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Journal:	*17th European Conference on Information Systems*
Manuscript ID:	ECIS2009-0218.R1
Submission Type:	Research Paper
Keyword:	Case Study, Complexity / Complex adaptive systems, Implementation, Health information systems / medical record systems / care delivery /

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Abstract

In this paper we discuss the challenges of dealing with interdependencies in complex assemblages of heterogeneous and interconnected information systems (IS), which we conceptualize as organization-wide information infrastructures. We draw on Perrow's studies of complex technological systems, where interactions, mechanisms, and couplings are emphasized. We base our paper on an empirical case study from a Norwegian hospital, where a seemingly trivial project aimed at the introduction of scanners turned out to be more complex than expected. This we claim is partly due to the interdependencies and tight couplings between information systems, actors, and work practices in the hospital environment. The paper's main focus is on describing what it entails in practice to deal with these interdependencies during and after implementation. We emphasize the work of sorting out and dealing with various types of interactions and couplings.

Keywords: Interdependencies, information infrastructures, couplings, health care.

1 INTRODUCTION

Organizations today rarely operate with isolated, task-specific information systems (IS). In general, they have interconnected collages of multiple and different systems, intended to support multiple work tasks, interaction and communication (Ciborra 1997; Star 2002). Some systems can be large, monolithic, and generic, such as enterprise systems, whereas others can be smaller and more dedicated. Legacy systems abound and thus the collection of systems span several technological generations. In addition, there is usually some degree of attempted, achieved or at least wished-for integration of these systems (Hasselbring 2000).

Much has been written about the implementation and use of IS in organizations. Studies have looked at changes in organizational practices (Vaast and Walsham 2005), collaboration and communication flows (Avgerou et al. 2004), and power structures (Robey and Boudreau 1999; Silva and Backhouse 2003; Howcroft and Mitev 2000) with the implementation of IS. Furthermore, researchers have studied the meanings that users ascribe to technology and how users' attitudes and perceptions relating to new technology are socially shaped (Orlikowski and Gash 1994; Davidson 2006). In the existing literature on IS implementation and use, however, we only find limited accounts of how new IS are related to and get intertwined with the existing portfolio of systems in the organization, also known as the installed base already in place and conceptualized as information infrastructures (Ciborra et al. 2000; Star and Ruhleder 1996). In contrast to isolated and task-specific information systems, information infrastructures pose particular challenges for the organization (Hanseth and Lyytinen 2004; Monteiro and Hanseth 1995) as they are characterized as being large, complex, heterogeneous, and emergent. There has been surprisingly little emphasis on the impact of interactions and tight couplings between the various systems that make up the information infrastructure.

In this paper we address the challenges of extending the existing portfolio of systems already in place in the organization, and of reorganizing work routines accordingly. We consider the installation and post-installation period where a new technology is to be integrated into current work practices (Jasperson et al. 2005). We emphasize the role of interdependencies and tight couplings between the new system and the pre-existing information infrastructure. The paper's main focus is on describing what it entails in practice to deal with these interdependencies during and after the implementation of new technology.

We illustrate these challenges by analyzing a case study from health care, where the issues of managing multiple IS (each of which contains parts of the relevant patient information) are highly relevant. We report on findings from a longitudinal study following the introduction of an Electronic Patient Record (EPR) system at a major Norwegian hospital. Most of the empirical material presented here comes from a seemingly trivial project where scanners were introduced in order to scan paper documents. The project turned out to entail more deep-going organizational changes and to be more time-consuming than expected. This we claim is partly due to the interdependencies and tight couplings between IS, actors, and work practices in the hospital environment. Issues such as these, we believe, constitute one significant reason for why the digitization of health care is complex and has been protracted. Consequently, we wish to examine this complexity that is evident even with seemingly simple projects.

For this we employ the information infrastructure perspective, which is presented in the next section. This is followed by a presentation of concepts used by Charles Perrow that help us conceptualize and discuss issues related to complex technological systems. Next, we present the research approach and the empirical case study, and finally we discuss the findings and their implications for the field of IS implementation studies.

2 ORGANIZATION-WIDE INFORMATION INFRASTRUCTURES

We base our work on a theoretical perspective that has its focus on the complexity of socio-technical assemblages. The information infrastructure perspective, as presented by e.g. Hanseth and Lyytinen (2004) or Monteiro and Hanseth (1995), has been developed to address the large-scale, heterogeneous, interconnected collections of systems. This way of conceptualizing the phenomenon emphasizes the long-term, gradual development of an information infrastructure. Rather than being implemented, it evolves over time through expansion, extension, and replacements. It is a socio-technical and heterogeneous collection of elements and it encompass much more than just the technological infrastructure. Star and Ruhleder (1996) argue that information infrastructures extend beyond human skills and materiality to include social, organizational, as well as moral elements. In contrast to the notion of IS, an information infrastructure is used by many for different purposes, not just one specific task. Thus an organizational information infrastructure is not “discrete, stable, independent and fixed” (Orlikowski and Iacono 2001), but multiple, evolving, and interconnected. Often information infrastructures span multiple inter-organizational contexts where they mediate interactions among several organizations (Gal et al. 2007).

Interventions in interconnected and complex environments can only be planned and rationally executed to a limited degree. Studies of information infrastructures tend to describe unintended effects of actions and the consequential slippage and “drift” of the processes and results (Ciborra et al. 2000). The same kind of phenomena is emphasized in the improvisational model for change (Orlikowski and Hofman 1997), which is claimed to be particularly relevant for open-ended and customizable technologies. Orlikowski and Hofman emphasize that implementing new information systems is not a one-time event, but an ongoing learning and adaptation process. Everything cannot be anticipated ahead of time, but the degree, depth, and complexity of changes is only fully understood when implementation is underway. Consequently, they see the resolution to this as lying in approaches that “enable organizations to systematically absorb, respond to, and even leverage unexpected events, evolving technological capabilities, emerging practices, and unanticipated outcomes. Such a model for managing change would accommodate – indeed, encourage – ongoing and iterative experimentation, use, and learning. Such a model sees change management more as an ongoing improvisation than a staged event.”(Orlikowski and Hofman 1997, p. 12)

In this paper we emphasize the need for such adaptive or learning-oriented approaches when dealing with the interconnectedness of the organization-wide information infrastructures. In order to analyze the nature and consequences of the interdependencies, we have chosen to draw on Charles Perrow’s conceptualization of complex socio-technical systems, where the role of complex interactions and tight couplings is emphasized (Perrow 1984). In laying the ground for the “normal accidents theory”, Perrow conceptualizes complex systems along two axes:

- The first axis concerns the character of interactions between the parts or elements of the system. The different parts of the system (e.g. organizational units) may collaborate through simple, linear relations. The linear interactions are expected and planned, and they stand out as clearly visible and understandable. Alternatively, the parts may collaborate through more interactively complex mechanisms with multiple dependencies and feedback loops. The complex interactions are unfamiliar, unplanned, and unexpected. They are not visible and not easily comprehensible (Perrow 1999 [1984], p. 78).
- The other axis concerns whether the linkages between the parts of the system are loose or tight. If the linkages are tight it means that action at one location has immediate and given effects elsewhere. When for instance the steps of action are tightly prescribed in advance, or when there is no slack in the production that allows for flexibility in handling disruptions, we have a tightly coupled system. On the other hand, a loosely coupled system may be slower to respond to interventions, but also more robust with respect to fault recovery due to its slack and buffer resources.

Perrow exemplifies how systems can differ with respect to their type of interactions and couplings along the two axes. For instance, a post office is characterized as a routine bureaucracy where the interactions between work practices, actors, and information systems are relatively linear and loosely coupled. In such a system, the order of sequences is straightforward. Changes in one part of the system can take place without having any prominent impact on other parts, e.g. mail can pile up without undue alarm. In contrast, a power grid system is also linear but tightly coupled, and disturbances in one network segment will immediately affect the other segments. Perrow suggests that universities are examples of organizations that exhibit complex interaction mechanisms, but are loosely coupled, while a nuclear plant is characterized by complex interactions and is also tightly coupled. Many unexpected interactions are possible and changes in one part of the system may have considerable consequences in other parts. This insight is the basis for Perrow's major thesis that accidents are unavoidable (hence "normal accidents") if the systems are complex and tightly coupled.

In this paper we use the information infrastructure perspective to define our research object: we do not study one single stand-alone information system, but rather an extended, socio-technical network that evolves gradually over time. We complement this view with the concepts of interactions and couplings used by Perrow to discuss the complexity in various forms of socio-technical organizations. We see Perrow's concepts as helpful because they complement the information infrastructure theory with a more fine-grained "lens" to examine the interdependencies of the different parts in information infrastructures. Also Perrow's conceptualization reminds us that different "configurations" of the socio-technical imply different forms of complexity and may have different effects. In the following we illustrate how the aspects of interaction mechanisms and couplings in the organization-wide information infrastructures had a practical impact on the implementation of a small project.

3 RESEARCH METHOD

Our empirical material emerged from longitudinal research collaboration between researchers at the University of Oslo and the IT department at a major Norwegian hospital in Oslo (Rikshospitalet, Oslo). The hospital is a highly specialized university hospital with regard to complicated treatments. In 2006 it had almost 8000 employees and treated more than 300 000 patients.

As a part of the implementation of an Electronic Patient Record (EPR) system at the hospital, a scanning project was initiated in 2003. This project was studied from November 2003 to October 2005. The study site was one of the four pilot departments – the Women's Clinic, one of the largest departments at the hospital and a major user of the patient record archive's services. The first author conducted seven formal interviews with the project management group and with staff from the IT and archive department. These interviews focused on the project's progress and the interviewees' perceptions of obstacles and opportunities. The interviews lasted for between 45 minutes and 1.5 hours and were usually taped and partly transcribed.

The study of the scanning project was a "side activity" related to a more structured and general study of the EPR implementation. This meant that no new formal research project was defined, and the access to the field site was more informal. For instance the researcher participated in 6 meetings at one of the pilot departments for the project and in return for access wrote minutes from the meetings. Some of the meetings were project meetings where IT staff was present, while others were internal meetings with only staff from the department. In addition, the researcher assisted the personnel in compiling detailed information about document flows in the department and documented the actual scanning work through time studies, including existing errors and problems etc. These results were fed back to the department and the project management. In total 17 hours of participant observation were conducted, and during this work a number of informal conversations were carried out; these added to the background perception of the process. Based on transcriptions of the interviews and field notes, we built a storyline of the scanning project and analyzed the material on the basis of the conceptualizations that we have presented above.

4 THE STORY LINE OF THE SCANNING PROJECT

4.1 Background of the case study

The transition from a paper-based patient record to a complete EPR system started in 1996 with a few departmental installations of the EPR system. The process was delayed because the hospital moved into new facilities in 2000, but in 2001 the EPR system was installed in all clinical departments.

The functionality of the EPR system, however, did not allow it to fully replace the previous paper-based system. The EPR consisted to a large extent of textual information and a large part of relevant clinical information was still on paper or stored in other specialized systems. Due to this, the legally valid record was still the paper-based record and all entries in the EPR were thus printed on paper and archived with the corresponding paper patient record. The vendor seemed unable to deliver updated and improved versions within the time frame expected by the hospital (contractually, the EPR system should have been fully developed by 1999). In 2003, this situation caused a critical space problem in the archive. Only limited space was allocated to the central archive in the new facilities as it was expected that a fully functional EPR system would be in place. While waiting for the full version of the EPR, the hospital management decided to scan both the existing patient record files in the archive and the individual paper documents in the clinical departments to decrease the paper flow to the archive.

The Scanning Project started in the spring 2003 with a bid for tender on scanners as well as software that imported the scanned documents into the EPR system. The plan was to select, test and finalize a solution over the summer, start the scanning in early autumn, and stop the flow of paper documents to the archive by January 2004. The project was perceived as a minor, straightforward, and problem solving project aimed at solving the archive crisis. The estimates predicted the employment of one support person from the IT department with a 50% position for 6 months. In December 2004, after some delays, the scanners were installed in four pilot departments and the secretaries started testing scanners and software. Most of 2004 and 2005 were spent on teasing out the actual work practices associated with digitizing the work flow within the departments and the hospital. The volume of paper being sent to the archive started to decrease more than a year later than initially expected.

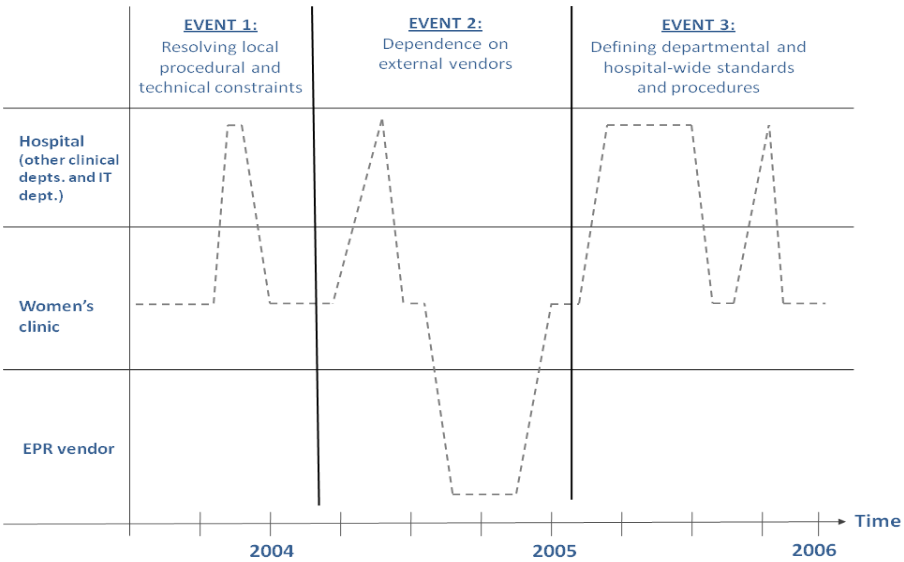

Figure 1. Chronology of the scanning project: The dotted line indicates dependencies on actors beyond the local context (i.e. the Women's Clinic, in the middle)

We enter the case in December 2003 and look at the scanning project in one of the pilot departments, the Women's Clinic. We describe three events (events 1, 2, and 3 in figure 1 above) that made the project deviate from its planned course and somehow complicated the process.

4.2 Event 1 (2003-2004): Resolving local procedural and technical constraints

During the first pilot period (December 2003 - January 2004), bugs were identified and fixed and the employees at the Women's Clinic developed routines for how to arrange the scanning.

The first documents targeted for scanning were the incoming referral letters, which are letters sent by external doctors to request a patient's admission to the hospital. These letters could be several pages long and usually all of the pages were scanned and saved as one file in the appropriate folder in the EPR and tagged with the date of reception. In some instances the referral letter was incomplete. For instance the letter would mention that additional examinations had been performed and that the results would be forwarded to the hospital when they were ready (e.g. when received from the laboratory). In such cases, the forwarded documents arriving later would logically belong to the same referral letter; however, it was not technically possible to append the after-sent documents to the previously scanned referral letter. The scanner software generated images using the TIFF file format, and in order to create one file, the different pages had to be scanned at the same time and joined before exporting them to the EPR system. Thus in the case of incomplete referral letters, an additional file had to be generated for the separate (after-sent) documents. The only way to link these documents in the EPR was to tag them both by date of the referral letter. To do this properly, the person who scanned the documents had to figure out which referral a particular document belonged to and use the same date for storing it. Initially, this work routine was accepted in the pilot departments, but it was later debated again. After some discussion, it was decided that after-sent additional information should be stored in an EPR folder called "External correspondence, miscellaneous".

The scanning activities were also shaped by other technical characteristics of the existing information infrastructure. The activities required cooperation between three different software systems: the scanning software, the Electronic Patient Record (EPR) system, and the Patient Administrative System (PAS). Before a document could be scanned, a digital record had to be created in the patient's name in the EPR system. However, even before the record could be created in the EPR system, the patient information had to be entered into the patient administrative system (PAS). Initially, it was assumed that the speed of the process would improve if the same person was responsible for all these steps; however, the PAS application was running on the hospital's Windows NT network. The new scanning application required Windows 2000 and was installed on separate machines initially, while waiting for the eventual upgrading of the whole hospital network. Consequently, the two applications were running on different machines in different work places, and at least two persons had to be involved in conducting the task.

Thus we see that the redesign of work practices did not happen freely "from scratch" but had to start from the given constraints, in this case constraints posed by the software, the operating systems, and the existing network technology. The redesign furthermore necessitated cooperation with actors beyond the department. The temporary workaround utilizing different workstations and different network segments involved the hospital's IT department. Furthermore, negotiations with other departments were required to establish common work routines with respect to the scanning. But still these issues did not entail dependence on actors beyond the hospital (i.e. external actors), such as the next example illustrates.

4.3 Event 2 (2004-2005): Dependence on external vendors

Some procedures for improved mail handling were drafted and implemented in the Women's Clinic during 2004, primarily to ascertain that incoming letters were distributed as efficiently as possible within the department, and that the evaluation was speedy. However, major changes could not be carried out because the EPR system, according to the contract specification, was not yet 'complete'.

The EPR system primarily served as a document repository and did not yet offer much work process support. For instance the system did not have a message functionality that could be used to notify the doctor when a referral letter was awaiting evaluation. The paper letter would be physically placed in the doctor's mail shelf and thereby serve to notify the doctor about the task to be handled (i.e. the evaluation of a referral letter). Ideally the paper letter should be removed from the work flow after scanning; however, that was not possible since the notification functionality was not yet implemented in the EPR system. When asking for this functionality in March 2004, the project team in the Women's Clinic was told (jokingly) by the IT department representatives that it would probably be a Christmas present. Then again in November 2004, they were told that it was a part of the version being currently tested.

The point we want to emphasize here is that the provision of this functionality was not within the mandate of the project, or even of the hospital. The vendor would make the decision of whether and when to implement this functionality based on weighing costs of development against a potential increase of market share and income generation. Thus not all wishes from the various customers (hospitals) were fulfilled. In practice this dependency on the vendor meant that the doctors continued to receive paper letters in their mail shelves (even if these letters were also being scanned). When finally implemented in 2005, the notification functionality allowed the removal of the scanned paper documents from the work flow. The problem illustrated here is just one example of how the clinical work procedures were complicated with the introduction of scanners and how changes were dependent on external partners. In this case, we see how the use of scanners did not immediately live up to the initial aim of reducing the amount of paper. Rather, it complicated the work even further as the health care professionals now had to work with both paper-based and electronic documents.

4.4 Event 3 (2005-): Defining departmental and hospital-wide standards and procedures

The various clinical departments were expected to reorganize their work processes. The hospital can be considered a professional bureaucracy (Mintzberg 1983) and no-one in the administration had detailed and extensive knowledge about the idiosyncrasies of documentation practices and work patterns. This necessitated a decentralized approach to workflow redesign. Still there existed a need to coordinate these redesign activities at an organizational level, since local changes in work practices could have consequences for other collaborating actors at other levels. The reorganization was initiated in the beginning of the project but it was becoming increasingly formalized by the end of 2004 and in 2005.

The local project team at the Women's Clinic was requested by the project management to develop procedures within given time frames. The project team drafted procedures for e.g. incoming mail handling, for evaluation of referral letters, and for detailed instructions as to which documents should be scanned and which not. These procedures were formally part of the organizations' quality assurance system, and thus this request had some legitimacy and became a rather well-working way to get the department to actually design changes. The procedures also served to standardize learning across the multiple departments. The standardization was achieved through a lengthy process where numerous versions of multiple procedures (both departmental and general, hospital-wide) were circulated and discussed. The project team asked for general template procedures in order to accomplish this task. The templates were made and circulated, and the project team worked with them for some time before sharing the drafts and discussing revisions to them with other departments. The required coordination of the redesign was thus achieved through a process where the local or departmental idiosyncrasies were exposed and adjusted, and where the overall requirements (central as opposed to local/departmental) also were met.

These discussions were not always straightforward. For instance, the general rule was that all incoming mail should be opened at once and processed immediately to avoid delays. In the Women's Clinic, the mail was distributed to the four sections before it was opened and processed. Initially, the involved persons thought it would be a good idea to centralize mail handling and scanning. Later in the process, other secretaries became involved, and they voiced objections to this model. The personnel in one section handled sensitive personal information (e.g. related to gender identity disorders, anonymous semen donors etc.) and they registered this information in a version of the EPR which had strictly limited accessibility. They wanted to continue to open their mail themselves in order to maintain the patient privacy. The general rule was also a problematic issue in the delivery section, which received more applications than it could grant. They rejected approximately half of the yearly 5000 applications from women wanting to give birth there, and these referral letters were forwarded to other hospitals. The hospital's established procedure (to scan incoming referral letters at once) worked well for most departments. But in the delivery section it would not be appropriate, as it would necessitate the unnecessary creation of around 2500 files in the EPR system for women who would not be admitted after all.

Several of such special cases were brought forth in the ongoing discussions in the project meetings, and the job of distinguishing between what should be general, hospital-wide procedures, and what should be specific to each local department took several months. This process needed to allow for local variations in the procedures (e.g. as the case of the delivery section shows), but also to eliminate these variations when they were not necessary and considered counter-productive.

5 ANALYZING THE FINDINGS

We have described some concrete examples of how a seemingly trivial project of implementing scanners turned out to take much longer time than expected and was dependent on a multiplicity of actors and actions. We do not offer this account as an example of negligent estimation or suboptimal project management. Neither is it an example of an unusual IS project. The case is rather trivial, even banal, and certainly not dramatic. The story illustrates the impact of interactions and couplings; issues that are crucial, we claim, but of such a mundane character that they are often overlooked by IS researchers trying to conceptualize IS-related change processes. In the discussion below, we focus on these interactions and couplings as well as the strategies employed to manage them during the scanning project.

5.1 Linear or interactive interactions, tight or loose couplings

In some instances described above, the type of interaction was simple and linear whereas in others, they were highly interactive. Event 2 illustrates how the hospital was dependent on the vendor to develop and deliver the notification functionality of the EPR system. The relation between the hospital and the vendor can be characterized as simple; the vendor was the only one who could provide a solution, and as long as it was not provided, a delay occurred with respect to the particular usage pattern of the EPR system. The difference between the scanner software's requirements (Windows 2000) and the existing Windows NT network, as illustrated in event 1, was another example of a linear and simple relation. This time, the dependence was on another entity (the IT department) within the hospital organization, not an external actor. Nevertheless, the project team in the Women's Clinic could only wait for the change to happen. They did not have any power to change the timeline for network upgrading as this was a separate process in the organization. In the meantime, they needed to design a workaround to deal with this issue. The possibility to design workarounds and tolerate delays in this process shows that the couplings were loose, not tight. There were multiple ways for the organization to keep on working, despite the delays introduced by the other actors and processes.

The definition of procedures for the new work practices showed a more interactive pattern as illustrated in event 3. The various departments needed to sketch the new procedures and try them out locally. At the same time, the employees at the Women's Clinic had to discuss with the other departments in cases where the procedures were dependent on or had consequences for them. The procedures were tightly linked with the documents associated with the internal patient transfer between departments. In addition, the hospital's quality system imposed a structure of distinguishing between general and local procedures, and we witnessed a degree of interactively sorting out the procedures that belonged to the hospital versus the departments. Experiences from the pilot departments were collected and compared in the process of sorting this out. With respect to the difficulty of replacing the referral letter, it was discovered that a single artifact (i.e. the paper letter) served two functions simultaneously; it was both an information carrier and a “signal” for action in the process. One of these functions could easily be digitized, while the challenges of digitizing the other were discovered along the way. Such double- or multi-mode functioning is, according to Perrow (who called it “common-mode functioning”), one of the major reasons behind interactively complex systems.

5.2 Sorting out and dealing with interdependencies

Most of the interdependencies accounted for in the case description were not predicted in advance. This is not to say that they were impossible or even difficult to predict. For instance, it could easily have been foreseen that the TIFF file format would exclude appending the test results to a referral letter, if anyone had asked the question. However, even if predicted, it was doubtful whether the product, a commercial off-the-shelf application, would have been changed. In principle, these issues (at least some of them) could have been predicted if the organization had run a process where they used for instance story boards or use cases. However, the introduction of scanners was not considered a major project that required involvement from IT professionals. Since the process was handled by the workers themselves, storyboards and use cases were unknown techniques and were not used, except for quite simple drawings with boxes and arrows in order to show the work flow. In practice, these dependencies were only realized as the actual and practical work progressed. This is not necessarily because they were complex and intractable; rather, there were just too many and too small dependencies, and it was a task in itself (“beside” the primary project work) to find out what to look for and to realize who needed to be involved.

It is the work of sorting things out and dealing with interdependencies that we wish to draw the reader’s attention to. In the case, we see that the discussions often centered on sorting out what to take first and second, and what to prioritize and what to downplay. This process was linked to the uncertainty in the process because of its links beyond the local context. The team members needed to sort out a number of issues such as: What are the preconditions and consequences (upstream and downstream)? What are the limiting factors and what are the constraints of change? What can we do and not do? Where do we have any impact and what is beyond our scope of influence? The actors also needed to consider how to run a changed procedure in parallel with maintaining the pre-existing paper-based ordering so that the Women’s Clinic could still interact with the non-pilot departments. In response to our inquiry on the progress of providing a feature that the users had requested, one of the project managers from the IT department replied: “No, we haven’t fixed that and we will not do that for the time being. Remember, we’re trying to eat an elephant here. We cannot take it all at once”.

The changes had to occur in a coordinated way so that the ongoing work of patient care would not suffer during the transition process. This interlinked nature of the organizational routines and the dependencies on other actors, both internal and external, delayed the process compared to the initial estimates.

5.3 Infrastructural implementation

We believe it is significant in this respect that the implementation of scanners was not considered a strategic and important project. Infrastructural technologies are expected to just “be there” and support the core organizational activities. In a hospital, the activities are centered on patient treatment and care, and the information infrastructure is seldom considered to be of strategic importance in its own right. Especially this goes for the ongoing incremental extension or replacement of the elements of an information infrastructure, which is often seen as necessary maintenance. This may have the effect that change processes (both implementation and assimilation) associated with them receives low organizational attention, priority, and allocation of resources.

The change process was by necessity decentralized, but the clinical staff lacked expertise and applicable models for how to handle the required changes, as these were not related to their core competency. Thus, when no external resources (such as consultants) were available, the process may be handled in a suboptimal way. Since no resources were allocated, the actors perceived these tasks as additional to their ordinary work burden, and they easily defected the meetings and activities. This character of the process may be a challenge since it delays actions and dissipates the change momentum in the organization.

6 DISCUSSION AND IMPLICATIONS

In this paper we have argued that the existence of interconnections and dependencies is a fundamental trait of the information infrastructures of today's organizations. While these interdependencies can be of many types and degrees, we have focused on the mundane and trivial types of interdependencies rather than large-scale and dramatic ones. When changes occur in the organization, small interdependencies may become significant enough to have an impact on larger organizational processes.

In our case study, we emphasized how the actors involved in the project resolved the challenges associated with the interdependencies. This was a cumbersome process of sorting out the consequences of them. It involved negotiations with other actors (outside the project), coordination of multiple local changes with one another, and coordination of local with overall changes (i.e. both cross-site and cross-level negotiations).

We claim that IS implementation studies have to a limited degree focused explicitly on how new IS are related to and get intertwined with the existing portfolio of systems in the organization. The emphasis is usually rather on project management and reception in the organization. This orientation is also reflected in how failures and problems are conceptualized. Common "folk explanations" for delays or failures of IS implementation often emphasize incompetent project management, inappropriate design, or lack of user involvement. In addition, IS researchers have emphasized the importance of upper-level management support (Myers 1994), the role of users' resistance due to various reasons, such as badly designed systems, or organizational politics (Markus 1983; Keen 1981). Failure to learn from previous experience or to transmit learning between projects has been seen a major reason for IS failures (Lyytinen and Robey 1999). Also with Orlikowski and Hofman's improvised change model, the need for learning-oriented and adaptive approaches is emphasized (Orlikowski and Hofman, 1997).

Our study does not lead us to disagree with these insights. On the contrary, we argue that our emphasis on minor instances of interactions and interdependencies are complementary to these studies. We believe that such details are important in any project, although they may be overlooked or abstracted away in the accounts that are produced. We want to draw attention to this specific issue since we believe attention to this can contribute with conceptualizations that are practically useful in IS projects. These conceptualizations need to describe how we can identify and deal with the issue of interdependencies that emerge because of the infrastructural character of an organization's systems portfolio. Our empirical case study could be considered as a first step in this direction.

The question now is how actors, who are involved in similar projects where multiple types of interactions and couplings are encountered, may act and react? The answer is not straightforward, and we will not be able to provide managers or other actors involved in IS implementations with clear-cut answers and a list of best practices. However, one way of acting in such a context is suggested by the "bootstrapping" strategy proposed by Hanseth and Aanestad (2003). In discussing how to establish information infrastructures in health care, the strategy addresses the dilemma when the number of adopters is below critical mass, i.e. too low to ensure general benefits from the infrastructure. The focus of the bootstrapping approach is on how one can work in such a situation in order to establish a self-reinforcing growth process. It advises the selection of an appropriate starting point in order to create a platform that allows some action to be taken, given the existing constraints and opportunities.

The next step is to search the context for opportunities and then to expand this platform on the basis of these available opportunities. General principles within this model are to expand existing solutions rather than request new solutions (more users before more functionality), to experiment in shielded areas only, to learn from simple use areas before complex ones, and to identify usage areas with low cost and high gains for the prospective users. These principles help in sorting the immediate steps from the future steps, in choosing what to do first and last.

The benefit of this strategy lies in breaking down a task that seems impossible when considered as a whole. This is of relevance also with respect to handling and dealing with interdependencies during implementation, a task which an IT employee characterized as “eating an elephant”. If it is possible to plan organizational implementation in a way where a starting point has been carefully selected so that the dependencies extending beyond the project’s sphere of influence are minimized, and where the need to negotiate cross-site and cross-level are also minimized, then the greater the chance for successful implementation of this limited change.

If a starting point like this can be found where a limited change can be achieved, then a platform has been built from which to proceed. At this stage, some interdependencies have been uncovered and perhaps even sorted out. Ideally, the project team should have learnt from this process, and be in a better position to predict and prepare for new and “larger” (i.e. more far-reaching or comprehensive) interdependencies in the next rounds. On the contrary, if no such selection has been carried out, and the whole project (“the elephant”) is taken on, the more likely are delays and frustrations in the change process due to the couplings and dependencies of systems and procedures beyond the project site. It may not be possible to achieve this in a perfect or optimal way. For instance, there may be no area where there is not a need to coordinate change across locations. We have no reason to claim that the selection of a starting point or the planning of a sequence of steps in our case was not the most optimal strategy. However, even if the single optimal strategy cannot be defined, this way of thinking may effect a change in mindset. We believe that the project management should be oriented towards vigilance and detection and focused on learning to deal with interdependencies rather than insisting on meeting milestones and deliverables.

7 CONCLUDING REMARKS

The purpose of this paper was to illuminate a specific source of complexity associated with implementing IS that becomes an integrated part of an organizational information infrastructure. We have emphasized the role of complex interactions and tight couplings in such a process and described how a long and cumbersome process of dealing with such interdependencies delayed the project we studied. The challenges associated with the interdependencies had to be resolved in a manner which entailed sorting out the consequences of the couplings that were proposed, introduced or detected. It also involved negotiations with other actors, over whom the project did not have control. Finally, due to the nature of an organizational infrastructure, the solutions had to align multiple local changes with one another and coordinate local with overall (organization-wide) changes. We believe this phenomenon is understudied, yet significant. It constitutes a particularly challenging aspect of leveraging information infrastructures to achieve organizational change. Finally, we have sketched how a learning-oriented approach to deal with these multiple interdependencies and couplings could look like.

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