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Organisational Implementation of Collaboration Technologies - an integrative review

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Abstract

The paper presents an integrative review of field-based research on organisational implementation of collaboration technologies. Based on a typology of collaboration technologies, findings from previous implementation research related to different types of technologies are identified and discussed. A taxonomy of implementation factors is presented, that may serve as the basis for further implementation research and development of implementation strategies for different types of collaboration technology.

Keywords

Collaboration technology, groupware, IT implementation, adoption, diffusion, literature review

INTRODUCTION

Collaboration technology is the common term used for information and communications technology (ICT) supporting collaboration at various levels, from interpersonal to inter-organisational. These technologies are currently gaining increased attention, as they form the infrastructure for important strategic concepts such as collaborative commerce (Bond *et al.*, 1999), knowledge management and global teamwork.

Organisational implementation of collaboration technologies has been an area of research ever since the first organisational applications of groupware technologies. The early research identified important issues affecting the implementation of collaboration technologies, such as critical mass (Grudin, 1994; Markus and Connolly, 1990) and perceived disparity in work and benefit among adopters (Grudin, 1989).

With the technologies evolving and gradually diffusing into organisations, an increasing number of studies have been reported on the process related to organisational assimilation of these technologies. However, few attempts have been reported of accumulating the findings generated from field-based research on the implementation of *different* collaboration technologies, focusing on implementation factors specific to each type of technology. This is the aim of the research presented in this paper. Based on an extensive review of research on implementation of collaboration technologies, the paper presents a taxonomy of implementation factors for different types of collaboration technology. This taxonomy may serve as the basis for further research on the implementation of different types of collaboration technology, as well as for developing implementation strategies adapted to each technology.

The next section presents a typology of collaboration technologies that forms the basis for this review. This is followed by a review of previous field-based research on the organisational implementation of the different categories of collaboration technologies in the typology. Based on this review, a taxonomy of implementation factors for different types of collaboration technologies is presented. The final section presents conclusions and implications.

A TYPOLOGY OF COLLABORATION TECHNOLOGIES

Collaboration technology basically supports the following three functions (Grudin and Poltrock, 1997):

- Communication; interpersonal communication through audio, text, video, etc.
- Information sharing; creation and manipulation of shared information objects
- Coordination; managing interdependencies between participants and their activities.

This forms the basis for the typology of collaboration technologies applied in this paper, presented in Table 1. Compared to the functions listed above, the typology comprises two additional categories. Meeting support technologies are included as a separate category due to the special application area of organisational meeting processes targeted by this technology. Integrated products combine features from several of the other categories, representing the growing trend towards products supporting 'anytime, anyplace' collaboration. Table 1 also lists examples of technologies for each category.

Main categories	**Examples of technologies**
Communication technologies	Email Instant messaging Audio/ videoconferencing
Shared information space technologies	Document management systems Knowledge repositories Data conferencing/ application sharing
Meeting support technologies	Electronic meeting systems (EMS)
Coordination technologies	Workflow management systems Online calendar and scheduling systems
Integrated products	Collaboration product suites, desktop conferencing systems, e-Learning technologies

Table 1: A typology of collaboration technologies

A REVIEW OF PREVIOUS RESEARCH ON IMPLEMENTATION OF COLLABORATION TECHNOLOGIES

This section presents key findings from previous field studies of the implementation of different collaboration technologies. The review has included more than thirty implementation studies of different collaboration technologies. In addition, former review articles summarising previous field-based research related to a specific technology have also been included (e.g. Fjermestad and Hiltz, 1999; 2001; Karsten, 1999).

Following the typology in Table 1, the current status regarding implementation research for each type of technology is briefly presented, together with empirical findings related to this technology. However, the format of this paper only permits a brief summary of the empirical findings. (For a more extensive discussion of the research on collaboration technology implementation, see Munkvold, 2002.)

Implementation of Communication Technologies

This category includes both asynchronous and synchronous communication technologies. Field-based research on communication technologies has focused more on how the electronic media affect communication and interaction, than on the process of organisational implementation of these technologies. Establishing universal access to the services and building a critical mass of users are key issues in the implementation. A major challenge is also to establish guidelines and norms for effective use.

Email

Email has so far been the most successful collaboration technology regarding diffusion and user adoption. This is explained by the intuitive nature of this service and the clear analogy to 'traditional mail' (Bullen and Bennett, 1990). However, despite the simple and intuitive functionality, there may still be barriers to effective use of this technology. Due to the general familiarity with this technology among today's employees, user acceptance does not represent a problem in the implementation of this technology. As a result, this technology is

often implemented without much emphasis on training or practical guidelines. This may actually result in problems related to ineffective use of the technology.

For example, a survey of email users in a Norwegian public service organisation half a year after implementation, showed that 50 % of the users still had problems with the system and did not know how to take advantage of all its possibilities (Kautz, 1996). Lack of guidelines may result in infrequent use (such as not checking the mailbox daily) and uncritical distribution of documents as email attachments to a large number of employees without considering who really needs this information.

For distributed organisations that rely heavily on electronic communication, establishing protocols for effective communication is especially important. This may include creating closed 'communication loops' by always verifying the receipt of messages, practising "active electronic listening" through email, and assigning appropriate priority to messages. In addition comes the development of general norms for what is to be considered acceptable 'tone' and forms of electronic communication in the organisation ('netiquette').

Videoconferencing

The diffusion of videoconferencing in industry has been slower than originally predicted. Costly investments, technological requirements and a relatively high learning curve have acted as barriers (Egido, 1988; Sanderson, 1992). Further, as for all synchronous collaboration technologies, time zones may constitute a barrier for use of this technology in global companies and projects. Research on the organisational use of videoconferencing and the related effects has also been fairly heterogeneous regarding focus, methodological approaches, research design and equipment used, with findings being equally mixed (Finn *et al.*, 1997).

With the development of PC-based desktop videoconferencing systems several of the implementation problems have been eliminated, and the rapid development in these products offers improved quality and accessibility of services for less cost.

Instant Messaging

Even though email is the most widespread communication tool today, it has some limitations. When sending an email, you do not know if the receiver is online, and the asynchronous mode of this tool makes it difficult to have a running conversation with this person. Instant messaging (IM) combines the real-time advantages of a phone call with the convenience of email. With IM you can see whether a person is online, and exchange text messages in near real-time. Most IM-products also include functions for establishing chat rooms with friends and co-workers, exchanging files, and conducting audio- or videoconferences. IM therefore also serves as a medium for coordinating interaction, launching other communications services after checking the communication partner's presence and availability.

A recent study on the use of IM documents how this technology enables new forms of communication and interaction in the workplace (Nardi *et al.*, 2000). The flexible and immediate nature of IM was found to support a range of informal communication tasks: quick questions and clarifications, coordination and scheduling, organisation of impromptu social meetings, and keeping in touch with friends and family. Compared to email, the immediacy of IM makes it more suitable for scheduling, while also avoiding the more lengthy interaction of a phone call.

By providing awareness information about the presence of communication partners, IM also served an important function in negotiating the availability of others to initiate a conversation. When a session was initiated IM was also used to manage the conversational process, including switching to other communication media (phone, email, etc.) during the interaction. This type of media switching coordinated by IM can be expected to become increasingly widespread, as IM systems become integrated with audio, video and data conferencing. The flexible interaction forms enabled by this thus calls for guidelines for effective media switching and use.

Implementation of Shared Information Space Technologies

Shared information space technologies include document management systems, knowledge repositories and data conferencing. Few studies have been identified in the collaboration technology research literature that focus explicitly on the organisational implementation of document management systems. However, related to the focus on knowledge management (KM), these technologies are addressed as part of the implementation of a 'KM infrastructure' (Davenport and Prusak, 1998). There is also a growing focus on enterprise content management (ECM) as an overarching information management strategy in organisations, but there is still little field-based research on the implementation of this type of solutions. As for data conferencing, studies of organisational adoption and use of this relatively new technology are starting to appear.

Document Management Systems

Based on a field study of the implementation of a document sharing system in a UK government organisation, Bowers (1994) discusses how the transition from paper based to electronic document handling introduces new challenges related to accessibility, ownership and maintenance of the information. The introduction of new technical possibilities was found to provoke debates about existing practices. An important question in the introduction of the technology became whether the existing documents and related practices should be changed, or if the technology should be rejected as being inconsistent with the existing practices. For example, in addition to making the documents easily available the technology also made the practices used for producing the documents "visible, inspectable and manageable". This led to suggestions of changing the temporality of existing work practices, such as using 'continuous' status reporting instead of monthly reports. However, this raised several questions related to who should have access to these status reports, and at what stage in the process 'work-in-progress' documents should be made available in the network. These issues actually resulted in much of the 'real work' of the document production remaining off the network. The ability to share documents was also found to result in dilemmas of responsibility and ownership.

Knowledge Repositories

Davenport and Prusak (1998) report on industry practices related to the conduct of knowledge management projects. Based on studies of more than thirty leading companies worldwide, they found that these projects usually comprise one or more of the following three elements:

- creation of knowledge databases or knowledge repositories
- improved access to knowledge in the company ("who knows what") and the transfer of this knowledge
- improved "knowledge culture" and "knowledge environment".

These projects include different technological architectures. The knowledge databases are based on technologies such as Lotus Notes databases or document management systems. A general challenge related to the development of these systems is to establish a set of common keywords for information searches. In addition, clear roles and responsibilities need to be established for maintenance and quality assurance of the database contents. Effective use of shared databases and knowledge repositories also require routines for information sharing, backed by explicit incentives (see also related to Integrated Products).

Data Conferencing

Data conferencing combines text-messages (chat), shared whiteboard and application sharing. The most widespread product in this category is MS NetMeeting, available as a service in MS Windows. Several studies report weaknesses and technical problems related to data conferencing, such as incompatibility between different versions of NetMeeting, problems with locating other users due to the lack of a common default server, slow refresh ("motion sickness") when moving or resizing shared windows, and the graying out of windows of non-shared applications blocking shared windows (Finholt *et al.*, 1999; Line, 1998). With the audio quality of these products still being somewhat limited, many

organisations choose to use phone conferences in parallel with the application sharing functionality in NetMeeting.

The Boeing company makes extensive use of data conferencing for supporting distributed meetings. Based on observation of four permanent teams, Mark *et al*. (1999) describe the practices developed around use of NetMeeting in Boeing. Without an assigned role of "technology driver", establishing the NetMeeting sessions often took ten minutes or more, representing a substantial loss of time for the 10-20 members present. Further, problems were also observed due to different configurations being used at each site, and limited use of some of the functionality. During the meetings there were also frequent problems with coordinating interaction, involving difficulty in knowing who were present at each site and uncertainty about turn-taking during the discussions. Many people also conducted "multitasking" when attending these distributed meetings, such as reading email or talking with other people in the room. While the participants considered this to be an advantage, it also lowered their involvement and commitment in the actual meeting.

As a result of these problems, some of the teams created new facilitator roles similar to ones used in face-to-face meetings. The technology facilitator would be responsible for all aspects of technology use, such as establishing a connection, trouble-shooting and controlling the presentation (for example through gesturing with the cursor and zooming in on relevant content). The virtual meeting facilitator took some of the load off the meeting leader, focusing on integrating the remote sites in the meeting discussion. This involved identifying who was speaking, explaining comments for the benefit of remote sites and probing their responses, and facilitating turn-taking in speaking.

Implementation of Meeting Support Technologies

Most of the research on electronic meeting systems (EMS) has been conducted in academic, "laboratory" settings, studying the impact of EMS support on process and outcome for student groups working on assigned tasks and comparing this with "traditional" face-to-face teamwork. The lack of organisational context in these experimental studies clearly limits the possibility for generalising the findings from this research to use of the technology in real organisational settings. With increasing proliferation of this technology in organisations, the number of field studies is also increasing. A recent review found more than fifty such studies, focusing on use of EMS in a range of different areas such as strategic planning, business process modelling, and requirements analysis and design (Fjermestad and Hiltz, 2001).

In general, the results from these field studies are much more positive regarding the effects of the technology on the process and outcome of organisational meetings, than the more mixed findings from the experimental research. For example, group productivity gains from EMS use – such as 50% reductions in labour costs and 90% reductions in elapsed project time – were found in studies at IBM and Boeing (Grohowski *et al*., 1990; Post, 1992). Broader and more active participation has been widely substantiated in both lab and field research, and buy-in and ownership of the meeting results is often increased by EMS use (Nunamaker and Briggs, 1997). EMS use may lead to improved decision quality, through increasing the number of creative ideas put forth, and stimulating more thorough problem analysis (Tyran and Dennis, 1992).

Despite an increasing number of field studies, there are still few studies that focus explicitly on organisational implementation of EMS. The unit of analysis is mostly at the team level, with most studies focusing on the appropriation of the technology by permanent teams. Further, much of this research is conducted in organisations that use these technologies at third party sites. The costs involved in installing technologies like GroupSystems imply that many organisations find it too expensive to purchase a company licence, and instead prefer to use the technology through consulting services provided by academic institutions. The studies that do exist on organisational implementation of EMS report the following critical success factors: organisational commitment, the need for an executive sponsor, training, facilitation support, dedicated meeting facilities, cost/ benefit analysis and meeting managerial expectations (Bikson and Eveland, 1996; Grohowski *et al*., 1990; Munkvold and Anson, 2001).

Implementation of Coordination Technologies

The two most important technologies in this category are workflow management systems and online calendars. This section summarises key findings from the implementation research related to these technologies.

Workflow management systems

Workflow management systems (WfMS) have had a relatively slow growth in industrial use, compared to other collaboration technologies. Several studies report of problems in the process of implementing workflow systems, and in the academic literature there are still few examples of success stories on the use of this technology. Skeptics have pointed to inflexibility in the automated routines as well as possible misuse of managerial surveillance as potential negative aspects of this technology.

A study of WfMS implementation in German industry identified several problems in the development of workflow applications, resulting in extensive delays or complete abandonment of the technology (Weske *et al*., 1999):

- Lack of integration of organisational and technical aspects of the workflow model, as these often were worked out independently
- Selection of workflow system in a very early stage in the project, later experiencing problems with supporting specific requirements needed in the project
- Lack of prototyping in the development process
- Problems in transferring the business process model into a workflow model, due to different focus and possible limitations in the workflow system
- Resource demanding integration with legacy systems
- Severe performance problems identified during field tests.

Adding to the problems in the early stages as described above, a frequently cited study also report problems in the operational stages of workflow implementation (Bowers *et al*., 1995). As part of the requirements of a major tender won by a UK printing company, they had to install a workflow system for monitoring work at the shopfloor. The researchers observed how the shopfloor workers prior to the implementation applied different ways for ensuring a “smooth flow of work”, such as prioritising work on the spot, reshuffling tasks among the different workers to balance the load, and preparing for anticipated tasks.

When the new system was implemented, this imposed a new work model that was basically different from the one being practised among the shopfloor workers, thus disrupting the smooth flow of work and creating major overhead and obstacles in the shopfloor operations. For example, the new system identified all tasks by its job number, making it difficult to register activities related to preparation of incoming tasks. Further, the system was built around a one to one relationship between operators and processes, making it difficult to register the common practice of sharing processes among operators during execution. As a result, the workers had to develop different ways of working around the system and its constraints. The most extreme of these workarounds was that of one department who only entered data into the system at the end of the day based on manual notes kept as before.

However, albeit somewhat slower than expected, the number of company installations of WfMS is rising steadily, and examples of successful use are also starting to appear in the research literature. For example, a field study in two companies in the IT industry describes how workflow management features are successfully used to support configuration management in systems development (Grinter, 2000). Contrary to the findings from the printing company discussed above, the formalisation and automation of work processes offered by the workflow technology here led to successful improvements of the work process compared to the previous manual methods for configuration management. This was obtained through providing support for identification and control of changes to components (“checking out in” of software for revisions), problem management through logging of problems and process management by assigning roles to the different tasks in the development lifecycles. These features resulted in the following areas of improvement:

- faster and more reliable assembly of software components to build new testable versions of the software, and improved support for locating the source of errors
- increased awareness of the development state through logging information about changes made
- support for prioritisation and assignment of outstanding work to developers, through integrated problem reporting facility.

In contrast to the printing case, the work model embedded in the configuration management tool corresponded well with that of the software development practices previously enacted by the developers, and the developers thus understood and accepted this model. Further, the processes automated were "right" in the sense that both users and managers supported these. The system was also flexible in that it did not automatically assign problems to individual developers. Instead, a group of people would meet and assign problems based on the problem log, and assign priorities to these. The developers would then notify each developer responsible for resolving the problem, but would not require that the problems were addressed in the prioritised sequence. Finally, the supportive culture of these companies was also important for the successful use of the technology. As examples of this, the developers were able to structure their workdays and schedules in an autonomous way, and managers were willing to take the developers` opinions.

Similarly, the use of two Lotus Notes-based workflow systems for tender assessment and service request management in a medium-sized IT company in Australia, provided the following benefits (Atkinson and Lam, 1999): improved status tracking and liability, consistency and conformity, standardising work practices, improved productivity, and improved management support through providing status information and enabling load balancing of task allocations.

However, some negative impacts were also identified related to the social interaction within the organisation. Some employees pointed out that there tended to be an over-reliance on use of the system for communication, leading to a reduction in human interaction. Further, the possibility for surveillance by management through the system was perceived to increase work pressure among employees, and they had a constant feeling of 'Big Brother' watching over their shoulder.

Online calendars and meeting schedulers

The second major category of coordination technologies is online calendaring and scheduling systems. Calendar systems enable groups and organisations to maintain individual calendars and share these related to common events and resources (such as meetings and meeting rooms), while scheduling systems enable automated search through these calendars for finding available time slots for meetings (Knudsen and Wellington, 1997). Scheduling systems are also often integrated with email for automated invitations to meetings.

Online calendars for long were referred to as an example of a 'groupware failure', not being widely adopted in organisations. A possible explanation for this was problems in establishing a critical mass of users due to disparity in work and benefit from maintaining these calendars (Grudin, 1994). However, during the 1990s this technology has become more widespread in use. This is explained by improved network and client server architectures, better user interfaces, improved support for individual tasks and better email integration (Grudin and Palen, 1995). For this technology, peer pressure from colleagues was found to be the dominating factor stimulating individual adoption, rather than managerial mandate or support from champions.

Implementation of Integrated Products

This category comprises products combining features from several collaboration technologies. The typology in Table 1 included three major types of integrated products: *collaboration product suites* such as Lotus Notes, combining various asynchronous technologies (email, document management, threaded discussions, calendar and scheduling, etc.), *desktop conferencing systems*, combining audio, video and data

conferencing, and *e-Learning technologies*, combining various asynchronous and/ or synchronous technologies.

The research on implementation of collaboration product suites is clearly dominated by studies of Lotus Notes, and this section will present some key findings from this research. As for desktop conferencing systems there are still few studies focusing on the implementation of combined audio, video and data conferencing. Several companies actually seem to do without the video channel when running distributed meetings from their offices (Line, 1998; Mark *et al.*, 1999). However with increasing bandwidth and lower costs, the use of these technologies can be expected to grow in the future.

E-Learning technologies have only just started to become widespread, so apart from consultants' reports and vendor white papers there is yet little field based research available to inform us on guidelines for successful implementation and use of these technologies.

Lotus Notes

Being the first collaboration technology to gain widespread adoption in industry and considered the "groupware standard" for many years, the number of field studies on Lotus Notes is greater than for any other collaboration technology. The flexibility and related complexity of Notes combined with its marketing as a tool that will "transform" the organisation through increased communication and information sharing, have also attracted interest from the research community.

Despite the potential of Lotus Notes for supporting increased information sharing and collaboration, many of the field studies of Notes implementation and use report problems in realising these benefits (Downing and Clark, 1999; Vandenbosch and Ginzberg, 1997). This is often ascribed to insufficient user training in the collaborative potential of the technology, lack of explicit routines for effective use, and lack of incentives for information sharing (Orlikowski, 1992). The flexible and 'malleable' nature of this technology also means that the individual user's interpretation of the technology becomes important for framing the use (Korpela, 1994).

Based on a review of 18 case studies of Lotus Notes implementation, Karsten (1999) conducted an extensive analysis of the relationship between collaboration and collaboration technology. She identified three categories of Notes use:

- Exploratory, conservative or cautious use;

  This involved six cases where the applications were only used to automate the existing routines, or they were very limited in scale, or no major applications had been built at the time of the study.

- Planned and expanding use;

  This was the largest group of organisations, comprising eight companies that had implemented initially restricted applications, but which had plans for expanding these.

- Extensive and engaged use of Notes;

  The third category included cases where the use of Notes was extensive and where the users took an active role in integrating Notes applications into their work. Further, the nature and amount of collaboration was changed in the cases. Only four of the eighteen cases fell within this category.

Based on this analysis, Karsten (1999) questions the "deterministic" preconditions for increased collaboration through implementation of collaboration technology suggested in previous studies and in the trade press. Rather, she argues that whether collaboration technologies such as Lotus Notes can contribute to an increasing level of collaboration is highly contextual, depending on conscious and continued efforts to change the work arrangements related to the technology.

These implementation studies also illustrate the complex change processes often associated with the implementation of Lotus Notes, spanning several years and involving 'drift' from the planned objectives and a resulting need for improvisation (Ciborra, 1996; Orlikowski, 1996). A key challenge here is to provide the right balance between

management directives and user experimentation for fostering creative incorporation and application of the technology in the users' work day.

A TAXONOMY OF IMPLEMENTATION FACTORS FOR COLLABORATION TECHNOLOGIES

Table 2 presents a taxonomy of implementation factors for collaboration technologies, derived from the review in the previous section. For each factor, possible effects on implementation are also listed. However, due to the importance of contextual factors in the implementation of this type of technology, attempts at presenting clear causal relationships are bound to fall short.

IMPLEMENTATION FACTORS	POSSIBLE EFFECTS ON IMPLEMENTATION
COMMUNICATION TECHNOLOGIES	
Critical mass	Establishing a critical mass of users is crucial for collaboration technologies where the users' benefits are dependent on universal adoption.
Routines for electronic communication	Such routines may contribute to effective use of the services, and reduced information overload.
Social protocols for communication (netiquette)	Important for building relationships in electronic communication, and avoiding misbehaviour.
Bandwidth and image quality	Critical factors for videoconferencing systems.
SHARED INFORMATION SPACE TECHNOLOGIES	
Document management systems/ Knowledge repositories	
Increasing visibility of document production process	Transition from paper based to electronic document handling makes the document production process more transparent. This requires an analysis of possible changes in the temporality of work routines, such as related to publication and distribution of documents.
Ownership and responsibility of information	Sharing electronic documents may raise new issues related to ownership and responsibility for the information in its various production stages.
Effective search mechanisms	Critical for effective use of knowledge repositories. For organisation-wide databases, there may be a need for developing a thesaurus.
Roles and responsibilities for content management	Effective content management using document management systems requires new roles and responsibilities for maintenance and quality control.
Data conferencing/ Application sharing	
Distributed facilitators	There is a growing attention to the importance of this role to ensure effective communication 'flow' in distributed meetings.
Technical support	Dedicated technical support can eliminate start-up delays and problems in distributed meetings. This function can also be fulfilled by the distributed facilitators.
Routines for structured use of application sharing	Such routines/ protocols are needed to avoid 'chaos' and ineffective use of application sharing.
Audio quality	Limited audio quality may restrict the use of integrated audio and data conferencing.
MEETING SUPPORT TECHNOLOGIES	
Electronic meeting systems (EMS)	
Dedicated electronic meeting rooms	Co-located, electronic meetings require dedicated meeting rooms with adequate IT infrastructure. This may be a significant investment for a company.
Access to trained facilitators	The meeting facilitator is instrumental for successful electronic meetings. S/ he is responsible for planning and running the meeting, and processing the meeting report.
Matching EMS tools with meeting tasks	Using the right EMS tools for the meeting activities is vital for the process and outcome of an electronic meeting. This is specified in the meeting agenda prepared by the facilitator.

Balancing electronic and verbal interaction	Electronic meetings require a balance of electronic and verbal interaction to be effective. The facilitator manages this balance.
COORDINATION TECHNOLOGIES	
Workflow management systems	
Transferring business process model into workflow model	The workflow model needs to incorporate both organisational and technical aspects of the business process.
Correspondence with users' model of work	Imposing new work models that do not correspond with the users' model of work may disrupt the 'smooth flow of work' and lead to user resistance.
Flexibility in process	Necessary for exception handling and allowing some user autonomy in job allocation and prioritisation.
Timing of selection of workflow product	The workflow product should not be selected until after the new business process model has been designed, to assure that the product meets the requirements in full.
Integration with legacy systems	Important but often challenging and resource demanding task in workflow implementation.
Management surveillance	Potential risk of misuse for control purposes may result in users being skeptic. It is important to deal with this up front, to reassure users.
Online calendars and meeting schedulers	
Improved support for individual tasks	Increases the perceived benefit from adoption for single users.
Integration with email systems	Makes use of the calendar features more unobtrusive and easier to incorporate in the daily work routines.
Peer pressure	Identified as the most influential social mechanism for stimulating adoption. Often exerted by administrative assistants.
INTEGRATED PRODUCTS	
Lotus Notes	
Users' individual interpretations (mental models) of the technology	The users' interpretations of the technology frame the scope and effectiveness of its use. Explicit training in the collaborative features of the technology is important for demonstrating its potential to the users.
Balance between management directives and user experimentation and improvisation	Some guidelines for 'best practice' are needed to ensure effective use. This must be balanced against the need for allowing users to experiment with the technology to come up with creative applications.

Table 2: A taxonomy of implementation factors for collaboration technologies

CONCLUSION AND IMPLICATIONS

Based on an extensive review of the field-based research on organisational implementation of collaboration technologies, this study has identified a wide range of implementation factors for the different categories of collaboration technologies. These comprise factors related to technology and infrastructure, project management issues, development of guidelines and routines for effective use, as well as social mechanisms influencing adoption and diffusion. This enables a more detailed understanding of the factors influencing the implementation of different types of collaboration technology. The taxonomy in Table 2 can serve as the basis for further research related to the implementation of different collaboration technologies, as well as for developing implementation strategies adapted to each type of technology.

The review illustrates how guidelines and routines are important for maximising the benefit for each technology. The more flexible and complex the functionality, the more important it is that the collaborative work model imposed is made explicit to the users, and adapted to make this compatible with the users' existing work model. This is illustrated by the emphasis on modelling aspects in implementation of workflow management systems, and the importance of focusing on collaborative vs. individual applications of collaboration product suites such as Lotus Notes. This may require "working on" the users' mental model of the technology and their work through communicating explicit visions and benefits from adopting the technology. Providing extensive and adequate training and ongoing support is key to

effective appropriation and use of collaboration technologies. This also requires establishing dedicated support roles such as facilitators and product champions/ change agents.

Management should also take on a proactive role in stimulating adoption and use of the technology among their employees. This requires that management undertake sufficient training to serve as role models in use of the technology. Second, new incentive systems should be created for stimulating employees' contribution to collaborative processes and forums such as knowledge bases and online discussions. Third, management should participate in developing routines for best practice in use of the technology, and also enforce that these rules are followed. This may involve restricting the use of alternative media for communication and information sharing, and also taking actions if the routines are not followed.

However, it is also important to leave some room for experimenting with the technology, to come up with new creative applications. In general, implementation of collaboration technology often takes the form of an evolutionary process that requires "improvisation capability" (Orlikowski and Hofman, 1997) to be able to overcome unforeseen barriers, and exploit new opportunities that emerge during the process. Organisations should therefore establish forums for ongoing reflection on the implementation process, involving the different stakeholder groups. Collaboration technology may here also play an important role in providing virtual meeting places, supported by asynchronous and synchronous collaboration tools.

Further research should expand the taxonomy developed in this paper with studies on implementation of emerging collaboration technologies such as web based project/ teamrooms and use of mobile computing. As companies continue to implement several collaboration technologies, there is also a need for empirical research on how the implementation process of these technologies are interrelated.

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