects, I do learning through the internet, I go to forums … also find opportunities for education such as conferences and subscribe to special interest groups.*(OS-based Project Manager)

Sometimes the allocation is inadequate, for example moving the customer knowledge of remote staff to the proposal secretariat or market area managers at head office:

> *Communications with outside staff has been so poor there is a big need for improvement. There has to be an increase in value for the outside. If we gave them better support, we would be able to take advantage of their business intelligence and closeness to what is happening: we need to understand this and adapt and use their information to win more business.* (HO-based Department Manager)
>
> *The new people doing proposals don't ask me anything about the country where I just spent ten years: I have a network of 1000 people there. I haven't been asked to do proposal review: this is a management problem. I could be very useful here (*OS-based Project Manager*)*

A recent innovation is the implementation of a divisional knowledge portal, accessible beyond the head office firewall via the Internet. This portal is being used to give access to current activities and proposals, meeting minutes, country and client information and social events. Nonetheless, although

document management is rigorous and disciplined, personal TMS appear to remain critical for access to discipline knowledge:

> *The knowledge of the work content is kept in people's heads* (HO-based Market Area Manager)

Apart from domains, there appears to be a type of organizational memory which we might call 'self-awareness' or 'mindfulness' which is an awareness of the existence and characteristics of other parts and components of the organization. This mindfulness of head office management and staff for outside teams and workers is under-developed and the members of these outside teams suffer from a feeling that they are not cared for or considered:

> *Absence of mindfulness ...indeed this is a major absence. There has been a change in the level of awareness...the internal dissemination of information is getting better...meetings...the overall level of information has improved but it is that of those who are in the building...not the systematic gathering of information from those who are out in the field (*OS-based Project Manager*)*
>
> *There is low mindfulness of the needs and knowledge of outside staff (HO-based Administrator)*

This mindfulness can be seen as a partial absence of TMS directories regarding remote staff, which deal with who needs to know what and who knows what. There appears to be a lack of directories pointing to the capabilities of virtual staff and this leads to ongoing under-utilization of their knowledge as well as poor updating of their knowledge of head office.

These data suggest some additional characteristics of allocation and storage in an organizational TMS:

> Some allocation and storage of knowledge reflects organizational structure and defined organizational roles
>
> Knowledge allocation need not be done through transactive processes but can be the result of performance of work within a defined role
>
> Passing knowledge on to those who need to know it depends upon mindfulness and remote staff are out of sight. Therefore mindfulness of their need to know is reduced.

## Retrieval

Much information in the case study organization is stored electronically or in reports, which can be accessed via computer networks or hard copies. But knowledge retrieval is overwhelmingly performed on a personal basis, by simply asking someone who might know, by asking a manager or an administrative assistant, or by pursuing one's own personal directory:

> *People just walk down the corridor when they need to know something or get pointed to the right documents. It is casual and informal. (*OS-based Project Manager*)*

Physical access to HO resources is difficult from outside locations. This is due to poor technology links, the arduousness of the relationship in not being able to walk down the corridor and the greater efficiency in simply asking someone for directions to a knowledge source. The access appears to be through a particular relationship (such as to a manager or administrative assistant) or a defined role, such as a particular group who are responsible for certain types of project:

> *The 'know who' is very important: knowing who to approach, or who to ask on who to approach for certain skills and questions. There is a map in my head of all the requirements. CV search would be very useful, but it is not useable from Africa (*OS-based Project Manager*)*

Retrieval by staff often involves access to a manager's personal directory as an intermediate access point:

> *The motivation to share (in particular as a manager) is very high, as this is what creates success in projects. I am the gatekeeper for information, people come to me and I know where to go for it. Having said that, a lot is done informally, where local people come in. Their capability is enhanced through space. The remote people cannot do this and I do not have the time to build relationships with remote people to make myself available and discover their needs. So time and space are restricting the remote staff from accessing my knowledge as a gatekeeper and source of advice and wisdom (*HO-based Market Area Manager*)*

This quote also demonstrates that remote workers have greater difficulty accessing information via a manager's directories. The same happens when the manager is travelling for example, they themselves become 'virtual':

*Knowledge is all kept in heads… It is a problem when [we managers are] travelling. But when people come to me, it's not a problem, but travelling can disrupt availability. Writing it down and putting it on the net is not a solution, because if you "have isolated small flowers in a big jungle, people will never find them'. (HO-based Market Area Manager)*

One international specialist gives an insight into the difficulty of retrieving knowledge from overseas. The following statement shows how the dynamics of interaction and knowledge retrieval become more difficult over distance and how different strategies apply:

*With regards to finding information, this is through a map in my head, my personal network, where I know where to go. This is far easier when I am in head office. It is more difficult to access the network when I am overseas: the bandwidth is too low and you need to be far more specific in what you need. You can't discuss something and build up to your question, you have to formulate it quite precisely from the beginning. You tend to communicate when you have a problem. The point at which you decide to use communications is far higher. However, you normally get a good reply from head office. Personal contacts are very important (OS-based Consultant)*

Retrieval of knowledge from known sources depends upon the seeker's motivation. This motivation itself seems to be influenced by several factors, including a desire to be original and not reuse material, a curiosity to see what others have done, and perceived time and availability of other staff:

*Many people … are academics. They like to reinvent the wheel. .. don't get this exchange...what are your best practices...what are my best practices (OS-based Project Manager)*
*Curiosity is required to seek knowledge that could be applied (HO-based Department Manager)*

Accessing performance knowledge of what is happening outside head office is also problematic:

*Accessing and finding knowledge is not a problem, However, in remote cases it is far more difficult to gain a true picture, especially when things are going wrong and there are conflicting reports (for example, when the customer complains and at the same time the employee is saying that everything is going well). (HO-based Market Area Manager)*

In summary, what emerges from the data about TMS retrieval is:

Retrieval of information depends upon some personal characteristics, such as the desire to reuse the work of others.

A culture of personal contact influences organizational preferences for retrieving knowledge

Retrieval may have to go through intermediary directories.

Managers may act as gatekeepers (intermediaries), but when they are absent there are access difficulties

Physical separation makes it more difficult to use the knowledge of others and requires different strategies for formulation of inquiries

In this organization, codification of knowledge seems inferior for building directories than conversing with a knowledge holder and using a human directory is perceived as more reliable than a technical one such as an electronic CV

# 5      DISCUSSION

The analysis presented here indicates that an organization – as well as the dyads and groups observed by other researchers – can be characterized as a TMS. In an organizational TMS, people across all levels and from within all groups access each other's knowledge through a combination of personal and codified directory systems, personal and codified storage mechanisms, and retrieval systems based on human directories in the absence of knowledge management systems. People may have substantial

directories in their heads. The development and use of these directories appears to be primarily inter-personal, and consequently degraded when the staff of an organization are distributed across locations.

The notion of TMS can enrich the umbrella term of 'organizational memory' by providing a more specific sub-unit of analysis. Transactive memory is particularly that part of organizational memory concerned with signposts. Whilst the directory portions of personal, internal knowledge are most clearly signposts, so too are parts of the organizational structure (official roles and market areas) and the workplace ecology (where people are seated and gather).

Reliance on TMS may be strongest in organizations that have a high degree of individual and tacit knowledge, low codification, strong personal relationships, a tradition of cooperation, communication and participation. A high level of personalization of knowledge implies that maintenance of directories (not only the transfer of knowledge itself) is better done through personal contact, in which the listener can abstract from what is being said and develop the appropriate labels in their 'internal directory storage'. The consequence of this is to provide opportunities and forums for this inter-personal interaction to occur wherever possible.

We anticipate that the role of technology would be to support but not replace TMS networks. Electronic tools to support TMS would need to support the three dimensions of TMS: directory maintenance, storage, and retrieval. Any system of yellow pages, user forums, intranets or glossaries proposed to support a TMS should be embedded in the specific organizational and social practices which underpin directory maintenance, use and knowledge allocation.

Managers and administrative staff may act as key nodes in the overall organizational TMS, linking those who need to know with those who know. This function of knowledge gatekeeper is well known, but the impact of travelling managers upon knowledge processes needs to be more carefully considered if they are to act as effective gatekeepers. This suggests that managers require mobile tools, so that perhaps simple requests such as 'who knows about x' can be easily routed to them.

In a head office organization, it appears that remote staff have greater difficulties in maintaining and accessing transactive memory. The capability to access information and knowledge sources is lower, which affects the coordination function of the overall TMS. Because virtual staff are not present, mindfulness of them is reduced and knowledge of their capabilities is low. Conversely, lack of mindfulness means that they are not informed of the knowledge existing within the head office and they lack opportunities to construct their internal directories. We suspect that lack of mindfulness also applies to distributed staff in other forms of distributed organization because of the lack of face-to-face contact among distributed staff. To overcome inhibitors to TMS, particular thought needs to be given to the needs of remote staff.

In the case study organization, the data gave us insight into the TMS as a dominant form of knowledge management, and underlines the differences between the capability of virtual and local staff to maintain and use the TMS. The inability to access information from remote colleagues (due to the arduousness of the relationship) might be specifically addressed by placing repositories on line (such as placing reports, CV's and marketing information in the portal) and creating bulletin boards to access people where the ultimate knowledge repository is personalized rather than codified.

# 6    CONCLUSION

Previous research into dyads and work teams has shown that a well-developed TMS has a positive impact on group performance. As a result of this study, we agree with Nevo and Wand (2005) that organizations can also be thought of as TMS. The notion of TMS suggests a form of knowledge management that focuses on using directories and metadata to find and use knowledge, rather than codifying the knowledge itself. Thus, systems that enhance TMS may be suitable where a 'personalization' strategy is pursued or where knowledge is largely 'embedded' in people.

On the basis of the case study described here, we have made the following observations regarding TMS:

The concept of TMS provides a framework for an examination of knowledge systems in organizations where such systems are highly personalized with low codification.

The notion of TMS can be extended beyond couples and teams to an organization as a whole, but the behavior of the organizational TMS exhibits particular characteristics.

Organizational TMS directories appear to consist of multiple storage media (formal groups, roles, informal groups, people, computer-based systems) containing certain metadata about the knowledge holders and their expertise.

It seems possible to identify gatekeepers, either by organizational role or by personal characteristics. Gatekeepers not only have access to information but are also readily available to provide directory information to others. Gatekeepers' directories are maintained through actions performed in the course of their work and accessed by virtue of their role.

Personal directory storage media appear to be maintained and used largely through interpersonal contact, discussions which allow a contextualized abstraction of the knowledge by others for future reference and is influenced by proximity, opportunity and personal characteristics. This approach appears to favor staff who are collocated or who come together in formal and informal meetings.

TMS processes appear to be influenced by physical remoteness. In the absence of systems that explicitly support development of TMS, staff remote from one another seem to be less likely to include distant staff in their directory systems even when these staff might want to share knowledge with one another.

It may be possible to develop information systems that support TMS, but these systems would need to be supported by the actions of individuals and procedures to keep directories up to date. Computer-based TMS systems may provide wider access to the organizational TMS, but may be less credible and informative than personal directories.

Future research in this area will examine how information systems might be used to improve organizational TMS, and in particular, the TMS of organizations whose staff are geographically distributed. Directory systems such as electronic yellow pages and signposted user forums could, for example, be used to overcome the lack of conversations and face-to-face discussions.

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