Managing Knowledge through Company Networks: A Stage Model

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ABSTRACT

Knowledge is only created through communication. Organizational networks, having their hearth in the local area networks, are the primary tool for business communication. Here we present a stage model, which shows that organizational networks gradually grow from 1) basic operations support to tools for 2) data collection, then to 3) information exchange, in order to finally enter to the 4) knowledge management stage. Key characteristics of the organizations and organizational networks that change over the stages include the used technology, scope of the network, state of network management practices, richness of communication methods, time and place synchronization, user awareness state and diversity of end user devices and applications.

Furthermore, we define a model of the basic infrastructure needed for any knowledge management activity. The components of this model are: Knowledge storage, resources for knowledge collection, support tools for knowledge formation, resources for knowledge distribution, as well as tools for knowledge quality management and knowledge mapping. Within each of these infrastructure components, communication networks play a crucial role.

Our study rests on an empirical study on ten Finnish organizations. We support our theoretical model through a mapping of our case companies to it. To provide concrete recommendations for business, we list key actions that are needed in order to proceed from one phase to another in the model.

Our studies show that insufficient technology management, but more importantly, missing user communication skills – both at technological and at human-human level – badly impede the development of knowledge management in many organizations.

Keywords: Local area networks, LAN, network management knowledge management, stage model

1. INTRODUCTION

In current information systems (IS), data structures are deeply intertwined to the network structures. Consequently, our access to networks also define our access to data. If network arrangements are underdeveloped, an organization can neither have effective knowledge management.

We use the classical definitions of information system science for data, information and knowledge. Data is the basic unit born in actions, and can be that it is never utilized. Data turns into information when utilized in cognitive processes, usually in the heads of humans, but too in processes implemented to software, say also artificial intelligence. Knowledge is the total amount of data and information commanded by a unit, individual or organization. Knowledge should be turned into wisdom and into competitive advantage, to take the business language. Our definition of knowledge is: information that can be used to have an effect on something. Even most important information is valueless unless it can be implemented to work in an organizational context. This implementation can only happen through communication taking place through organizational networks. Our educative goal is to show the close relationship between knowledge and network management.

The networked organization is usually not born out of grand alliance thinking. It is born out of daily information exchange between active organization members: "Prophets of the 'networked company' have focused on top managers and big grand-concept level alliances. But many of the most effective networks are being woven by unsung middlemen." [1]

Classically, network management has been seen as a technological domain consisting of such tasks as

- Configuration management
- Fault management
- Performance management
- Security management
- Account management

In this view, knowledge and network management were separate functions. Currently, however, these two activities are tightly bound together. Several reasons for that exist.

It is understood that knowledge is born out of a communication process between actors [2]. Without communication and constant exchange and monitoring of information, it will never mature to valuable knowledge. Networking allows communication to happen.

Within less than ten years the Internet and especially the WWW have opened the domain of available knowledge to a new dimension. Availability of information and knowledge is no more bound to access to physical media such as books and CD's, but to the structure of networks. Network configurations and access rights are the key technology to allow or inhibit access to knowledge.

Organizations themselves get more distributed, or even function as virtual network organizations. For the virtual organizations, networks are the glue keeping them together.

Peer-to-peer computing is winning ground. In this form of computing, the key point is that sharing of resources, including knowledge, is based on mutual and equal activities and positions. In the purest form, there are no servers or clients, but the information itself is distributed to the network [3]. Information sharing actually is the key application of peer-to-peer computing. Especially useful it is in cases when there is no central authority to guide knowledge formation, or when such one is not welcomed. Peer-to-peer computing is a key application to increase creativity. In creativity, mistakes must be allowed, and a central authority with punishing and controlling activities does not usually enhance productivity.

The concept of hidden knowledge too deserves some attention [4]. This kind of knowledge cannot be implemented to common databases and hardly even to any explicit form. However, it can be exchanged to some extend between humans. For this process, effective communication channels are needed.

Information is presented in modern organizations in many other forms than just structured data. With that in mind, database administrators have in many aspects given way to webmasters as the most important authority in organizations as it comes to information management.

2. A STAGE MODEL FOR ORGANIZATIONAL NETWORKS

In this section we shortly define how organizational networks grow through four stages from basic operational support to tools for knowledge management.

Table 1 A stage model for organizational networks

	Basic operations support 1985 -	Data collection 1995 -	Information exchange 2000 -	Knowledge Management 2005 -
the used technology	basic LAN	broadband LAN	Wireless LAN	Private Virtual Network
scope of the network	unit	organization	campus	unlimited
network management practices	running	controlling	developing	enabling
time syncronization	offline	on-line	syncronized	anytime
place syncronization	fixed workplace	teamwork	virtual organization	nomad
user awareness state	"my data"	"our data"	"public information"	joint source of competitive advantage
richness of communication methods	phone	e-mail	intranet	instant messaging
end user devices	PC	PC	Laptop	Digital personal assistants
end user applications	Legacy systems	Basic office tools	Browsers	Peer-to-peer applications

Our first stage is **basic operations support**. Here the local area network is to support basic office routines, such as access to mainframes and printing services. Technology is based on established products such as Ethernet or Token Ring, in their basic forms. Network management is happy with keeping the network running, and does not have very much effort to develop the network further and educate users. Activities happen mainly within one organizational unit, say department, and intra, - not to speak of inter-organizational, communication is scarce. Computer tools for synchronous communication are few, and phone is the main tool for such communication. Workers concentrate in maintaining their own data for their own usage, either in mainframes or personal computers. Legacy systems are the main application to be used, and knowledge sharing happens through their central databases, not in human-human communication.

The second stage is that of **data collection**. Emphasis turns more to data, not just operational routines. However, data is being collected for personal or group use, and active exchange of it is still out of question. As groupwork is increasingly adopted, sharing data between the group is important, and e-mail allows on-line communication, which anyway seldom is conducted in real-time synchronized mode. Network management concentrates very much on controlling, both in costs and user access to services and data. Data and network security is an important aspect. A visible change in the technology is often the switch-over to broadband-Ethernet, which will allow for new applications. This is the golden age of classical PCs and basic office tools such as word processing and spreadsheets. A visible sign of this period is the vivid exchange of documents as e-mail attachments, indicating that information exchange is still in an immature stage.

We call the third stage **information exchange**. Here the key change is from collecting information to actively distributing and exchanging it. The keywords are web-publishing and Intranets. Similarly, for users net browsers are a key application. LAN technology is often turned to wireless LAN, and classical PCs give way to laptops. The wireless LAN typically covers what might be called a campus. Local area network management takes an active role in the information exchange, a metaphor for their new role is that of web-master. Communication emerges in virtual organizations that are not restricted by geographical limits, and new tools such as conference systems emerge for synchronous communication. A typical milestone signalling that the organization is entering into this stage is the establishment of an Intranet.

The so far final stage is that of **knowledge management**, named also after our goal. Communication is totally mobile, and happens over virtual private networks. Mobility increases the amount of nomad workers [5], who by definition travel around and usually are seen by customers, or on the move at airports, hotels etc. These people seldom enter the main office. Technologies such as instant messaging are in rich use. Data, information and knowledge are seen as a shared core competence and resource, and they are all the time cultivated to become knowledge in groupwork.

User applications are based on peer-to-peer communication tools, and classical computer-based solutions increasingly give

way to small personal digital assistants, which integrate small size and communication possibilities.

3. LOCAL AREA NETWORK AS A COMPONENT IN KNOWLEDGE MANAGEMENT

In this section we represent a conceptual architecture for knowledge management, and discuss the role of communication networks, especially local area networks, in the case of each component. The conceptual architecture is presented in Figure 1, constructed from the inspiration by Bo Sundgren's concept of "infological databases" [6].

The kernel of knowledge management is **knowledge storage**. It is usually defined to be the basic official knowledge, often called data warehouse, and to a set of supporting unofficial data storages. Communication networks enter to the picture very strongly, as the basic database usually is distributed, also needing communication between the parts. Another, increasingly dominant form of data storage is that of Intranet, where the data storage is even more integrated to communication tools and structure. In a wider sense, the whole Internet is the knowledge storage of our age [7].

Knowledge collection in automated form mainly takes place through legacy systems. Strictly speaking, we can just collect data, not knowledge. Depending on the type of operations, legacy systems can be very dependent on communication networks, take logistics as an example. In addition, employees survey the environment through the Internet, in a process often called competitive intelligence [8].

Knowledge formation tools put structure to knowledge. Whereas older knowledge structures were dominated by classical database management tools, current formation of knowledge is very much dictated by Internet-standards such as HTML and XML. However, knowledge formation is the most human-work intensive part of the knowledge management activities.

Knowledge quality management happens through continuous assessment and validation of knowledge. Knowledge matures as it is being used and at the same time validated. The process is very much integrated to knowledge distribution and usage. **Knowledge distribution** increasingly happens just through electronic means, also over communication networks. However, we must remember that informal information channels, also human-human –communication, is always a basic cornerstone in knowledge distribution. Human-human –communication, however, is usually mediated through electronic means, phone maybe being the most used tool.

By knowledge distribution we mean push-technologies. Knowledge is however often too pulled for, also actively searched. This process we call **knowledge mapping**. Here browsers, search engines and network directories, all key technologies in networking, are in a dominant role. Even access to distributed classical databases happens through communication networks.

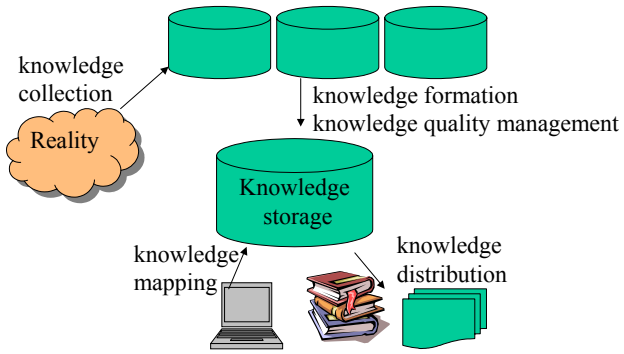

Figure 1 Knowledge management tools

4. EMPIRICAL INVESTIGATION

Our study rests on an empirical study on ten Finnish organizations. The case organizations are situated mainly in Western or Southern Finland. Some of them have offices in several locations, operate internationally, have offices abroad or belong to a larger international group. However, also very small organizations are included in the group of case organizations. Their organizational networks were studied during winter 2000-2001. Altogether 66 interviews or meetings took place during the empirical research project.

The sample contained both private companies in many size classes as well as experienced networks and knowledge managers – among them the operating company for the maintenance of the Finnish University Network FUNET: CSC Centre for Scientific Computing – to set a contrast to many organizations just in the beginning of their knowledge management practices.

The case organizations are heterogeneous on purpose. They were selected to the case group in order to bring different viewpoints to management of local area network. Therefore they come from different industries. Only two of the case organizations work with high technology or information technology. Other organizations operate in industries where expertise, services and production are in areas other than information technology. A heterogeneous group of case organizations should make it possible to compare management approaches and help to find best practices.

Methodically the study was a combination of case study and statistical research. Both qualitative and quantitative data was collected from the organizations. In this research we use two main research methods; the primary method was interview with managers, key persons and IS-people. The second method is a user questionnaire, which was the main method to find out what users think of their organizations infrastructure.

Interviews and other discussions in the case organizations indicate that there are no major problems in the infrastructure. The local area network is considered as a reliable basis for operations, and in most cases it works smoothly without interruptions. The relative importance of information technology in the industry and the organization does influence

the perceived role of infrastructure, but generally network is considered as a critical resource.

Based on discussions in the case organizations robustness and reliability in the infrastructure is a result of many choices. Firstly, there is a tendency to trust well-known brands when selecting components like hubs, switches or network adapters to workstations. Error-free and reliable functionality of the device are considered more important than price. Usually IT managers favor one or two brands when new hardware is being chosen because a small number of different brands are easier to manage and support. Secondly, controlling and monitoring the network help to prevent problems.

In most organizations operations are not possible without data. However, there are several risks that threat data (like fire and intruders), and therefore it is important to make sure that data is not lost if a serious problems occurs. This is why backup of important data is critical.

We found that in larger organizations servers are backed professionally. However, in smaller organizations server backup procedures could be more extensive. For example, in one of the case organizations critical financial data had not been backed up in months even though this data is critical for operations and not available anywhere else. Workstations and laptop computers (there were surprisingly few laptops in the case organizations) are more problematic. Workstation files are poorly backed, and in only one organization files on workstations are systematically backed up. In most cases users are supposed to do backups themselves. However, interviews and discussions revealed that users may not know how what to do, which commands to use etc. - and the backups will not be done. In both workstations and laptops a centralized backup solution would be superior, because it would make backup systematic and extensive. Otherwise backups will remain ad hoc.

We found that in most case organizations the level of security is not as high as it should be. In typical case there are shortcomings in both the protection of the local area network from external threats and in the way people work. It seems that most organizations believe that "nothing bad can happen to us". Typically precautions are ad hoc and there has not been thorough security planning and risk charting of any kind. However, in some organizations risks are understood and security is on a high level. In organizations that work in fields that are in high technology security is considered as an important issue.

In general, maintenance of the existing infrastructure is important. However, it seems that in most organizations maintenance is event-driven: when something fails it will be fixed. This indicates that network managers try to keep the systems running – but the networks are not necessarily very controlled. The network management is far from systematic activity. Based on this research the networks are controlled systematically only in larger organizations, in smaller organizations there are typically no tools for controlling what is happening in the system.

The technology that is used in the case organizations consists of both basic and broadband networking technology. A shift to faster technology is happening – most users have a 100 Mbps connection to the LAN. However, wireless technology is not common, only one of the case organizations used wireless network. In this case wireless connections covered only a part of the organization, most users were connected with "traditional" hard-wired technology. Some other organizations had tested wireless technology, but it was not yet in business use. In a typical case user has a "traditional" PC and runs basic office tools and some legacy business application. Surprisingly few people had laptop computers, and practically only Intranet is being used with the browser - if the organization had an Intranet.

In most cases the IT infrastructure was considered as an organization-wide network: discussions in the case organizations indicated that the function of a LAN is to connect departments, units and offices. The network was not considered "unlimited" - it is a system that connects "us" together and leaves "others" outside.

Even though users are connected they work alone in a fixed workplace "offline". Interviewed persons did not mention on-line work, or use terms like virtual organization or nomad access. However, in one case organization users work in teams. We noticed also that in leading positions working takes place anytime and anywhere. Place and time synchronization depends on the industry and organization - and especially each person's work and task in the organization.

Typically the data that will be shared is stored in servers. Discussions indicated that there does not seem to be any strategy on where data will be stored – knowledge management is rather ad hoc. Knowledge management is more a result of the technology and applications that are used – when a new business application is implemented, the data is stored to a database server. Consequently, this data is considered common "our data". In addition, we found plenty of data that is stored on personal computers or laptops, and only occasionally shared with others. In this case the data was typically send by e-mail. This data is most often "my data", and far from "public information" or seen as a common source of competitive advantage.

Users seem to favor phone and email in their communication. Also Intranets were used in communications in some case organizations. Despite this users tend to favor direct phone call rather than typing the message. One explanation is that there were no instant messaging applications available – email forces one to think what to say as the email message can later be used as an "evidence against you". In instant messaging this would not be the case.

To sum up, most of our organizations were at the "data collection" phase of our stage model. Especially for smaller organizations, setting up an Intranet is a big step. In addition, wireless LAN is still often too expensive and complicated a technology. In the organizational sense, however, many of our case organizations already were in the process of entering to the "information exchange" phase, as much of work already happened in a virtual type of organizing.

Entering the information exchange phase is too dependent on the industry of the organization. Organizations in information-intensive industries more naturally too perform information exchange, whereas organizations active in physical production are faster stuck to the earlier phases of our model.

5. CONCLUSIONS

In modern organizations, network and knowledge management activities are strongly bound together. Actually we see transition from centralized to distributed databases to happen once again, now anyway in a very much larger scale, breaking even the boundaries of classical organizations. What has too changed is the nature of knowledge: structural data has been bypassed by multimedia data and even hidden knowledge.

The Internet revolution with WWW, data presentation standards such a XML, Intranets, webmasters and peer-to-peer computing have integrated concepts of network management and knowledge management together.

Our studies show that most organizations still find themselves at the data collection phase. The computers are networked together in order to use common business applications. However, otherwise data is shared by e-mail. In most organizations is security inadequate: the network is not protected from possible outside intruders and the risk charting is missing. Generally, users do not know what security threats there are and how to work in a more secure way. The shortcomings can also be seen in backup procedures – especially data from personal computers and laptops is not properly backed.

To be sure, many organizations have not yet even entered to the first stage in our model. We feel that they enter this stage as they implement a local area network. The critical point to move to the next phase of data collection is the introduction of team-spirit. Workers must understand themselves as value-adding actors in work-processes. “My data” becomes “our data”. Extensive introduction of e-mail is usually the visible action that brings the organization to this stage.

To enter the information exchange phase, the organization must turn a lot of information exchange activities to the Internet. Introduction of an Intranet is usually the technology trigger. At this stage, management must give the organization freedom to innovate and try new solutions: too much control instead of incentives for development can hinder the transition.

The knowledge management phase is a kind of future vision, which cannot easily be accessed in most organizations. Here constant value adding to public knowledge is the norm way of working. This is what they call the hacker ethics [9]. Creation of knowledge is not limited by organizational boundaries, and most work is done in virtual organizations. The key management action is employee empowerment [10-12]. A visible step to this stage is the introduction of instant messaging, which creates a value-climate of instant action.

Insufficient technologies, but more importantly, missing user communication skills – both at technological and at human-human level badly impede the development of knowledge management in many organizations. A further problem is that even in advanced organizations people do not recognize the value of knowledge as an organizational asset. As a result, we propose more networking education for knowledge workers, again both at technical as well as at an organizational terminology. The goal of the education should be an increased motivation and pressure to take part in knowledge collection, creation, maintenance and sharing activities through organizational networks.

References

1. Schrader, S., *Gaining Advantage by “Leaking” Information: Informal Information Trading.* European Management Journal, 1995. **13**(2): p. 156-163.
2. Astley, G.W., *Administrative Science As Socially Constructed Truth.* Administrative Science Quarterly, 1985. **30**: p. 497-513.
3. Oram, A., *Peer-to-Peer: Harnessing the Power of Disruptive Technologies*. 2001: O’Reilly.
4. Nonaka, I. and H. Takeuchi, *The Knowledge-Creating Company*. 1995, New York, NY: Oxford University Press.
5. Crossan, G. and P.F. Burton, *Teleworking Stereotypes: A Case Study.* Journal of Information Science, 1993. **19**: p. 349-362.
6. Sundgren, B., *Databaser of datamodeller*. 1981, Lund: Studentlitteratur.
7. Morrison, J., ed. *Organizational Memory Information Systems - Characteristics and Development Strategies, Proceedings of HICSS-30 Conference*., ed. H.R.J. Sprague. 1997: Hawaii.
8. Cronin, B., et al., *The Internet and Competitive Intelligence: A Survey of Current Practice.* International Journal of Information Management, 1994. **14**(3): p. 204-222.
9. Himanen, P., *Hakkerietiikka ja informaatioajan henki*. 2001, Helsinki: WSOY.
10. Randolph, W.A., *Navigating the journey to empowerment.* Organizational Dynamics, 1995. **23**(4): p. 19-32.
11. Smialek, M.A., *Team empowerment: A simple and easy solution.* Quality Progress, 1998. **31**(9): p. 65-71.
12. Quinn, R.E. and G.M. Spreitzer, *The road to empowerment: Seven questions every leader should consider.* Organizational Dynamics, 1997. **26**(2): p. 37-49.