

**EXPLORING TENSIONS IN
INFORMATION SYSTEMS STANDARDIZATION**

Two Case Studies from Healthcare in Norway and South Africa

by

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To Claudio.



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A c k n o w l e d g e m e n t s

A PhD is a long journey. My journey started in December 1997, while I was still preparing exams for my Master in Computer Science. There was snow, my days were split between skiing and studying, and an (until then to me) unknown eccentric guest from Milan was arriving soon. I cheered this tall athletic Professor, his quick eyes and ironic smile not realizing that in the next few days he would shake the foundations of my understanding of technology and influence the course of my future professional and private life.

This was the beginning of a very nice relationship. Fascinated and inspired by his insights and irony I consciously (and sometimes perhaps unconsciously) grasped any opportunity to come closer to study him better. I started reading Heidegger. I moved first to Sweden where he helped setting up the Viktoria Institute, then to Oslo for the PhD: the University where perhaps the roots of his studies can be found. I even married one of his students from Bologna, which I met in Göteborg.

I had the fortune to meet Claudio Ciborra and enjoy his friendship also (if not primarily) outside the professional life. He has been to me a friend, a guide, almost an uncle.

While he virtually was the puppet master (as his called himself) of this situation, the day to day life of the PhD was populated and surrounded by numerous people who supported my work. To these people I owe immense gratitude. First of all, to my supervisors: Ole Hanseth and Sundeep Sahay. I will here also remember Eric Monteiro, who I enjoyed having as supervisor for a few months.

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But life in a PhD extends also outside the walls of the home University. This experience gave me the possibility to work and interact with numerous exceptional people. I will start with Antonio Cordella: a great friend, more than a colleague, which always inspired me with his energy and ability to become ubiquitous. I always looked forward to working with Jannis Kallinikos and being inspired by his intellectual depth and care in choosing the right words to express a thought (reminds of Italo Calvino).

Outside the traditional duties of a PhD I had the honor to organize and edit a special issue on “Complexity and IT Design and Evolution” for Information Technology & People. While not integral part of the PhD, this experience helped me mature and gave me the

opportunity to work with outstanding people. I will always be grateful to Eleanor Wynn and Edgar Withley for their trust and support.

Finally, my family. My sweet half Miria and my splendid daughter Maia. You often read in PhD thesis how the author is grateful to his wife (when the author is male and married, and has a good marital relationship...). This has never been as true as in this case. Miria during my PhD has been many multiple Mirias. I am not exaggerating when I say that I wouldn't have completed the PhD without her support.

My brothers, Carlo and Giulio: companions in the *diaspora* of the Jacucci family in the quest for PhDs (in 2006 we score 3 on 3). My father and mother, Gianni and Maria Teresa, who have been following and supporting with patience the crazy trajectory of their son(s) across the world collecting by now millions of bonus miles.

These have been some of the greatest years of my life. These years have been great primarily because of the people I met and worked with. Thank you again to you all and to those that I have here forgotten to mention.

A b s t r a c t

This thesis presents an interpretive study of standardization processes related to the development and implementation of Information Systems. Standards and standardization processes are ever more important and pervasive in ISs. Standards range from technical specifications of communication protocols to informal organizational agreements and guidelines. Their scope ranges from the boundaries of a small organizational unit to international standardization committees. Today the development of any information system is made of, based on, related or linked to standards. The development process itself can be seen as a standardization process.

This thesis thus tries to deepen our understanding of the dynamics of IS development as standardization. In particular it tries to address a particular class of problems which has been already identified by previous empirical research and which manifest as paradoxes, side-effects, and non-closure of standardization projects. The research presented here aims at dwelling into this class of problems with the attempt to identify theoretical as well as practical issues which can provide a relevant explanation of the observed dynamics. Based on an empirical base constructed over two case studies in the healthcare sector in Norway and in South Africa, I conduct an analysis of standardization processes and formalize a set of theoretical and practical implications.

From a theoretical point of view the thesis makes three contributions: (1) it contributes to the understanding of the complexities related to standardization processes by developing the concept of *tensions*; (2) it points to the need and provides an example of how to link micro and macro theorization of standardization processes; (3) it contributes to the discussion on the relation between standards and modernity by pointing to the need to include and understand the *multiple modernities* of our contemporary society.

Finally, based on these findings and on the theoretical contributions, the thesis seeks to provide a set of recommendations regarding aspects to take into consideration when addressing the management of such tensions in order to improve the outcome of standardization processes.

P r e f a c e

This thesis is submitted as a partial fulfillment of the requirements for the degree of Philosophy Doctor (Ph.D.) at the Faculty of Mathematics and Natural Sciences, University of Oslo, Norway. The work has been conducted at the department of informatics in the research group for Information Systems.

The thesis consists of six papers and an additional introductory paper. The introductory paper presents the problem area and research question, discusses relevant literature. Then the context of the two cases studies is presented along with the methodological approach. Subsequently, the findings of the research are presented followed by discussion and conclusion. The six papers listed below are included as appendixes¹:

1. Iacucci², E., Nielsen, P., Berge, I. (2002), "Bootstrapping the Electronic Patient Record Infrastructure", In: Bødker, K., Kühn Pedersen, M., Nørbjerg, J., Simonsen, J., and Thanning Vendelø, M. (editors): *Proceedings of the 25th Information Systems Research Seminar in Scandinavia (IRIS 25)*, "New Ways of Working in IS", Bautahøj, Denmark, August 2002.
2. Jacucci, E. (2004), "Temporal Disclosedness of Innovations: Understanding Innovation Trajectories in Information Infrastructures", In: Fitzgerald, B., Wynn, E. (eds.), *IT Innovation for Adaptability and Competitiveness*, Springer.
3. Jacucci, E., Grisot, M., Hanseth, O. (2004), "Fight Risk With Risk: Reflexivity of Risk and Globalization in IS", In: Reponen, T., Saarinen, T. (eds.), *Proceedings of the 12th European Conference on Information Systems*, Turku, Finland, June 2004.

¹ In the remainder of this document the papers will be referenced with the indicated number.

² In 2002 I have changed my last name from Iacucci to Jacucci.

4. Jacucci, E., Shaw, V., Braa, J. (2006), "Standardization of Health Information Systems in South Africa: the Challenge of Local Sustainability", Accepted for publication in *The Journal of Information Technology for Development*.³ (*forthcoming*)
5. Jacucci, E. (2005), "Duality of Control in Large-Scale IS: the Case of the Health Information System in South Africa", In: Schreyögg, G., Sydow, J., Quack, S., Rudolph H. (eds.), *Proceedings of the 21st EGOS Colloquium*, Berlin, Germany, July 2005.
6. Hanseth, O., Jacucci, E., Grisot, M., Aanestad, M. (2006), "Reflexive Standardization: Side-Effects and Complexity in Standard-Making", *Management Information Systems Quarterly*, King, J. L., Lyytinen, K. (guest eds.), Special Issue on Standard-Making, *forthcoming*.

³ A previous version has been published in: Abiodun, O. B. (ed.), *Proceedings of the IFIP 9.4 Working Conference on Enhancing Human Resource Development through ICT*, Abuja, Nigeria, May 2005.



1 INTRODUCTION

1.1 Problem Setting and Motivation

The advancements in Information and Communication Technologies (ICT) of the last decades have boosted the ability of organizations to store, process, distribute and interpret the information representing their work flows. The diffusion of networking communication technologies has amplified the ability to reach, link, and integrate information, work processes, and social relations on a global level. This trajectory of increased global integration and standardization, work specialization, and information digitalization has been recognized as paradigmatic of our modern society (Giddens 1990; Beck 1999a; Beck 1999b; Kallinikos 2005; U.S. Congress 1992; Brunsson & Jacobsson 2000). This shift has been both the cause and effect of the growing number of implementations of IT based Information Systems (IS) in organizations, and consequently the growing need to link and integrate them.

The implications of the current scenario are that: (1) ISs are now seldom developed from scratch, rather as modules and layers built upon and interconnected with other existing systems and standards⁴ (Hanseth *et al.* 1996; Hanseth & Lyytinen 2004); (2) by becoming interconnected and interdependent with other systems, ISs become part of a larger infrastructure operating at multiple scales, thus challenging current design and development strategies (BCS 2004); (3) the increased interconnection between IT systems also reflects the increased interdependencies between work practices and social arrangements within and between organizations, making the socio-organizational aspects of IS more and more important (Kling & Scacchi 1982); consequently (4) the designs and implementation of IS is more and more a process of creation of

⁴ These may range for example from network communication standards (e.g. TCP/IP) to health information standards (e.g. IEEE standards for device communication; CEN TC 251; ICD10 for the classification of diseases; Health Level Seven; ISO/TC215 Health Informatics Committee) to work processes and governance standards such as ITIL (IT Infrastructure Library), CMM (Capability Maturity Model), Cobit, PMI, Prince2, and the compliance to the Sarbanes Oxley regulation.

a set of common artifacts, practices, conventions, or, in other words, a process creating a common “standard”.

Hence, firstly it is becoming of practical relevance to understand how to design and implement ISs which are ever more intertwined with already existing systems, practices, and social conventions, and which need to mitigate and satisfy the diverse needs of a larger number of actors. Secondly, it is paramount to develop an appropriate theoretical apparatus which can provide a deeper understanding of the challenges and dynamics of IS design, development and implementation in such settings.

In this scenario and with these motivations the thesis studies cases of IS standardization focusing on a particular class of problems which have both been recognized by IS literature as critical phenomena and have emerged in the empirical material of this thesis: the emergence of *side-effects*, *paradoxes*, cases of *ambiguity* and a general difficulty in meeting schedules and budget constraints.

For example, because of the increased interdependencies between systems, changes in one system may trigger unintended effects on other systems or jeopardize the whole infrastructure. Ciborra and Osei-Joehene refer to this as the first- and second- order risks related to integration and standardization: in a large global bank, integration and standardization of the e-mail systems reduced the (first-order) risks stemming from a redundant and fragmented e-mail infrastructure. At the same time, however, standardization and centralization generated second-order (or unintended) risks. In the new configuration, e-mail systems globally were run and controlled from one location. During a routine shut-down and reboot one of the main servers refused to boot due to a technical glitch. As a consequence on Monday morning, when the stock exchange opened, no users in the bank (globally) were able to access their e-mail, creating understandable panic (Ciborra & Osei-Joehene 2003).

Furthermore, as one of the case studies will show, situations may be created where the standardization process is not completed nor it is dismissed: a situation which cannot either be categorized as a success or as a failure. Risks of failures in IS have been widely documented for more than twenty years (see for example the survey by Lyytinen 1987; see also BCS 2004). Yet, these problems seem only to have worsened with the intensification of the number and

interdependencies between systems and processes in organizations, often causing drift and out-of-control dynamics (Ciborra *et al.* 2000).

Side-effects and paradoxes have been partly explained as effects of network dynamics and standards economics (Ciborra *et al.* 2000), thus suggesting that IS systems are to be conceptualized as infrastructures of interconnected standards (Hanseth & Lyytinen 2004; West 2003; Kahin & Abbate 1995; Damsgaard & Lyytinen 2001; Brynjolfsson & Kemerer 1996; Pollock *et al.* 2003; Kosanke 2005). But are there common aspects in those problems? How can they be conceptualized in relation to IS standardization processes?

In order to proceed on this line of inquiry, I will now discuss the definition of standardization and its centrality in IS research. Then I will introduce the basic research question of the thesis; I will then briefly illustrate the theoretical framework proposed to address the question, the research setting and approach and the expected contributions.

1.2 Positioning and Theoretical Motivation

Standards and standardization processes have been the object of study from economics to social sciences for decades (see for example Farrel & Saloner 1985; Brunsson *et al.* 2000; Egyedi 1996; Fomin & Keil 2000). The perspective adopted in this thesis is that, especially in IS, the creation of standards is not unproblematic. Firstly, it is highly political (Schmidt & Werle 1998; Star 1999; Bunduchi *et al.* 2005; Graham *et al.* 1995; Hanseth *et al.* 1994): it involves negotiations and compromises to mitigate interests in a long term perspective. Secondly, it is rarely an isolated process (Jørgensen & Sørensen 1999; Hanseth & Lyytinen 2004): the creation of a standard is always related to other existing underlying, competing or complementing standards. Thirdly, standardization processes in organizations do not necessarily come to a closure (Williams *et al.* 2004; Hanseth & Braa 2001); that is, they may remain as open ended negotiations which may convey some kind of convergence of interests, they may die out or trigger new processes of standardization.

Hence, in approaching the study of standards I will adopt a working definition that allows these controversial characteristics to be included and accounted for. A good (though rather general) definition is the one proposed by deVries⁵, in his view standardization is:

“the activity of establishing and recording a limited set of solutions to actual or potential matching problems directed at benefits for the party or parties involved balancing their needs and intending and expecting that these solutions will be repeatedly or continuously used during a certain period by a substantial number of the parties for whom they are meant” (deVries 2003, p.155)

A standard is the product of such activity. This definition allows the emergence of political aspects of standardization processes. It focuses on the establishment of a “set of solutions” that can “balance the needs” of the involved parties in a long term perspectives. It is indeed a processual definition which underlines the negotiation aspect aimed at producing and recording a solution which can be made of any material (thus social or technical or both) that solves the problem. This view contrasts, for instance, with the widely accepted but rather technical definition by David & Greenstein (“a set of technical specifications adhered to by a producer, either tacitly or as a result of a formal agreement” (David & Greenstein 1990: p.4)). Arguably, the flexibility and political focus of deVries’ definition is important when studying the development of IS standards: that is standards which may include technical as well as social components.

In the IS arena the study of standards and standardization processes has recently acquired larger attention: books, newly established research communities and journals, and a special issue on Standard Making by MISQ, are a clear sign of the emergence of this field as a new important frontier in IS research (Egyedi 1996; Shapiro & Varian 1999; Timmermans & Berg 2003; see also the recently established *Journal of IT Standards & Standardization Research* (JITSR); see also the forthcoming special issue on Standard-making organized by MISQ (King & Lyytinen 2006)). However, most of the existing literature on standardization in the IS field is related to the study of standards as technical artifacts; in other words the studies focus on IT standards (West 2003). While it is still disputed what IT is in IS research (Orlikowski & Iacono 2001), it is widely agreed

⁵ deVries brings together, confronts and synthesizes sixteen different definitions of standardization, drawing (among others) from the definitions by standardization bodies such as ISO, CEN, DIN, BSS (British Standards Society).

that an IS is more than its mere technical components (Lee 1999). Accordingly, an information system is a social system (Walsham *et al.* 1988) or, more precisely, a web of technical artifacts, people, and procedures immersed in a particular context (Kling & Scacchi 1982).

Moreover, studies in IS standardization tend to focus on a standard in isolation from the infrastructure in which they are immersed (with some rare exceptions: Berg & Timmermans 2000; Jørgensen & Sørensen 1999). In contrast, standardization processes are rarely isolated from other standards and are rarely self-referential: they always build on and contribute to an existing installed base of other standards (Hanseth *et al.* 1996). Hence, the perspective adopted in this thesis is to view IS development as a process of standardization which contributes to (and is part of) the development of a larger information infrastructure. This demands (1) to focus on processes of standardization as object of study and (2) to understand how to theorize them in the context of a developing infrastructure. The latter point sets some theoretical challenges which need to be addressed and which will constitute the theoretical motivation of the thesis.

On the empirical side, infrastructures (and standards they are made of) are technologies which have a local dimension of use tied to the local context, and a global dimension of connections with other adopters of the same standards or user of the same infrastructure. For instance, Windows Word (which can be considered a standard based infrastructure for word processing (Shapiro & Varian 1999)) is both a local application which allows the user to edit a text for local fruition, and a global network of users which allows the user to communicate (exchange compatible files) globally. How should the study of Word as a standard be pursued? By looking at the local level of use or looking at it as a global?

Another example can be drawn from the trend of standard-driven product globalization strategies of (e.g.) software vendors (Levitt 1983; Boddewyn *et al.* 1986; Walters & Toyne 1989). The effects for customers adopting globally developed and marketed products can be that decisions in local IS projects become part of and are influenced by a larger global network of decision makers. From a practical point of view, how should a manager of a IS project in an organization perceive and manage the risks related to the project? Is it more risky to contract a national vendor with one single product sold within the national boundaries? Or is it more risky

to contract a multinational vendor which is currently pursuing an aggressive product globalization strategy?

A “national” vendor may have less resources but greater stability and predictability, and the manager would have greater negotiation power being comparatively a large customer. However, a “multinational” vendor may have more resources but greater uncertainty related to its current risky (though potentially profitable) strategy, and the manager would have very little negotiation power, being just one customer among thousands. How are the multinational vendor’s global risk affecting the local IS implementation? If the manager of the IS project chooses the multinational vendor, she will have to address the risk related to the project on a local level (the organization) as well as on the broader level of relations with the multinational.

This example, which is inspired by one of the case studies, shows how the development of IS today raises questions and problems which are well beyond the organizational boundaries. The more IS project rely on international standards, the more they become entrenched and intertwined with wider networks of actors and decision makers, which can ultimately affect the success of the project. Where and how should we focus our attention? Can we understand local decisions without understanding the context of globalization processes in which they are taken and to which they are intimately related?

The methodological and theoretical questions which emerge are: should standards be studied in their local context of use? Or should they be studied as technologies which connect actors on a global level? What *scale* to use? What *size* of the unit of analysis? What *level* of abstraction?

Edwards (2003) raises exactly this issue by observing how technology in general is either studied at a micro level (e.g. through social studies of technology like SCOT or ANT) or it is studied at a macro level in theories of modernity (e.g. as expert systems (Giddens 1990)). However, as he puts it:

“[I]nfrastructures simultaneously shape and are shaped by – in other words, co-construct – the condition of modernity. By linking macro, meso, and micro scales of time, space, and

social organization, they form the stable foundation of modern social worlds.” (Edwards 2003: p.186)

Furthermore:

“[...] if to be modern is to live within multiple, linked infrastructures, then it is also to inhabit a traverse multiple scales of force, time and social organization.” (*ibid.*: p. 222)

Hence, because we live “within multiple, linked infrastructures” and because they have the particular characteristic of working on multiple *scales*, the *analytical* need to bridge the different levels of theorization emerges (Brey 2003): Social Construction Of Technology (SCOT) and Actor-Network-Theory (ANT) inspired micro-level studies and macro level modernity studies alone are not sufficient and are the base of a mutual blindness. Additionally, the study and theorization of infrastructures cannot transcend their relation with modernity⁶.

Summarizing the analysis above, when considering the study of standardization in the IS field the existing literature has three major limitations: (1) social and socio-technical facets need to be developed further, being a major aspect in IS standardization, to overcome the current bias towards the study of purely technical and economical aspects of standards; (2) standards are often studied in isolation, whereas they are increasingly immersed in a network of competing, overlapping and complementing standards which are all part of a larger infrastructure; (3) consequently, there is a lack of theoretical and analytical linkages of multiple levels and scales of analysis in which the infrastructure operates.

This thesis aims at addressing these limitations by firstly proposing a socio-technical perspective to the study of the development of standards. Secondly, the study views the standardization process as the unit of analysis adopted to study a larger phenomenon, that is, the development of *infrastructures*. Thirdly, by linking the multiple levels and scales, the thesis highlights how

⁶ An exception is represented by the recent works by Knut Rolland (2003). He addresses precisely this gap by conducting a study on the design and use of an information infrastructure in a global organization. He analyzes the way local (micro) actions propagate through the infrastructure causing effects on a global (macro) level and how these hit back locally reflexively influencing further actions. In the implications and contributions chapter I will further elaborate how this thesis extends and is different from his work.

infrastructures are a distinguishing feature of modern societies and are shaping and are shaped by processes of *modernization* (Brey 2003).

1.3 Research Questions

This thesis is the result of four years of research. Throughout the journey there has been one basic practical question which has triggered my curiosity and boosted my motivation. Standards and standardization processes are means of rationalizing coordination, cutting transaction costs, and simplifying the complexity of IS development. The natural outcome of the massive introduction and use of standards should hence be greater control and predictability of IS projects. While this is probably true, standards and standardization processes seem to produce other effects as well. This thesis, based on two case studies in healthcare, moves from the observation that *side-effects*, *paradoxes*, *ambiguities*, and difficulty of closing projects are frequent in IS standardization processes. This concern can be captured by the following research question:

- **RQ:** Why are standards and standardization processes in IS project increasingly affected by unintended effects and paradoxes?

This research question can be broken down as follows:

- a) How do these side-effects originate? Are there recurring patterns?
- b) What is their relation with the primary aims of standardization, that is the rationalization of coordination?
- c) Are the observed effects specific of a particular class of projects?
- d) How can they be managed?

This is the basic research question which signed the beginning and the conclusion of my research journey. I will here provide a little historical background about my initial research interest and motivation and how they are reflected in this research question. More than four years ago I came across a group of researchers distributed between the London School of Economics, the Viktoria Institute in Göteborg and the University of Oslo: there were two main themes at the

core of their research which captured my attention: phenomenology and information infrastructures. What attracted me was the original and controversial insights in the dynamics of IS in organizations that phenomenology could provide, especially in an era (the new economy) when there was great faith in the power of technology. Moreover, I found the focus on infrastructures (rather than systems) more appropriate to conceptualize the information exchange in today's organizations. When I joined the group for the PhD my main interest was well aligned with their line of research: the phenomenological investigation of problematic dynamics in complex IS standardization processes, such as drift and unintended consequences.

Once I started the research program, my research focus and questions changed adapting to the context of the case study, to the new findings, to the editorial needs of conferences and journals. This variety is well represented by a certain degree of diversity of themes touched upon in the various papers. When I found myself writing this introductory paper I was confronted with this variety and, at start, bedazzled by it. I had to make sense of my journey in order to wrap it into a meaningful message. Despite the variety and the initial frustration I managed to identify the "red thread" across all six papers. The red thread is now the main line of argumentation in this introductory paper and is well reflected in the contributions of the thesis which are here condensed and formalized. While the contribution was clear, ironically, the research question was difficult to grasp. It was until the very last days of writing that I struggled formalizing the appropriate research question. Until realizing, at last, that the appropriate research question was not necessarily supposed to reflect the conclusions I was aiming at (that is the end of the research journey), rather the beginning: the basic reason I started the research in the first place. In this sense the research question signs the beginning and the conclusion of my journey.

With this basic question in the back of my mind I have proceeded in my research by focusing on some particular aspects which seemed to provide a good key of interpretation to the described problem: (1) the observation that standardization breeds the need for more standardization; (2) the observation that standardization processes are made of negotiations which manage to come to an agreement and closure (ultimately becoming part of the specification of the standard) but also of negotiations which remain open and possibly become source of new problems.

These two observations provided the motivation to explore the basic assumptions and logics of standardization and to investigate the nature and dynamics of this particular type of “open” and unresolved negotiations. Exploring the assumptions and logics of standardization (and its possible contradictions) translated into the study of the link between standardization and modernity. The focus on unresolved negotiations and their effects translated into the need to create an analytical concept which could allow better identifying and investigating this phenomenon. These two aspects, as exemplified in the discussion above, raised the problem of finding a way to theorize about standardization on the multiple scales where the observed phenomenon is unfolding (e.g. linking the local context of use and the global context of formulation of the standardization strategy). Throughout the research I have refined the formulation of the problem and of the theoretical motivation in the way which is described in the following section.

1.4 Theoretical Framework

The thesis addresses the study of IS standardization processes as part of the development of a larger infrastructure. In particular it addresses the challenge of “linking” phenomena on multiple scales and bridging the existing theoretical “gap” between micro and macro studies of infrastructures (Brey 2003). What I am building is a theoretical framework which allows me to focus on standardization as “linking” so to be able to address both local contexts of use and larger contexts of organizations and society. Furthermore, the theoretical framework should help me to analyze standardization in the context of modernity so to further explore the fundamental linkage and co-construction of infrastructures (and their standardization) and our modern society.

I address this challenge in two steps: first I develop the analytical concept of *tensions* in standardization processes. Secondly, I use three perspectives from theories of modernity to study how tensions evolve and unfold over time: *reflexivity*, *multiplicity*, and *complexity*. Thus *tensions* become the unit of analysis to interpret the sources and dynamics of observed effects of standardization such as side-effects, paradoxes, non-closure and the like, and will be briefly discussed here. Subsequently, I will further elaborate on the three perspectives which constitute the core of the theoretical framework.

1.4.1 The analytical concept of “tensions”

In order to grasp and generalize about problems in IS standardization processes, I propose the concept of *tensions*. I use this concept as unit of analysis to study the *mediating* characteristic of infrastructure (Edwards 2003: p. 186). Hence, through the case studies, I will propose that looking at infrastructures as *mediating* means studying the *tensions* between actors in different scales as the result of negotiations emerging from standardization processes. Secondly, the *tensions* will be analyzed and interpreted through the lenses of concepts and theories related to modernity.

What work does this concept do analytically? How does this analytical concept help me to interpret the unfolding of standardization processes?

With *tensions* I identify a particular type of the negotiations highlighted by deVries’ definition of standardization (see page 4 of this manuscript). deVries’ definition conceptualizes standardization as the balancing of needs between different parties with the aim of the establishment of a common durable solution: this may be seen as a negotiation process. Hence, tensions are negotiations which either cannot or should not reach closure. They can refer to the difficulty of coming to a stable agreement and specification of the standard, or they can be a constituent part of the standard network once it is put in place, for instance in the form of permanent struggle for the control of the standard. They can also refer, as we will see from the cases, to what Rolland and Monteiro highlighted as the “balancing of the local and the global” (Rolland & Monteiro 2002), or standardization and flexibility (Hanseth *et al.* 1996), or local and universal (Timmermans & Berg 1997), or, finally, central control and peripheral flexibility (Ellingsen 2004).

Thus, by focusing on *tensions* I aim at unveiling certain aspects of standardizations which are often overlooked by mainstream literature. The very definition of deVries (which stands for many others as well), for example, does not consider the possibility that the “solution” can remain open yet still working, or that the “balancing” is continuously questioned. The point made here is that there is much more about standardization phenomena to be unveiled than it is

not theorized in current conceptualizations. Apparently, what is left out is what is largely responsible for the observed side-effects in the IS field.

1.4.2 Building a theoretical framework: reflexivity, multiplicity, and complexity

While *tensions* represent the unit of analysis, further theoretical concepts are needed in order to interpret and theorize about how tensions unfold in time. The theoretical framework of this thesis builds on three key concepts: reflexivity, multiplicity, and complexity. As I will illustrate they have in common a tight link with studies of *modernity* and are “scale independent”: a necessary property to study the mediating feature of infrastructure and seamlessly navigate through multiple scales.

The concept of reflexivity is taken from the theory of *Reflexive Modernization* developed by Ulrich Beck (1999b; see also (Beck *et al.* 1994) for alternative formulations of the theory). The idea of multiplicity comes from later studies in science and technology studies (STS) and emerged as a methodological and ontological need to better address the study of our contemporary society (Mol 2002; Law 2002). The perspective of complexity is mainly drawn from the field of complexity theory (Kauffman 1993; Holland 1995; Simon 1962) and is motivated by the need to better conceptualize the increasing global complexity of social relations (Urry 2003).

The motivation for adopting this theoretical approach is the need to deepen the understanding of IS standardization processes in the case of emergence of paradoxes, tensions, side-effects and ambiguity. These phenomena have been particularly observed in the case of standardization of large IS in the private and in the healthcare sector (Ciborra *et al.* 2000; Timmermans & Berg 2003). In these cases, standardization acts as a connecting mechanism which, on the one hand, tends to reduce variety, on the other, increases the sheer number of interconnections and interdependencies. Through a standardization process, heterogeneity is suddenly challenged by a tension towards homogenization. Local needs become mediated by global goals. In cases where these tensions are not resolved (i.e. the standardization process does not come to a closure (Law & Bijker 1992)), side-effects, permanent tension, and contradictions may emerge unveiling the complexity of the standardization process. The aim is to use the theoretical framework to better conceptualize these phenomena which are challenging traditional IS development approaches.

More specifically, the concept of *reflexivity* is taken from the theory of Reflexive Modernization which helps identifying and explaining the dynamics of social changes in our society. In particular, it proposes concepts like high-modernity, risk-society, and reflexivity to characterize the transition from a modern to a late- or high-modern society (Beck *et al.* 1994). High-modernity and Reflexive Modernization are relevant theories in the study of the role of IT in processes of social integration and globalization (Hanseth & Braa 2000). The development, diffusion and increased standardization of ICT represent logics of rationalization and control over social relations, which are typical of the first (industrial) modernity (Giddens 1990). As people and systems become more and more interdependent, small changes in the system may inadvertently affect other parts of the system or jeopardize the existence of the system itself.

For instance, integration of large number of systems in a large organization may produce as an effect the loss of control over the whole system, in contradictions with the original aims (Hanseth *et al.* 2001). This implies that along with processes of IS standardization (e.g. in the form of integration) new unwanted risks may emerge, which may reflexively strike back undermining the whole standardization attempt.

The idea of *multiplicity* is derived from recent discussions in STS, and thus falls into the program of socio-technical perspectives. Socio-technical theories, such as Actor-Network-Theory (ANT) and Social Construction Of Technology (SCOT), are theories developed in the field of STS with the aim to study the relationships between social and technical actors in the production of scientific knowledge and technological artifacts (Bijker *et al.* 1987; Law 1992; Law 1999; Akrich & Latour 1992; Latour 1987; Latour 2005). In particular, ANT allows focusing on the semiotic aspects of socio-technical networks, and is not new in the field of IS (Monteiro & Hanseth 1995; Monteiro 2000; Walsham 1997). ANT has proven to be useful to analyze the development and use of IT as processes of negotiation accounting for the agency of both social and technical actors.

Finally, the *complexity* perspective emerged as a viable alternative for the advancement of social science in the study of contemporary globalized society (Law & Urry 2004). Law and Urry identify the limits of traditional social sciences in the theorization of contemporary dynamics and

propose to look at Complexity Theory as a source of useful concepts and metaphors. This perspective well suits the ever more intricate world of IS, where number of components, their interdependencies and the reliance on adaptation are symptoms of an increasingly complex reality (BCS 2004).

The combined use of socio-technical theory, the theory of Reflexive Modernization and Complexity Theory will allow bridging the theoretical and analytical gap between different but equally important scales and analytical levels in which infrastructures operate (Misa *et al.* 2003). Socio-technical theories and Complexity Theory will provide a micro- and meso-level analysis of the infrastructure (and its processes of standardization) as technology in use. Moreover, it will provide the micro-level explanation of larger reflexive phenomena visible at larger scales and conceptualized as effects of Reflexive Modernization.

1.5 Research Setting and Approach

The research reported in this thesis is based on two interpretive case studies of standardization processes in the healthcare sector.

The first case study tells about the development of an Electronic Patient Record (EPR) in a large hospital in Norway. An EPR is a computer-based information system for storing and presenting patient clinical data in hospitals. The aim of the EPR project was to provide a common information system between clinical departments within the hospital and (ultimately) between hospitals in Norway. This implied to adapt, substitute or integrate existing systems in different departments and in different hospitals, in order to establish a common system for information exchange. This involved several formal and informal processes of standardization which aimed at contributing to the establishment of what could be called a National Health Information Infrastructure.

The second case study is based on a large project for the development of District Health Information System for routine reporting of activity/statistical/epidemiological data (DHIS). The project, at the time of writing, is running in several developing countries around the world, among which South Africa. The fieldwork was conducted in the Province of Eastern Cape and focused on the establishment of a new information system inside all the hospitals aimed at

reporting hospitals' data at higher levels of the health administration's hierarchy. The observed process involved the establishment or the improvement of an IS inside the hospitals by means of introduction of data collection tools and processes, as well as basic training on information use and computer literacy. The information system included both paper and computer systems. The project concerned processes of homogenization and standardization within hospitals and between the hospitals and the upper layer of the health administration. Also in this case the observed processes of standardization aimed at creating a sustainable National Health Information Infrastructure.

The study of healthcare represents an ideal ground to investigate the intricacies of socio-technical relations in the development of information systems. Specifically, standardization in the healthcare sector has proven to be particularly challenging. Healthcare provides an ideal workbench to unfold some of the complexities inherent in processes of standardization of Information Systems. In such settings, the degree of specialization of medical practices challenges attempts of defining information requirements common to several departments or hospitals. Information shared between departments and professional groups tends to be reflected in multiple levels of meaning, rendering the information and its structure highly context dependent. Besides, professional bureaucracies (such as most healthcare institutions) are known to challenge any attempt of standardization, as usually standardization happens within the different professions rather than between them (Mintzberg 1992).

For instance, Klein recognizes the importance for health information to be standardized and hence be compatible and transferable between health IS (Klein 2002). Inconsistency and incompatibility of health information can generate risks to patients and there is a growing demand from the patients to be able to access their health related data. However, he also observed, healthcare is extremely complex (*ibid.*). Several aspects of complexity related to the standardization of health information have been so far highlighted in the literature. For instance, the contextual nature of medical information (Berg & Goorman 1999), the dilemmas arising from standardizing inter-organizational communication (Wintherheik & Vikkelsø 2005), the need to balance management control and local flexibility (Ellingsen 2004), the tension of changing

work practices while at the same time being grounded in the same practices (Timmermans & Berg 1997), or finally the challenges of modeling health information (Berg & Toussaint 2003).

Despite these complexities, standardization in healthcare is clearly happening: there is an increased demand of intra-organizational information systems, IT departments and functions in hospitals are growing in size and competencies, and the number of standardization bodies related to healthcare is increasing⁷.

Hence, studies on information systems standardization in healthcare are needed in order to shed some light on its dynamics and complexities. Managers of large IT projects need to be better informed on the challenges in order to develop appropriate development and implementation strategies. International standardization bodies require a better understanding of the heterogeneity and multiplicity of logics present in healthcare institutions. Finally, designers and developers of technological components also require a better understanding of the installed base of practices, traditions, and path dependent decisions which challenge any new design from scratch.

1.6 Expected Contributions

Motivated by the practical need to understand the sources and nature of unintended effects in standardization processes, I have structured and focused the investigation on the identification and study of *tensions* and of the means to provide a theorization of infrastructures which can account for the micro and macro scales in which infrastructures operate in the context of modernization.

Hence, the thesis aims at providing the following contributions:

- To deepen the understanding of sources and dynamics of problems in IS standardization by studying the *tensions* which generate them

⁷ IEEE for device communication, DICOM for imaging, CEN (the European Committee for Standardization) TC 251 focusing on standardization in the field of Health Information and Communication Technology, ISO/TC215 which covers similar aspects as the latter one, and the US based international committee Health Level Seven (HL7), to name the major ones.

- Consequently, to formulate insights and recommendations on *how to manage* them and investigate what theoretical and practical implications this has on current approaches
- To provide an example of micro-macro theorizing of information infrastructure development linking micro theories of technology with macro theories of modernity

Table 1 represents a synthesis of the main points of the thesis: its object of study, the observed effects which create the practical motivation, the analytical concept used to investigate the object of study, the positioning within a particular theoretical discussion, the theoretical framework, and the expected theoretical and practical contributions.

Table 1 What my thesis is about, in a nutshell.

<i>Object of study</i>	Standardization processes in II development , with the following manifestations:
<i>Observed effects</i>	▪ Side Effects ▪ Paradoxes ▪ Duality and Ambiguity ▪ Non-closure which originate from:
<i>Analytical concept</i>	Tensions , emerging as relation between
<i>Theoretical Positioning</i>	Standardization – Modernity (as a particular case of the widely studied relation Technology – Modernity)
<i>Theoretical Framework</i>	A relation which can be studied with “modern” concepts such as: ▪ Reflexivity ▪ Multiplicity ▪ Complexity to shed some light on the dynamics of standardization processes producing the observed effects
<i>Theoretical Contribution</i>	1) Develop “ Tensions ” as key analytical concept , which allows an 2) articulated insight into the relation between standardization and modernity , to help 3) bridging micro-macro gap in the theorization of II
<i>Practical Contribution</i>	Insights in how to manage tension in IS standardization, as opposed to developing systems

1.7 Structure of the Thesis

The remainder of the thesis is structured as follows. First, in the theory chapter, I will provide a review of relevant literature on IS standardization and position this work in it. This will be followed by the formulation of the theoretical framework. Secondly, I will illustrate the research approach and method, together with a description of the two cases presented in the thesis and the fieldwork activities I have conducted to collect the data. This is followed by a reflection on data analysis, use of theory, and type of contribution and generalizability. In the fourth chapter I will present the research findings by providing abstracts of the papers and summarizing the findings in a preliminary analysis. In the subsequent chapter I will finalize the contributions and implications.

2 THEORY

2.1 Introduction

The thesis addresses the need for a better understanding of the development of information systems in an increasingly interconnected and informed society. The phenomena I will investigate are processes of standardization of information, and of the technical and social means to store it, represent it, and distribute it. These phenomena all contribute to the development and change of the large set of existing and interconnected flows and structures of information which populate what we can call the information infrastructure of organizations.

The theoretical scope to interpret the development of infrastructures should go beyond the locality of the observed phenomenon (e.g. in this case a hospital or several hospitals in a province). There are two reasons for this: (1) infrastructures are technologies which *mediate* among the actors, hence their study should cover multiple scales of analysis which can include the micro-level study of the actor and the macro-level study of the mediation; (2) infrastructures are a distinguishing feature of modern societies and hence their study cannot transcend a study of their relationship with modernity (Misa *et al.* 2003).

Studying the mediating aspects of infrastructures (in particular, in this thesis, studying the *tensions*) means developing a methodological and theoretical approach which accommodates the zooming in and out of contexts and actors, allowing developing analytical linkages between local and global (or micro and macro) level of study. The theoretical approach proposed here tries to address exactly this, by focusing on theories which are appropriate to navigate across scales. My theoretical framework builds on the theories of Reflexive Modernization, late ANT, and Complexity Theory.

Studying the relationship between infrastructures and modernity first of all implies understanding what are the foundations, the assumptions, and the basic logics behind the creation, distribution,

and consumption of information in our modern society. Secondly it implies the identification of salient aspects of infrastructure design and development (i.e. standardization) and their interrelation with the logics of modernity. Accordingly, the relation between information and modernity is first discussed by providing the conceptual background to understand information infrastructures as modern technology. Then three salient aspects of modernity are selected and proposed as theoretical framework to analyze information infrastructures development in the context of modernity: *reflexivity*, *multiplicity*, and *complexity*.

The remainder of the chapter is structured in two parts. In the first part I will provide reviews of literature on infrastructures and standardization and position my work within ongoing discussions. In this part I will infer the “meaning” of information infrastructure by first discussing the relation between information and contemporary society. Hence I will discuss existing perspectives on information infrastructure, highlighting the relevant facets, which will lead to the identification of the core challenges of infrastructure development. These challenges will help to better identify and characterize *standardization* as infrastructure development. Overall, this first part will allow focusing the object of study and defining its main characteristics.

In the second part I will proceed one step further into the core issue of this thesis, which is the theorization of standardization as a process of infrastructures modernization. Here I will first provide a review of what modernity means and elaborate a particular perspective on the current modernity. Subsequently I will discuss three central aspects of *our* modernity which characterize the development of information infrastructures and discuss why they can be used to bridge the micro-macro gap: reflexivity, multiplicity, and complexity.

2.2 Review and Positioning

2.2.1 Information and the Contemporary Society

The aim of this subsection is to approach the concept of “information infrastructure” as it emerges from the relation between information and our contemporary *information society* (Castells 1996).

Theories of the *information society* recognize how the proliferation and diffusion of technologies for producing and distributing information together with the intensification of relations and

exchanges across the globe have produced a paradigmatic shift in the economy from an industrial to an information (or post-industrial) age. That is, information, not goods, has become the organizing principle of society (Webster 1995). Additionally, the process of *globalization* (“[...] the intensification of worldwide social relations which link distant localities in such a way that local happenings are shaped by events occurring many miles away and vice versa[...]” (Giddens 1990: 64)) amplifies the need of flow of information and people. In turn, the increased pervasiveness of information technology accelerates the process of globalization. As a result, Castells argues, our society is increasingly based on a *space of flows*, as opposed to the *spaces of places*, which are the base of our common experience (Castells 1996). This means that the *flow* of information becomes the new space which organizes social relations and constitutes the salient characteristic of the *information society*.

In this paradigm shift, Castells analyzes the revolution in information technologies. In fact, he underlines how the first “layer” of the space of flows is constituted by the technology which enables the transfer of electronic impulses representing information (Castells 1996, p. 412). However, IT is more than the simple consequence of the need to support the *flows* of information. In a way, the more IT fills the need of information to be distributed, the more information needs to be supported by new IT. This mutual relationship between IT and information is one of the aspects of what Kallinikos calls the reflexive production of “information out of information”, idiosyncratic of this society (Kallinikos 2006).

Firstly, information is in nature self-referential. That is, it is mostly based on the reference to other information, which in turn can be based on other information or finally be a description of a reference domain. Secondly, new information is produced by its simple permutation in different context. This (re-)production is accelerated and amplified by the use of IT. However, the consequent growth of information requires yet new systems to be built and interconnected, producing a “[...] process whereby the proliferation of information and technological innovation reinforce one another in an expanding spiral [...]” (Kallinikos 2006; Ciborra *et al.* 2000).

The resulting relationship between information and technology is mutual and reflexive: information requires new technology to produce new information which requires newer or more

integrated technologies which produces even more information, and so on. This self-feeding process allows the emergence of the fact that technology is not merely a means to achieve the end of (say) better information: it is both the means and the end of modern society (Heidegger 1977). In particular, *information* technology constitutes the foundation of the *information society*, in the same ways manufacturing technologies were for the industrial society (Castells 1996).

Accordingly, IT is much more than the product of intentional plans (a means): it can be viewed as the co-cause of our condition. Rather than a *tool*, IT ought to be seen as an *infrastructure-Gestell* representing and manipulating our daily activities (Heidegger 1977; Ciborra & Hanseth 1998; Kallinikos 1995). The concept of *Gestell*, as proposed by Heidegger in his study of modernity, helps unveiling the essence of IT as an independent logic of placing, arranging, regulating, ordering things to store them as “[...] reserves of resources (including human) made available for future deployment” (Ciborra & Hanseth 1998). In this modern perspective, information-technology as *Gestell* organizes the *space of flows* and constitutes the *infrastructure*, or all without which the information society cannot function.

2.2.2 Information Infrastructures

In the previous subsection I have conceptualized II as “modern technology”. Looking at how II emerge as co-construction of our modern *information society*. In this subsection I will discuss existing perspectives on II as an “object of study” in order to understand what infrastructures are made of and how they can be analyzed. I will here review four different perspectives on II which can provide a useful ontology. The four perspectives are: technical, managerial, socio-technical, and social. Sometimes they are complementary, other times conflicting. The perspective adopted in this thesis is near the socio-technical and social views.

Firstly, the technical view characterizes II as (e.g.) a “[...] constellation of networks, services, and applications that are interconnected and, for many purposes, interoperating.” (Branscomb & Kahin 1995) A similar definition is proposed for the Internet at large, defined as a global infrastructure running on interrelated layered protocols and standards (Abbate 1999; Leiner *et al.* 1997). Continuing the parallel with classical infrastructures (electricity, transportation, water etc...) II can be seen as the new generation of technical infrastructures supporting and enabling the

daily business of organizations and citizens (Carr 2004). This view helps to highlight the technical materials infrastructures can be made of. The same material Castells recognizes as foundation in the organization of space of flows (Castells 1996).

Secondly, this view can be expanded by putting the technical material of standards, networks, and application in the context of an organization or several organizations striving to accomplish their daily business. In the organizational context, the managerial perspective contextualizes IIs as resources to be strategically managed. II's material is made of systems, networks, applications, but also business processes, organizational routines, and guidelines (Davenport 1998; Davenport 2000; Broadbent & Weill 1993; Ives & Jarvenpaa 1991; Henderson & Venkatraman 1993). The main objective of the managerial perspective is to inform manager on how to achieve an alignment between the strategic objective of the organization and the capabilities of the IT infrastructures. The alignment is achieved by conceptualizing the II as a “portfolio” of IT assets that needs to be developed according to the changing strategic needs (Broadbent & Weill 1998). While this view proved to have good explanatory power and became popular in the management field in the 90s, its implementation often resulted problematic (Ciborra 1997; Ciborra *et al.* 2000).

Thirdly, the socio-technical perspective helps overcoming the limitations of the managerial one by highlighting both economical and social aspects. On the one hand, concepts from standards economics are brought in to describe macro dynamics of infrastructure development. Such view includes concepts like network externalities, path dependency, lock-ins, switching costs, and positive feedback (David 1985; Shapiro & Varian 1999; Antonelli 1992). On the other hand, the plasticity of IT in use and its interweaving with the social context underlines the need of a theoretical vocabulary capable of bridging the apparently false dichotomy between the technical and the social. The resulting definition of II is of a heterogeneous, open, shared, enabling *installed base* of social and technical actors (Hanseth & Lyytinen 2004).

Finally, the social perspective views infrastructures as sunk into multiple social arrangements and institutions, embedded in a set of conventions of practice, or emerging in people's practice connected to activities and structures (Star & Ruhleder 1996). Consequently, infrastructures can be seen as a relational property rather than a set of interconnected (socio-) technical artifacts.

Probably the main implication of this broader definition is a shift of the research focus to inquiring “when” (rather than “what”) is an infrastructure (*ibid.*). Accordingly, an infrastructure “is” when it emerges as such in the form of social relations, practices and related artifacts: an II may be made of people, meetings, paper forms, and social and organizational conventions, and (possibly, but less importantly) as computers, LANs, software, protocols and other technical artifacts.

2.2.3 Developing Information Infrastructures

What does it mean to develop an Information Infrastructure? What relation exists between II development and standardization? How do we relate this to IS development? Regarding the last question, Hanseth and Lyytinen argue that:

“The notion of system and the planning and control oriented strategies associated with it will still be useful in the development of new components that are going to be included into infrastructures. Systems have to be seen as part of larger infrastructures and the strategies for developing them have to be implemented within the context of strategies for developing the infrastructures the systems are becoming parts of.” (Hanseth & Lyytinen 2004)

This perspective repositions the problem of IS development as II development. The view I will propose is that II development is about processes of standardization. I will in this subsection let emerge two main characteristics of II development as *standardization*: the management of *interdependencies* and of *control structures*.

Technically, development can mean the implementation of a new standard that builds upon, substitutes, or competes against other standards serving in the same infrastructure. For instance, a new classification systems for diagnosis in a hospital will either substitute or coexist with other classification systems embedded in the many systems in the hospital’s II. It can also refer to a new system which needs to be connected (through standard interfaces and protocols) to the network of existing systems. For example, a new laboratory system which needs to integrate with the Electronic Patient Record systems to manage the workflow of lab test results, requests, and reports. From the managerial perspective, it can refer to the substitution or extension of IT

“assets” in the portfolio. Or it can refer to the development of a new business process to better align IT and business strategies. Again, in a hospital this may refer to the implementation of a new strategy of adopting a national standard EPR to substitute the existing one. From a socio-technical point of view, development can represent the introduction of a new actor in the actor-network, or the inscription of new routines in technical material.

In each of these perspectives there are two main issues which emerge as salient characteristics of II development: *interdependencies* and *control*. The introduction of a new system, the improvement of a work procedure, and the development of a new EPR strategy are not anymore isolated problems. Each of these actions requires the careful negotiation and interconnection with the existing set of systems, practices and rules. Consequently, negotiations and interconnections tend to redistribute the control over the changed part. Hence, development refers mainly to the management of interdependencies between (technical, social or socio-technical) actors, and of the related control structure.

First, as mentioned, infrastructures “mediate” between actors on the same or on multiple levels (Brey 2003). The mediation is achieved by means of technical or social, formal or informal, intentional or unintended interdependencies. Second, the issue of control consequently becomes central. On the one hand, interdependencies may be created on purpose (the integration of a new system, the establishment of a new social rule) and in this sense be the result of planned change. On the other hand, they can emerge as a consequence of the creation of other interdependencies and in this sense uncontrollable or not deliberate. Installed bases, path dependency, and self-reinforcing mechanism may hamper the attempt to regain control.

2.2.4 Standardization

In the previous subsection I provided a working definition of II development as standardization. In this subsection I will discuss some perspectives on IS standardization. In the introduction I have provided a working definition of standardization, which is compatible with the focus on interdependencies and control suggested above. Here, I will discuss standardization more in detail with a particular focus on the materials which constitute the standards and the

standardization processes. In parallel with the review on the definitions of an II, here I will first highlight technical sides, then social sides of standards and standardization.

As we have seen, studies in economics of standards developed central concepts such as path dependency, network externalities, lock in, switching costs, compatibility, and increasing returns (David 1985; Katz & Shapiro 1985; David 1990; David & Bunn 1988; Arthur 1989; Antonelli 1992; Arthur 1994; Farrel & Saloner 1985; Farrell & Saloner 1986; Farrell & Saloner 1992; Liebowitz & Margolis 1995; Garud & Karnøe 2001; Besen & Farrel 1994; Gandal 2002). The focus of the economic perspective is in general on models of standards development and their consequences on firms and markets. Standards are accordingly defined as technical elements, while less attention is given to their social shaping and social and political implications. For instance, David and Greenstein (1990) define (technological) standards as “a set of technical specifications adhered to by a producer, either tacitly or as a result of a formal agreement” (page 4).

Acknowledging the economic contribution, I would like to point at other aspects of the process of standard making specifically emerging from the case studies. Standardization is not a purely technical process, and is not a process that inevitably leads to closure as definition of a complete technical specification (Hanseth & Braa 2001). It is important to analyze not just the social impact of technical standards, but to contribute to the conceptualization of the socio-technical process of standard-making and of what a socio-technical standard is (Egyedi 1996; Monteiro & Hanseth 1995). We can turn then our attention to the socio-technical approach, where I recognize four elements important to our understanding.

First, standards represent always *local* universality (Timmermans & Berg 1997). By this concept it is emphasized that universality always “rests on real time work and emerges from localized processes of negotiations and pre-existing institutional, infrastructural, and material relations” (p. 275). There is no rupture between local and universal, but it is from the very local that universality emerges, and in turn transforms back the local. Understanding local universality, means therefore to commit to the understanding of the historical dimension, or trajectory, along which a standard is constructed and reconstructed (Dosi 1982; Strauss 1993). This implies also to

look at aspects of adaptation of the universal into the local (Hanseth & Braa 2001), and of *generification* of the standard across contexts (Pollock & Williams *forthcoming*).

Second, the process of standardization is conceptualized as a process of technology generation as discussed by Schmidt and Werle (1992; 1998) in their study on committee standards and telecommunication technology. They discuss how technology and the process of standardization are not neutral, but defined through and intermingled with social, political and economic factors. Similarly, Bowker and Star (1999) point out that standards are always embedded into local networks which inscribe specific beliefs and assumptions on reality. This perspective is informed by the social construction of technological systems approach (e.g. Bijker *et al.* 1987).

As third element, standards are not isolated elements, but as always embedded into a network of standards: one standard's order can be another standard's disorder (Berg & Timmermans 2000; Jørgensen & Sørensen 1999).

Fourth, significant concepts in understanding processes of standardization are (from STS and ANT literature) as closure (Law and Bijker 1992), stabilization (e.g. Bijker 1993) and alignment (e.g. Callon 1991) in understanding processes of standardization (Hanseth *et al.* 1996). Specifically, closure indicates a status where a consensus emerges around a particular technology. Closure stabilizes the technology by accumulating resistance against change. In this situation, the actor network where the technology is embedded can be said to be aligned. As we will see, in the case studies the alignment, stabilization and closure are not necessarily reached: the process seems to continuously be re-opened (no closure) and negotiated (no final alignment or normalization).

2.3 Theoretical Framework

“[...] a major distinguishing feature of modern societies is their reliance on infrastructures, large sociotechnical systems such as information and communications networks, energy infrastructures, and banking and finance institutions [...]”
(Philip Brey MISA p 60).

2.3.1 Introduction

In this subsection I will define the theoretical framework for the analysis of II development in the context of modernity. This will be done in two parts. First I will discuss through the works of Ulrich Beck and Anthony Giddens the origins and underlying logics of modernity versus late- or high-modernity, which characterizes our contemporary society. Secondly, I will propose three main “themes” (reflexivity, multiplicity, and complexity) as theoretical constructs to be used in the study of contemporary II development.

From an institutional point of view, the modern era originates in the eighteenth century, with the rise of the industrial society in Europe. According to Max Weber, this era is characterized by industrialism and capitalism, and its founding logics can be traced back to systemic *rationalization* (Weber 1958). Rationalization emerges as development of new time- and space-organizing devices and techniques (including IT) which cause a “time-space separation”. Secondly, it emerges as development of “disembedding mechanisms” (such as money, timetable charts, organization charts, and systems of expert knowledge, which could all be supported by IT) which separate social relations from local contexts. Finally, modernity is characterized by the “reflexive appropriation of knowledge” through the systematic production and reproduction of knowledge about social life (Giddens 1990).

However, Beck argues that there are signs which indicate that our contemporary society may have overcome modernity (Beck 1992). While principles of rationalization and control are still applied, the outcomes of their application have become less and less predictable. The global scale deployment of technological developments produces effects which go beyond rational prediction and calculability. This is, for instance, the case of proliferation of nuclear weapons and increased pollution. In this “late” modernity, technological development may bring on side-effects and unintended consequences which may result in new types of uncontrollable (and potentially global) risks. The new late-modern society thus becomes a “risk society” (Beck 1992, 1999b).

But what technology allows this degenerative process to happen? And how does it happen? One answer may be found in the increasing interdependencies which both the development of new technologies (including IT) and the processes of globalization create among social actors.

Growing interdependencies are the effect of development of increasingly interconnected (social- and technical-) infrastructures. In this sense, infrastructures can be seen as the building block of (late-) modern society; or as the *Gestell* breeding its own logics by locally generating and globally propagating unintended effects of rational planned actions. Infrastructures and their development are the product of modern organizing principles. However, the intensification of interconnections, interdependencies, and speed of change in them may be the source of a reflexive phenomenon by which the very same organizing principles are undermined. This process characterizes what Beck calls *reflexive modernization* (Beck 1994; Beck 1999b).

Understanding II as technologies implementing modern organizing principles is trivial. More interesting is trying to unfold what it means to study II as co-cause of Reflexive Modernization. This is the theoretical aim of the thesis. In order to achieve this aim three theoretical constructs are proposed: reflexivity, multiplicity, and complexity. The basic idea is to use these three perspectives to analyze II at different scales and to link the analysis to the context of late-modernity.

However, analyzing II at different scales, or bridging the micro-macro gap, may be achieved in several ways. For instance one could refer to separate frameworks for micro and macro and “jump” between them as a way of bridging the gap. Alternatively, one could try to look for something that allows the researcher to travel *continuously* in a “flattened topography” where micro and macro, local and global are not separate. On the contrary, as a result “[t]he macro is neither ‘above’ nor ‘below’ the interactions, but *added* to them as *another* of their connections [...]” (Latour 2005: p.177). Or, as Latour puts it:

“There is now a yawning break between what encloses and what is enclosed, between the more local and the more global. What would happen if we forbade any breaking or tearing and allowed only bending, stretching, and squeezing?” (Latour 2005: p 173)

Hence, the proposed theoretical framework tries to satisfy two important requirements: (1) it should include concepts that characterize modernity; (2) these concepts should allow navigating through different scales by focusing on their connections and avoiding the need to jump between different theoretical vehicles.

2.3.2 Reflexivity

“[Risk society] describes a phase of development of modern society in which the social, political, ecological and individual risks created by the momentum of innovation increasingly elude the control and protective institutions of industrial society.” (Beck 1999b, p. 72)

The concept of *reflexivity* refers here to the work of Beck on the theory of Reflexive Modernization (Beck *et al.* 1994). In his analysis of contemporary society, Beck underlines the increased importance of *side-effect* of human actions. He identifies an increased *unawareness* or *non-knowledge* at the basis of *side-effects*. As the modern world becomes more and more integrated and interconnected, it is increasingly difficult for humans to be fully aware of all effects caused by their actions. As side-effects become acknowledged, they challenge and question the basic knowledge of the modern society (Beck 1994; Beck 1999b).

More specifically, the exasperation of modern logics of rationalization and control push technological innovations in a spiral of increased technical and social integration. The key problem develops around the peculiar synthesis between *knowledge* and *unawareness*, which manufactures uncertainty and new risks. Technological innovation generates knowledge, but it also generates *non-knowledge*, that is *unawareness* of the possible effects of that very innovation. This logic applies for instance to green-house effect caused by pollution (Beck 1999b), to human genetics (Beck 1999b) and possibly to Information Infrastructures development (Rolland 2003).

We can view IS development (and in particular IS standardization) as a key feature of modernization. Consequently, reflexive processes should be visible in this field as well. As a matter of fact, recent studies on corporate Information Infrastructures identify and analyze the production of side-effects and unintended consequences arising from processes of standardization (Hanseth *et al.* 2001; Ciborra *et al.* 2000; Ciborra & Osei-Joehene 2003; Hanseth & Braa 2001).

In all of these studies there is one key aspect in Beck’s theory which seems to be systematically overlooked and which often generates misunderstanding. Ulrich Beck underlines how Reflexive

Modernization is not a theory of *negative fatalism* describing the necessary decline and self-destruction of modern society (although he does not rule out this possibility) (Beck 1999b). If it was, it would be a “modern” theory, as it would *know* (predict, calculate) what in fact the theory claims cannot be known (predicted, calculated): the outcome of global risks. Reflexivity, instead, has two meanings: one is *reflex*, that is the process by which modern logics (rationalization and control) generate side-effects and unintended consequences which undermine them (out-of-control); secondly, reflexivity means the process of self-reflection and self-confrontation of the society with these phenomena. The latter is what ultimately ignites self-criticism and the self-transformation of modern society into something else. Possibly self-destruction, possibly a *radicalized* (second phase) modernity “[...] concerned with its unintended consequences, risks and their implications for its foundation.” (Beck 1999b: p. 152) It is this very last aspect which provides the motivation for analyzing reflexivity in IS standardization: that is to change our way of conceptualizing technology, design and modernity.

2.3.3 Multiplicity

“For here is the problem. The objects we study, the objects in which we are caught up, the objects which we perform, are *always more than one and less than many*.” (Law 1999, p. 11; *italic original*)

Ulrich Beck is not alone when recognizing the change in the nature of our modern society. John Urry, for instance, observes how the 21st century is characterized by a “[...] global transformation through the ‘end of organized capitalism’ [...]” (Urry 2003). We live in a society where processes of globalization have drastically increased the intrinsic complexity of social relations in “[...] a world that enacts itself to produce unpredictable and non-linear flows and more mobile subjectivities [...]” (Law & Urry 2004). This large scale change in the society has caused a methodological crisis in social science. A world become unpredictable, shifting, ambiguous, non-linear, a ‘pluriverse’ (as opposed to ‘universe’) easily escapes the “Euclidean” compartments and categories of traditional social science and its methods (Law & Urry 2004).

Consequently, Law and Urry identify two alternatives for a “new version” of social science. One is to note that its current method has limits in understanding non-linear relationships and flows, and thus that Complexity Theory may provide tools to overcome these methodological limitations. (This alternative will be explored in the next subsection.) Another alternative is to rethink social science as decentered, with *fluid* and *decentered* modes of knowing. This last aspect is what will bring us to the idea of *multiplicity*.

The core methodological problem lies in the fact that research methods in social science tend to work on the assumption that “[...] the world is properly to be understood as *a set of fairly specific, determinate, and more or less identifiable processes*. [...] waiting to be discovered [...]” (Law 2004, p. 5). However, research methods do not simply describe but also produce and *enact* the reality under investigation. Moreover, objects in reality are real because they are part of a *practice*: they are reality *enacted* (Mol 2002, p. 44). It follows that the enactment of an object (a disease (Mol 2002), an aircraft (Law 2002), or an IS in our case) produces as many objects as there are situations, contexts, and assemblages of actors that interact with it. The different representations of objects are thus not different *perspectives* on the same object, rather they represent different enactments in different contexts which produce different objects. It is then the job of semiotics to see if, it all, they are connected together creating a single object (Law 2002, p. 35).

Doing (or better, *enacting*) social science should be sensitive to the coexisting realities of social objects, their different modes of being, which make them at the same time *always more than one and less than many*, that is always *multiple* (Law & Mol 2002). The idea of *multiplicity* thus tries to capture this aspect of complexity of contemporary society, which otherwise would be *reduced* to simple perspectivalism.

The idea of multiplicity, of multiple modes of ordering has already proven useful to the study of IS in healthcare (Berg & Timmermans 2000; Grisot 2004). In these studies the multiple meanings and logics residing in health standards are highlighted along with another central aspect: interferences (Mol 2002). As objects live multiple existences through coexisting enactments, the logics expressed by the different enactments may interfere with each other. Interferences between enactments of the same or of different objects constitute the enactment of their

“interdependencies”. The outcome of enacted interferences, however, may result in conflicts between orders which produce “disorders”. This, of course, raises the question about control.

In earlier Actor Network Theory (ANT) studies, a central concept was the one of “alignment”. This concept represented the process of enrolment of other actors to align to an actor’s interests. Thus control can be “measured” in terms of the strength of the alignment and of its irreversibility. But when we view reality as “multiple”, there is not one single network in which this strength may be measured. Multiplicity of orders and interferences opens up the complexity of the *relational materiality* of reality (Law & Hassard 1999) making it difficult to draw fixed boundaries and relations which can illustrate control structures. The result is that someone’s ordering actions can become somebody else disorders.

2.3.4 Complexity

“There is complexity if things relate but don’t add up, if events occur but not within the processes of linear time, and if phenomena share a space but cannot be made in terms of a single set of three dimensional coordinates.” (Mol & Law 2002, p. 1)

The second alternative Law and Urry propose in order to move on to a “new” social science capable of investigating today’s globally interconnected world is to build bridges with complexity theory (Law & Urry 2004). Complexity Theory (or complexity science) emerged as a set of concepts and models from chaos theory with the aim to study systems of interacting agents which work at the edge of chaos. These studies first originated in natural science, but soon expanded in the field of economics (see for instance the works by the Santa Fe Institute: Arthur *et al.* 1997 and Arthur 1994), organizational and social systems (see for instance the special issue on complexity edited by *Organization Science*: Anderson *et al.* 1999; or Anderson 1999; Stacey 1995; Thietart & Forgues 1995; Mitleton-Kelly 2003) and more recently in Information Systems (see for instance the following special issues Desai 2005; Jacucci *et al.* 2006; or Xia & Lee 2004; Schneberger & McLean 2003). However, unlike chaos theory, it studies what causes order, where

order emerges from self-organizing agent interactions (Kauffman 1993; Holland 1995; McKelvey 2004a; McKelvey 2004b).

Or as Urry puts it:

“Complexity elaborate how there is always order *and* disorder within physical and social phenomena and especially in various hybrids. Order and chaos are often in a kind of balance where the components are neither fully locked into place but yet do not dissolve into anarchy. They are ‘on the edge of chaos’” (Urry 2005).

To be more specific, complexity science is concerned with the study of ‘complex relationality’ (Urry 2005). Complex systems can be defined as made up of a large number of elements interacting in a dynamic and non-linear fashion, forming loops generating positive and negative feedbacks. Complex systems are open in the sense that defined boundaries are difficult to identify and have history: their past is co-responsible for their present and future. Finally, each element is ignorant of the system as a whole, responding only to information which is locally available (Cilliers 1998).

Some implications are that complex systems: (1) cannot be either understood or controlled as a whole; (2) are self-similar, that is they are scale-invariant; (3) are path-dependent; (4) local actions can propagate at global level in non-linear ways. Hence the study of complex systems is all about studying interdependencies and control.

There are implicit links between the concept of complexity and dynamics of modernity and globalization (Urry 2005). For instance, Giddens views modern society as a driverless out-of-control ‘jaggernaut’ system generating uncontrollable side-effects (Giddens 1990). Castells identifies the strength of the increasingly global networks in their selforganizing nature, rather than from centralized hierarchical control (Castells 1996). Finally, Beck’s ideas of unintended consequences and of boomerang effects again resemble dynamics of complex systems (Beck 1999b).

2.3.5 Conclusions

Reflexivity, multiplicity, and complexity are perspectives which can be put in relation to each other. They constitute a conceptual framework which can help analyzing the *tensions* emerging from the *mediating* character of modern infrastructures (see Table 2). For instance, they are all applicable on different scales because the focus is on the relation (i.e. interdependencies) among actors (or agents) instead of on the actors themselves. By being focused on the relations, they help analyzing the tensions arising from the establishment of new links in the infrastructure. Tensions are created when (e.g.) new standards link previously isolated actors, thus creating possibilities of *interferences* between different local modes of ordering. Finally, by describing the unfolding of reflexive process through the dynamics of a complex system, reflexivity can be linked and explained on multiple (self-similar) levels. This will allow applying the ideas of the theory of Reflexive Modernization from a macro-societal level to a local level. The paper on “Reflexive Standardization” included in this thesis provides an example of how these three theories are complementarily used to analyze IS standardization.

Table 2 Links between the theoretical framework and key aspects of modern Information Infrastructures addressed in the thesis.

Focus	Concept	Reflexivity	Multiplicity	Complexity
Modernity		Late-modernity as Reflexive Modernization	Modern society as made of objects that are always more than one and less than many	Contemporary society at the edge-of-chaos: order-disorder balance
Multi-scalar analysis		Links between local actions and global consequences	Focus on relations allows zooming in and out	Self-similarity of complex systems
Interdependencies		Innovation, rationalization, and globalization increase interdependencies of social actors	Interferences between coexisting modes of ordering	'Complex relationality' (Urry 2004)
Control structures		Unawareness creates risk of unintended consequences and out-of-control dynamics	Decomposed in the multiplicity of overlapping/interacting networks	No central control. Non-linearity and unpredictability of propagation of local actions

3 CASE DESCRIPTION AND RESEARCH APPROACH

3.1 Research Approach

“Understanding is grounded on this human attitude of being open to possibilities and continuous caring about events, resources, behaviors, and problems. [...] This is the domain of existing in the world. Hence, a different perspective on information systems should be anchored to the unfolding of the human process of encountering the everyday world.” (Ciborra 2002, p. 6)

3.1.1 Interpretive Approach

The research presented in this thesis is based on an interpretive approach to case study (Walsham 1993; Walsham 1995; Klein & Myers 1999). The reason for adopting an interpretive approach lies in the nature of the observed phenomenon and in the aim of the research. This thesis views IS as social systems, where the dichotomy between social context and technical artifacts dissolves in the complex intertwining of socio-technical actors. Moreover, the research aims at studying how the IS changes and is changed by the context (be it other IS or the logics of modernity). What I am after, are not tangible objective facts and relations. I am interested in the process of mutual shaping of IS as modern technology and our society. This fits well interpretive research, which aims “at producing an understanding of the context of the information system, and the process whereby the information system influences and is influenced by the context.” (Walsham 1993: p. 14)

The methodological principles adopted throughout the research were inspired by one the philosophical core of the interpretive approach: phenomenology. Phenomenology in its essence inspired early and pioneering works in IS by Boland and Mingers (Mingers 1984; Boland 1985) and deeply motivated the entire research journey of Claudio Ciborra (Ciborra 2002: pp. 173-179).

According to their approach, the research becomes an existential journey where we relate to and explore world phenomena. The phenomenological approach aims at *unveiling* the phenomenon from its *appearances* to let us encounter it and experience it in its essence through the emergence of *apparitions* (Heidegger 1962: p. 49-63; Ciborra 2002). In IS research this translates in questioning what is taken for granted or what is presented as *exposed theory* (Argyris & Schon 1995), and instead focus on the untold, often unofficial way the daily organizing of work takes place (the *theory in use*).

3.1.2 Case Studies

This thesis is based on case study research (Yin 1989). A case study can be defined as and empirical inquiry that (1) investigates a contemporary phenomenon within its real-life context, (2) where boundaries between the phenomenon and the context are not clearly evident, (3) and in which multiple sources of evidence are used (Yin 1989: p 23). Sources of data for case studies include (Yin 1989): documentation, archival records, interviews, direct and participant observation, and physical artifacts. However, the primary source of data in interpretive case studies is constituted by semi structured in-depth interviews (Boland & Day 1989; Walsham 1995b): “it is through this method that the researcher can best access the interpretations that participants have regarding the actions and events which have or are taking place.” (Walsham 1995b, p. 78)

In particular, this thesis is based on two case studies. The two cases are based in rather different settings (Norway and South Africa) and look at the standardization of different systems (Electronic Patient Record in Norway, and a Health Information System for anonymous routine data in South Africa). Hence, the aim is not to compare the cases but to enrich the base of empirical evidence related to processes of standardization of IS in healthcare. In both cases the focus is on the nature and dynamic of permanent forms of negotiations which constitute the unit of analysis.

3.2 Case One: EPR Development in a Norwegian Hospital

3.2.1 Rikshospitalet and the Norwegian Health Reform

The first case study is based on an Electronic Patient Record development project in Norway (the EPR system is called DocuLive and the project is called Medakis). The fieldwork was conducted at Rikshospitalet but the data collected covers the cooperation of this hospital with other four hospitals in Norway and changes in the Norwegian health system which took place in the last decade.

Today Rikshospitalet is the second largest hospital in Norway, with approximately 600 beds, 4000 employees and an annual budget of 2.5 billion NOK (around 360 million US Dollars). In 2002 more than 193'000 patients were treated. It offers specialised services, e.g. organ transplant, children heart surgery, and neurosurgery, but due to its role as a teaching hospital affiliated with the University of Oslo, it also offers general services to the immediate surroundings in Oslo, as well as to the government and the royal family. Rikshospitalet was established in 1826 as a hospital for the whole of Norway, and since then it has been directly owned and financed by the Norwegian state. Similarly, for the last 30 years, most hospitals were owned and run by the county where it was located (Norway is divided into nineteen counties and has 85 hospitals for its 4.5 million inhabitants).

This situation has changed during the last two years, as a major hospital reform was initiated 1.1.2002. In the new configuration the central government owns all the hospitals, but the hospitals are managed by five regional health enterprises. Below this level, also every individual hospital is organised as an enterprise. The reform was motivated by the need for increasing efficiency, reducing costs and improving quality of services. Despite the high public spending in health services (Norway is one of the European countries with the highest level of public spending on the health service per capita), waiting lists were stable or growing, there was a lack of health care professionals, and there was great disparity between hospitals as regards the use of resources and variation in the service offered depending on place of residence. These observations lead the government to set the scope of the reform to a necessary reorganization of the ownership and management structure was necessary.

As a consequence, the health sector faced a demand for change from a “public sector” culture to a “business/corporate” culture. For the average hospital worker, this has emerged as an increased attention to cost containment accounting and to documenting activities, use of resources and benefits. The implementation of this health reform also has had major impacts on IT strategies and on how current IT implementations are run.

3.2.2 The DocuLive Project

I will now provide more historical background to the case, describing some historical and contextual facts around the development of the DocuLive project.

Until early 1990s several clinical information systems existed in the various departments. Some of them were primarily used locally at one department, e.g. specialized patient record systems for pediatric cardiology (Berte), research databases (Datacor in cardiology), or image databases (e.g. for gastroenterology). Other systems located at service departments like laboratories or imaging departments produced information that was shared with other departments. The information from these systems would usually travel through the organization on paper or on other physical medium (e.g. x-ray pictures).

Patient records existed as paper files at a departmental level, which meant that if a patient had visited several departments, there would be several (non-linked) records for this patient, one in each of the departments. Moreover, the structure and organization of these various records differed between departments. In 1993 the Norwegian Board of Health (Statens helsetilsyn, administratively part of the Ministry of Social Affairs and Health) published guidelines for patient documentation in hospitals (document IK-2451). The guidelines contained indications on the content, structuring, and archiving of patient clinical information. The aim was to invite Norwegian hospitals to standardize information within and between hospitals. The guidelines structured the information in alphabetical chapter from A to J. Each chapter contained several forms (e.g. forms B.1, B.2 etc...). For example, chapter A contained referral letters and other correspondence internal and external to the hospital. Chapter B would contain forms for doctors' notes. C was used for Laboratory results, whereas chapter G contained forms for documenting nurses' work.

In 1995 Rikshospitalet decided to implement these national guidelines aiming at creating a central and unique paper-based record for each patient. This demanded two major changes: the patient information had to be centralized; and the clinical information had to be standardized between the departments. Special task-forces were set up internally in order to specify and implement the local (to Rikshospitalet) version of the guidelines. Several hundred different forms were standardized into a limited number. A central archive department was established, and all the distributed information about each patient was filed and archived here. From then on, each time a doctor or secretary (the person assisting the doctor on administrative tasks) needed a record she had to formally request the central copy via fax, phone or the Patient Administrative System (PAS). The archive department would then retrieve the record and deliver it. This change constituted a first step before introducing the digital record, which replicated the information structure of the standardized record.

In 1995 five Norwegian hospitals started a project (named Medakis) to develop an electronic patient record (EPR) system. The five hospitals jointly developed requirements for the system, which was planned developed in a distributed and iterative way, with Siemens (Norway) as the industry partner. The final product delivery was planned for December 1999, but in 2004 the project was terminated without delivering the final product. More on the historical background for the current product called DocuLive can be found in Ellingsen and Monteiro (2002).

3.2.3 Research Context

The research is the result of a long cooperation between our Department of Informatics at the University of Oslo and the IT department of the national hospital in Oslo. The fieldwork has been structured so to follow the evolution of the IT management strategy in its various stages. The focus of the research has evolved in time as I was gathering more data and developed my understanding of the case. At the beginning my interest was on the implementation and adoption of the EPR system (DocuLive). Subsequently the focus changed to include further developments in the EPR strategy which went beyond national boundaries to become part of Siemens' global EPR product strategy. Thirdly, the scope was increased also to include the regional and national changes in the health reform, which affected IT policies and the competitive environment.

Hence, it is possible to identify three main phases of fieldwork, which reflected different stages on the implementation process (Table 3).

Table 3 Phases of the fieldwork.

Fieldwork phase	Focus	Data source
Autumn 2001 – Spring 2002	Result of EPR implementation	Mainly clinical departments
Summer 2002 – Winter 2002	EPR implementation strategy	Mainly IT department
Spring 2003 – Winter 2004	Management of the whole IT infrastructure	IT department and regional strategies

As can be evinced from the table, the study of the implementation process was at first focused on the users. Subsequently it was extended to include an increasing number of actors. This process was necessary to reach a more thorough understanding of the tensions and problems caused during the implementation. In fact, the complexity of the case was not evident from the beginning.

I conducted the fieldwork on the EPR case entirely at Rikshospitalet. In 2001 our research group (IS group at the Department of Informatics, University of Oslo) had been contacted by a manager of the IT department at Rikshospitalet⁸. As mentioned, the cooperation already existed in the form of seminars and coursework. On that occasion, however, it was proposed and agreed upon that a more formal research activity would start. Part of the IS group (me included) joined the research project and started to organize the fieldwork. Hence, my fieldwork and data collection was often conducted in cooperation with other researchers of the same group. In this document I will report about fieldwork and data collection which I lead and have conducted in person. Additional reference to secondary sources will also be made.

⁸ The IT department at Rikshospitalet currently counts around 80 employees ranging from programmers, to project leaders and senior managers. The people working in the department have a mixed background: computer scientists, doctors, nurses, secretaries and business managers.

The motivation for the people in the IT department to seek cooperation from our research group was twofold: (1) they needed a deeper understanding of the sources of complexity encountered during the already delayed DocuLive project; (2) they hoped we could conduct some form of evaluation of the adoption of newly implemented IS and work routines in order to better understand their impact. On our side, the group was interested in studying the EPR development project as a socio-technical standardization process; this fitted well with the first aim of the IT department.

The fieldwork started in autumn 2001 and continued throughout spring 2004. We were granted support and full access to the hospital. In the first phase of the fieldwork (Autumn 2001 – Spring 2002) I focused on investigating on the outcome of the ongoing EPR implementation. The fieldwork started from the IT department, through interviews conducted with managers and project leaders. Soon we selected and approached clinical departments where further interviews and observations were done. Rikshospitalet has 17 clinical departments. Covering all of them was unpractical and unnecessary for the research aims we set. We then decided to select several departments according to a criterion of diversity of complexity of information and stage of adoption of DocuLive. The departments we (in time) selected have been: Pediatric Cardiology, Cardiology, Dermatology, Neurosurgery, Orthopedics, Rheumatology, and Thorax Surgery⁹. In addition to clinical departments we also collected data from the Archive department that is the department where all paper-based patient records are stored for update and retrieval.

Regarding the stage of adoption we collected data from departments which had already implemented and were already using the available functionality of DocuLive, data from those department which were still fully relying on the paper based record, as well as data from departments which were in the middle of the implementation process.

Regarding complexity of information, we addressed both departments with “simple” information systems as well as departments with a legacy of more complex ones. For instance, Rheumatology represented a department relying mainly on text based information and x-ray

⁹ As mentioned, these were the departments where I have conducted fieldwork alone or in cooperation with other researchers. Some of the co-authored papers included in the thesis are also based on other departments where co-authors have gathered additional data.

pictures from a dedicated system (PACS). The implementation in this department went quite smoothly and adoption likewise did not seem to raise relevant problems. A different example was Pediatric Cardiology, which was in the middle of negotiations to start the implementation. This department had developed a local EPR which proved to be very efficient, but which was also problematic to integrate or substitute by DocuLive. The reason was that the particular medical practice of that department required the use of an international semi-formal very specialized diagnosis classification standard which was very different from the widely used ICD-10 (International Classification of Diseases) which was integrated in DocuLive. This, of course, added to the complexity of the implementation as (still until now) it is not clear whether and how the system should be integrated or substituted.

In the second phase of the fieldwork (Summer 2002 – Winter 2002) I conducted (mainly on my own) a more focused investigation on the logics and strategies behind the EPR vision and project. In this phase I mainly interviewed senior manager and project leaders of the IT department, including the previous CIO of the hospital which followed the most intense phases of transformation of the IT department from a technical support to a multidisciplinary competitive service oriented organization.

In the third phase (Spring 2003 – Winter 2004) my fieldwork activity mainly consisted of seminars, meetings, and interviews with senior management of the IT department. The aim was to widen the scope of the investigation to study management practices and strategies relating to the IT infrastructure of the hospital as a whole. This implied also investigating strategic partnerships with other hospitals, as well as impact of the health reform on the IT strategies of the hospital.

3.2.4 Data Collection

As mentioned, a case study usually is based on data collection from a multiplicity of sources: documentation, archival records, interviews, direct and participant observation, and physical artifacts. I will now go through and discuss each of the sources of data describing how data were collected, with which criteria and in what quantity.

As Walsham (1993) submits, probably the most important source of information for a case study is constituted by interviews. I have conducted 23 interviews with 20 different informants in the hospital (see Table 4). The interviews were semi-structured (Hammer & Wildavsky 1989), that is, I always had a list of three to five issues or questions I wanted to cover. During the interview I would either address the issue directly or see whether the interviewee ended up covering them. I always remained open to see whether other interesting issues were emerging as the interview went on. Often I used this technique to inform my decisions regarding new people to approach and research leads to follow. In this sense the investigation was often exploratory.

Regarding criteria of selection of informants, I have explained this issue for the selection of clinical departments. Furthermore, in each clinical department I aimed at interviewing the main group of users (doctors, nurses and secretaries) or approach a particular person which had a specific role or relevance in the department in relation to IS use. For instance, at the pediatric cardiology department I directly approached the two doctors which were involved in the development of the local EPR system. In other cases the first contact was provided by our main contact in the IT department, which pointed me to specific persons according to the particular issues I wanted to cover. The process has mainly been iterative and explorative. At the IT department I interviewed senior managers and project leaders.

Table 4 Number of interviews and type of informants.

<i>Type of Informant</i>	<i>Number of informant per department</i>		
	IT Department¹⁰	Archive	Clinical Departments
Senior Manager	3	1	1
Project Leaders	5	-	-
Doctors	-	-	9
Nurses	-	-	1
Secretaries	-	-	3
Total	8	1	14
Total	23		

¹⁰ While the persons interviewed in the IT department were either senior managers or project leaders, most of them had a background as nurse, secretary, or doctor. This accounts for the multidisciplinary nature of the IT department.

I have recorded all interviews on MiniDisc and I have also taken notes during the interviews. For most interviews I have prepared a report summarizing the notes and (for the most important interviews) I have transcribed the whole interview. The reports were then circulated in the research group and commented upon during regular meetings.

Besides interviews I have also performed numerous participant observations (Adler & Adler 1994; Whyte 1997). Specifically, in the first two phases of the research I have attended four courses on the use of DocuLive at various levels and aimed at different users: nurses, nurses advanced, doctors, and secretaries. This allowed me to both learn the details of the technology and to observe and interact with the new users. In some occasion, this spawned new contacts and new instances of fieldwork. For example, through contacts made during the courses I organized a fifth instance of observation: the “shadowing” of a nurse during the last five hours of her morning shift at the Thorax Surgery department. The aim of that instance of observation was to collect ethnographic data on the work practices of nurses before the introduction of the system. I have used the collected information to deepen my understanding of the users’ perspective on the technology, and later shifted my focus more and more from work practices to logics and strategies.

Finally, I participated to and observed six meetings. Two were internal meetings in the IT department, one regarding a project dealing with the integration of a local system called Nyrebase with DocuLive. The second regarding the “scanning” project which was about to start. Another one was a routine nurse meeting to which I participated as final phase of the “shadowing” in Thorax Surgery mentioned above. The other three were part of the training and implementation process of DocuLive: the IT department held a *førstemøte* (first meeting) for introducing DocuLive to a new department, and a second meeting to start negotiating the adaptation of work routines in DocuLive and vice-versa. Usually these meetings were separate between nurses and doctors. I participated to two *førstemøte* with doctors and nurses and on negotiation meeting with nurses.

As for archival records, I had access to the contract and all the project documentation of Medakis. This includes all official correspondence of Rikshospitalet with the vendor. Additionally

I was granted full access to the intranet of the IT department. I thus collected data from yearly budgets and strategic documents. I have also been able to personally test and use DocuLive from a test environment.

Other documentation which I used for the research includes: web content, students reports, other research papers, and e-mail exchange. From the web I have collected information on definitions and strategic statements from Helsestør (the regional health company managing Rikshospitalet) and in general about the health reform. I have also collected public information from the vendor's websites and other websites specialized in health informatics regarding the developments of the EPR product strategy. I have also used students reports as a secondary source of data. During the second half of the 1990's several groups of students from the IS course collected data and reported on the advance of the implementation of DocuLive at Rikshospitalet. Other data was collected from research papers written by colleagues working on the same project, either in Oslo or in Trondheim. Finally, I also collected data from e-mail exchanges between the IT department and clinical departments regarding three negotiation instances of integration of local systems (Gastrolab, Nyrebase, Datacor) to DocuLive.

Finally, numerous and regular meetings were held with our primary contact at the IT department. During the most intense research periods the meetings were held every other week with the aim to provide feedback, discuss new findings, and organize further fieldwork.

Overall, throughout the three phases of fieldwork I tried to cover all stages of the implementation of DocuLive both from the user and from the developer side. I also tried to document to the extent possible the history of the IT department analyzing the various main ideas and organizing principles in each phase (this is well documented and analyzed in the second paper included in this thesis). Finally I tried to represent the unfolding of the strategies at the many levels of the health organizations involved in defining and implementing the IT strategies: department, hospital, region, national, international. One limitation, as I will discuss below, is the lack of primary data from the vendor, which I tried to approach but denied an involvement in the research project.

3.3 Case Two: Health IS Development in Rural Hospitals in South Africa

The second case study is based in the Eastern Cape Province of South Africa. The research was conducted as part of HISP (Health Information Systems Programme) and focused on the development and deployment of standards for collecting, structuring, reporting and processing of aggregated health routine data in hospitals in Eastern Cape. I will first provide some contextual information regarding the HISP and the scope and duration of the specific project which financed my fieldwork. Then I will provide some contextual information regarding the conducted fieldwork.

3.3.1 The HISP Project in South Africa

As part of the Reconstruction and Development Program (ANC 1994b) in South Africa an effort was launched for the restructuring of the health sector in all provinces. This effort included the creation of a unified Health Information System (HIS) (ANC 1994a). The apartheid legacy left a situation of fragmentation and poor coordination of gathering and reporting routine health data. These processes were fragmented regionally and divided in separate top-driven health programs. As a result the existing HIS was inflexible, uncoordinated, and was not properly supporting local management. This situation required the development of a vision of a unified (i.e. standardized and integrated) HIS to support health managers and improve the quality and effectiveness of health services (WHO 2000). The challenge was then to develop a HIS which could at the same time become a standardized infrastructure used to collect and report data up and down the health administration hierarchy, as well as a flexible information system to allow for decentralization of responsibilities and empowerment of management at the district level (WHO 2000; Braa & Hedberg 2002).

In South Africa the HISP (Health Information Systems Programme) played major role in the implementation of a new HIS. The HISP initiative first addressed this challenge in Western Cape in 1996 by defining an Essential Data Set (EDS) of indicators and by developing a dedicated software to support data collection, aggregation and analysis as part of the District Health Information System (DHIS). Eventually, in 2000, the HISP initiative scaled up to national level and the standardization process was carried out in the other provinces in a coordinated manner (Braa & Hedberg 2002; Braa *et al.* 2004).

My research was conducted as part of the HISP program. In particular it has been financed by a Joint Research Project under the South African – Norway Research Co-operation agreement which ran between October 2002 and October 2005. The Research Project was entitled “District Health Information Systems in South Africa: Empirical studies and interventions for improved use of information in health management”. One of the aims was to investigate the current implementation of information systems in the health sector in four districts located in four different provinces (Eastern Cape, Mpumalanga, Kwa-Zulu Natal, Western Cape Province) (Figure 1), and to improve the situation by intervening where appropriate. The research was a collaborative project between the University of Oslo (Department of Informatics) and the Health Information Systems Programme (HISP¹¹) of the School of Public Health at the University of the Western Cape.

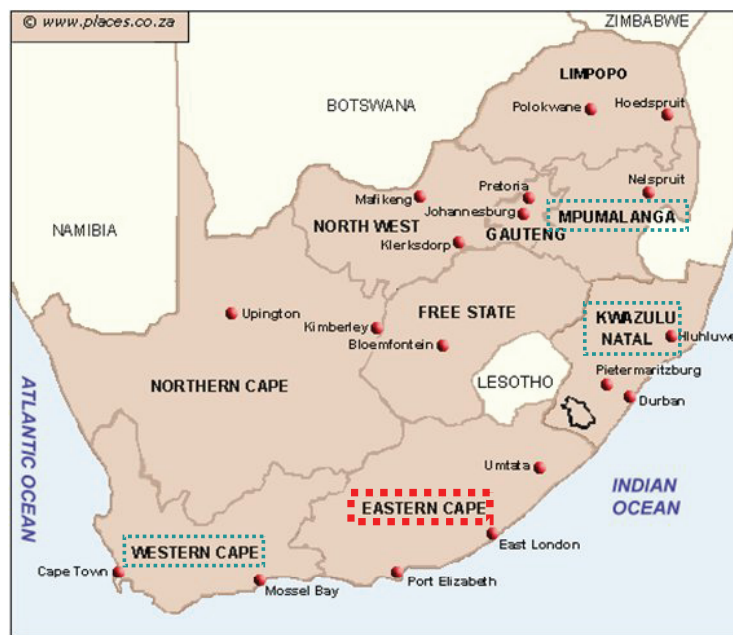


Figure 1 Geography of South Africa and location of the Eastern Cape Province where the fieldwork was conducted.

¹¹ More information on the project can be found at: www.hisp.org

3.3.2 Research Context

The fieldwork was conducted in three stages and focused on rural and regional hospitals in the province of Eastern Cape. The overall effort of the HISP is to develop a national health information system for routine health data. However, in accordance with the HISP team in South Africa I decided to focus on hospitals (particularly rural hospitals) and to limit the research to the Eastern Cape. The reason I choose to investigate hospitals was both dictated by the contingent need to address improvements in their Hospital Information Systems within the project and by the aim of creating some resonance with the Norwegian case.

In the first visit (conducted in Spring 2003), I joined the HISP team in an effort to assess and improve the adoption of data collection tools and procedures in rural hospitals (see Table 5). My role has been mainly as participant observer, as I will discuss later in this chapter. In my second visit (Spring 2004) I joined the early phase of a project which the HISP organization in South Africa just won, to improve data collection and reporting in 13 hospitals in the Eastern Cape. In this early phase, I participated and collected data from an ex-ante evaluation of the information systems in the hospitals. Further details regarding this process can be read in a paper which I co-authored but not included in this thesis (Shaw, Jacucci, and Braa 2005). In the third visit (Spring 2005) I participated to the ex-post evaluation of the same project visiting the hospitals to assess the improvements.

Table 5 Field work in South Africa.

Fieldwork phase	Focus	Data source
March – April 2003 6 weeks	HIS implementation in rural hospitals	-Hospital staff -HISP team -Province's Department of Health officials.
April – May 2004 4 weeks	Ex-ante evaluation of HIS improvement project in rural and regional hospitals	-Hospital staff -HISP team -Province's Department of Health officials.
February – March 2005 2 weeks	Post-mortem evaluation of HIS improvement project	-Hospital staff -HISP team -Province's Department of Health officials.

While conducting the fieldwork in South Africa, I always tried to balance my research interests and the project's needs. In all three cases I prioritized the latter, but, at the end, not compromising the quality and relevance of the data collected for research purpose. The result is a study of the process of implementation, adaptation and use of a set of tools and procedures for data collection and reporting in hospitals in Eastern Cape.

3.3.3 Data Collection

The fieldwork conducted in South Africa comprises the collection of data from a wide range of sources: interviews, participant observations, documents, and artifacts (computer systems and paper registers). However, the main source of data has been participant observation. I have also conducted several formal semi-structured interviews, but I have collected most of the data in the form of notes and recordings taken observing the HISP team at work in a number of hospitals.

During the three phases of the fieldwork I have visited eleven hospitals in the Eastern Cape Province (see Table 6). The health service in South Africa (as in many other places) is organized in four stages. A new patient will first approach a health clinic. If her conditions cannot be treated at the clinic, she will be referred to the district (that is local) hospital. The district hospital provides general (that is not specialistic) treatment. If her conditions are particular she can be referred to the secondary and then to the tertiary level hospitals. From the district to the tertiary hospital the level of specialization of the medical practices increases. Usually tertiary hospitals are located in large urban areas. Another common distinction is urban vs. rural hospitals. A hospital is considered rural when there are particular conditions of lack of or insufficiency of basic infrastructures (road, water, electricity) and if it is at a considerable distance from the nearest large urban area.

I have visited a total of seven district hospitals, one secondary and three tertiary. Seven of them were located in rural areas and the remaining four in urban areas. I spent a total of 26 days in these eleven hospitals (see Table 6). However, the length of the “day” heavily depended on the location and type of work which needed to be accomplished. In some cases I had to drive 8 hours a day (four in each way) and not spend more than four to six hours on the site. In each of the visits I either conducted direct investigations by interviewing or meeting with the staff of the

hospital, or I participated to the activity of the HISP group as observer, taking notes and recording the unfolding of the events.

In both cases, I have collected data from interactions with all professions at all levels of the standard hospital's organization: sisters, matrons, doctors, superintendent, information officers, administrative personnel, and CEO of hospital complexes. Usually, the fieldwork (and the work of the HISP team, when present) in each hospital started by meeting the top management. This allowed to be granted access and support during the intervention and to quickly get a grasp of the organizational structure of the institution and of the information system.

Table 6 Detail of hospitals visited in the Eastern Cape Province in South Africa.

Type of Hospital	No. Hospitals	No. Of Days
District – Rural	6	18
District – Urban	1	2
Secondary – Rural	1	1
Tertiary – Urban	3	5
Total	11	26

Besides the fieldwork in the hospitals, I have conducted formal semi-structured interviews with the head of the IS function of the Department Of Health of the Eastern Cape, as well as with members of the HISP organization in South Africa. In particular, I have participated to several meetings and workshops at the beginning and at the end of projects. In 2003 I attended a week long workshop in Cape Town which constituted the kick off of the research project which funded my travels. In that meeting all members of the HISP South Africa organization met presenting and commenting on the situation in the various South African provinces. In 2004 I participated to the whole kick-off phase of a one-year-long project won by HISP South Africa concerning the evaluation and improvement of the health IS in thirteen hospitals in Eastern Cape. In 2005 I participated to the closing phase and official evaluation of such project from the Department of Health (the contractor). This fieldwork included evaluation visits to two of the thirteen hospitals as well as all the meetings which preceded and followed the three days evaluation.

During the fieldwork at the hospitals and during the interviews I have taken notes and recorded most of the events with MiniDisc. I have then summarized the most relevant conversations and in some cases transcribed entire parts. Notes were summarized in a diary which I used for further analysis when returned to Oslo. In the first visit in 2003 I conducted the fieldwork with another doctoral student from the University of Cambridge. On that occasion we shared notes and diary.

As for documentation, I have collected numerous documents regarding use guidelines, management principles, and training related to the tools and work procedures for collecting and reporting routine health data. Additionally, I collected documents from the HISP organization regarding the description of roles, processes, and organizational structures needed to establish an IS unit in hospitals. A lot of the documentation was available at the HISP website (www.hisp.org).

As for artifacts, I learned how to use and interacted with the main software of the DHIS (District Health Information System), a computer based system where all routine health data were stored either at the hospital or at district level. I also copied and analyzed an MS Excel based program which constituted the pivotal system used at a rural hospital. The analysis of the work practices created around this system provided the data for the paper on “local sustainability”. (paper 4)

3.4 Data Analysis

In this section I will cover several aspects of how I analyzed the data and how I made sense of them. In particular I will address the following issues: (1) principles and techniques I have used to organize the data and inform further investigations; (2) how research themes emerged from the organized data; and (3) how I approached the “bridging” of micro and macro from a methodological perspective.

3.4.1 Principles and Techniques

Along side phenomenology, a principle I have adopted for approaching the fieldsite and analyzing the data is the principle of the “hermeneutic circle” (Klein & Meyers 1999; Boland

1991). As Klein and Myers state, “the idea of the hermeneutic circle suggests that we come to understand a complex whole from preconceptions about the meanings of its parts” (*ibid.*, p.71). Moreover, the hermeneutic circle implies an iterative process by which we come in contact with the observed phenomenon and progressively make sense of (or interpret) it. This has wide implications on the way the fieldwork is actually done and on the assumptions and hypotheses one brings into the field. In fact, while I had a general interest in adopting a “standards and infrastructure” perspective, the actual focus of the research was refined or shifted as the research went on.

The specific techniques I have used were inspired by Langley’s paper on strategies for analyzing and theorizing from process data (Langley 1999). Process research, she submits, “is concerned with understanding how things evolve over time and why they evolve in this way”, hence process data “consist largely of stories about what happened and who did what when” (*ibid.*, p. 692). The two main techniques I have adopted as a first step in data analysis are *narratives* and, to a smaller extent, *visual mapping* of events.

Hence the usual process of data analysis included: data where collected during fieldwork in the form of notes and recordings of interviews, observations, and documents; often transcripts or reports were then made; based on them I would write several narratives which constituted the first step of analysis and attempt to isolate the main themes. Narratives and stories were then rewritten or became parts of the empirical evidence included in the papers.

3.4.2 Emergence of themes

As for the second point (the emergence of themes) I adopted a mixed formal and serendipitous process of investigation. Specifically, I at times focused on the implementation process, on innovation, on risk, or on control depending on the overall research aim (understanding the unfolding of standardization processes and their many aspects) or on the contingent needs dictated by the research environment. For instance, the paper on “reflexivity of risk” (paper 3) is part of a larger project on ICT and risk running between the IS group in Oslo and the Center for Analysis of Risk and Regulation (CARR) at the London School of Economics. Similarly, the

paper on “reflexive standardization” was written to respond to a call for papers of the MISQ focusing on “standard-making” in IS.

Hence, while there are two distinct cases on which I base the research (the EPR in Norway and the HISP in South Africa), each paper represent a particular aspect of the case which can constitute a case in itself. Identifying the themes can be broken down in looking at how I analyzed the data in each paper and how I analyzed the findings all together. Hence, there are two different phases of data analysis (Eisenhardt 1989): (1) the within-case analysis, and (2) the cross-case search for patterns. As a result it is possible to identify a recurrent pattern or theme in each of the papers I have written: the study of the dynamics and effects of permanent negotiations emerging or formally established during standardization processes, that is what I here conceptualize as *tensions*.

3.4.3 Bridging the micro-macro gap

One of the main themes discussed in this thesis is the need to “bridge” the micro-macro gap in the theorization of Information Infrastructures. I also refer to the fact that infrastructures operate at “multiple scales”. This poses some methodological questions which I will here clarify.

I refer to micro-macro as an *analytical* distinction which can be used when approaching the phenomenon of study. In particular, micro and macro refer to (1) different unit of analysis (person, group, organization, society), and/or to (2) different level of abstraction (work practice, process, logic and strategy, modernity).

With regard to the unit of analysis, this analytical distinction turns useful (for instance) in the case of the EPR implementation to understand the many (multiple) logics and network in which the same artifact is connected to: it is a local work tool, but also part of a standardization strategy within the hospital, and the object of a regional standards war, and so on. Thinking that the EPR manifests as a phenomenon on multiple levels or scales helps to isolate each of the scale and study their relation.

With regard to the level of abstraction, the distinction helps to point out that existing technology studies are either pursued at the micro level of technology use and construction, or pursued at the level of macro-societal changes related to modernity (Brey 2003).

The implication, however, is that the need to bridge this micro-macro gap is a *theoretical*, not practical, problem. In fact, my position is in line with Latour's view that the micro and the macro are simultaneously found in the actors and artifacts we encounter in our investigation (Latour 2005). For example, the EPR is simultaneously part of the local context of users in the clinical department and part of the global product standardization strategy. Likewise, it is at the same time a tangible agglomerate of social and technical elements, as well as an expression and product of the logics of modernity.

3.5 Use of Theory

Walsham (1995a) identifies three distinct roles of theories in interpretive research: (1) as an initial guide to design and data collection; (2) as part of an iterative process of data collection and analysis; (3) as a final product of the research. In my thesis, I have used theories to guide the fieldwork and to perform analyses on the data.

I have used the theories (or set of concepts) of Information Infrastructures (Hanseth & Lyytinen 2004) to frame the research and provide a particular perspective to the problem: standardization. This provided me with a "model" to use to look at reality in order to let particular aspects to emerge (Silverman 2005): issues of negotiations, nature of the object of standardization, relation with time, number and heterogeneity of actors involved in the negotiations, and so on. This model has inspired the design and evolution of the fieldwork and eventually brought me to identify and isolate the analytical concept of *tension* as the recurring pattern and focus of the thesis.

While Information Infrastructure theories helped me to frame and formulate the research problem, I have in each paper adopted other theories and concepts to lead the analysis and to reach plausible answers to the research questions. For instance, I have used theories of innovation, theories of modernity, social studies of communication systems, theories of development, and theories of risk. Similarly, in this document, which summarizes the findings

and provides an analysis and theorization on its own, I adopted concepts from other theories (reflexive modernization (Beck 1999), multiplicity (Mol & Law 2002), complexity (Urry 2003)) to forge my own theoretical framework: reflexivity, multiplicity, and complexity. There are two reasons why I have chosen these particular concepts: (1) they are all related or rooted in theories about our contemporary (modern society), which makes them relevant for addressing the research questions; (2) they emerged during my research (specifically during the phases of data analysis) as appropriate ways to interpret and conceptualize the observed phenomenon. This framework allows me to analyze the recurrent pattern of permanent negotiations identified in the papers and to provide an insight into a particular aspect of standardization processes. The framework thus does not represent a theory of the world or of standardization processes. It serves the aim of contributing to the research with a “rich insight” through a theoretical analysis of empirical data (Walsham 1995a).

3.6 Type of Contribution and Generalizability

Generalizability in interpretive research is a disputed issue (Walsham 1995b; Lee & Baskerville 2003). How general are my findings: can the findings apply to other contexts? Are two case studies sufficient to generalize? Generalizability refers to the possibility that explanations of a particular phenomenon derived from the interpretation of empirical evidence collected in specific settings can turn valuable in the future in other organizations and contexts (Walsham 2002).

Lee & Baskerville argue that interpretive research, in contrast to positivist and quantitative, can also provide generalizability: analytical, as opposed to statistical, generalizability (Lee & Baskerville 2003). Walsham identifies four types of generalization (and thus types of contribution) in interpretive IS research: (1) development of concepts; (2) generation of theory; (3) drawing specific implications; and (4) contribution of rich insight. However, an interpretive research contribution may fall into one or more of these categories, as it is the case of the papers presented here and of this thesis as a whole.

I will here address the two questions raised in the paragraph above. The findings presented in this thesis, I submit, do apply to other contexts. Specifically, they apply to all the contexts where

it makes sense to interpret the observed phenomenon as a standardization process: standards always imply permanent forms of negotiations (Zuboff 1987; Mulgan 1991), and always can be seen as putting in relation actors on different scales (this can be seen through the zooming in and out proposed by ANT). The question is rather how *relevant* are the findings (and the particular perspective they propose) to the study of such contexts. My view is that the conclusions drawn in this thesis are relevant to at least all those situations where: (1) the object of standardization is represented for a considerable part by non-technical aspects (e.g. work procedures, organizational rules, knowledge), and (2) there is a high level of complexity in terms of number and variety of actors (systems, organizational units, artifacts etc.) to be aligned. As exemplified by the two case studies, healthcare represents such an environment. Other possible contexts (for example) may be represented by standardization processes of IT infrastructures according to established standards such as (e.g.) ITIL (IT Infrastructure Library) or by standardization of IT outsourcing frameworks in global consulting organizations (Strand 2005).

Regarding the second question (generalizability of the findings from two case studies), as pointed out by Lee & Baskerville (2003) interpretive based case studies provide an analytical type of generalizability. That is, not the sheer number of cases (which may be as low as one) but the depth and richness of the analysis can grant a level of generalization which makes the findings valid and relevant for other contexts. In this sense, the two cases presented here should not be viewed as comparable for the sake of finding and supporting similar (and general) conclusions. On the contrary, they are to some extent extremely different. Yet, their difference and non-comparability makes the theorizing of the identified patterns (tensions and micro-macro relations) considerably richer. For example, the findings related to the study of IS standardization as process of modernization are more complete than they would be, had I focused the research only in the “developed” world (the EPR case) (see the third part of the theoretical implications).

4 RESEARCH FINDINGS

4.1 The Papers

This thesis includes six research papers. The papers are presented in chronological order and in this sense reflect the research journey. The first two investigate the conceptualization of innovation processes in Information Infrastructure development at Riskhospitalet. The fourth and the fifth present the findings from the case study in South Africa and discuss sustainability and control related to standardization of the National Health Information System. Finally, the third and the sixth discuss risk management and standardization strategies in relation to Reflexive Modernization.

In each of the papers a different perspective is adopted and particular research questions are addressed. All together they provide a multi-faceted study of tensions arising from standardization processes in socio-technical Information Infrastructures.

4.1.1 Paper 1: *Bootstrapping the Electronic Patient Record Infrastructure*

Reference

Iacucci¹², E., Nielsen, P., Berge, I. (2002), "Bootstrapping the Electronic Patient Record Infrastructure", In: Bødker, K., Kühn Pedersen, M., Nørbjerg, J., Simonsen, J., and Thanning Vendelø, M. (editors): Proceedings of the 25th *Information Systems Research Seminar in Scandinavia* (IRIS 25), "New Ways of Working in IS", Bautahøj, Denmark, August 2002.

Abstract

In this first paper I approach the case of the development of the Electronic Patient Record at Rikshospitalet by looking at its implementation strategy. The IT department of the hospital is struggling with the project, which is behind in schedule and already over budget. They face

¹² In 2002 I have changed my last name from Iacucci to Jacucci.

another dilemma: the EPR is still to be implemented, but its real value emerges if all the departments can use it at the same time. Where to start? Should they adopt a gradual or a big-bang implementation strategy? On the one hand, a gradual implementation (one department at the time) would allow testing of the whole EPR functionality and improving it before moving to the next department. On the other hand, the real benefits of the EPR can be harnessed if the maximum number of users is reached already in the early phases of implementation. However, this second strategy can become too complex if the whole functionality of the EPR needs to be implemented at once in all departments.

The strategy adopted by the IT department will be one of implementing a “thin layer” of essential functionality across all departments almost simultaneously, while leaving the development of other functionality for later stages of implementation. How to analyze this strategy?

By focusing on “innovation” the paper aims at contributing to the conceptualization of innovation processes related to the implementation of new parts of an Information Infrastructure. The paper first critically reviews traditional studies on innovation (e.g. Diffusion Of Innovation theories) pointing at their shortcomings when studying standard based infrastructural changes. Secondly, by conceptualizing the EPR as a socio-technical infrastructure, discusses the interpretation of the adopted implementation strategy as *bootstrapping*.

4.1.2 Paper 2: Temporal Disclosedness of Innovations: Understanding Innovation Trajectories in Information Infrastructures

Reference

Jacucci, E. (2004), “Temporal Disclosedness of Innovations: Understanding Innovation Trajectories in Information Infrastructures”, In: Fitzgerald, B., Wynn, E. (eds.), *IT Innovation for Adaptability and Competitiveness*, Springer.

Abstract

This paper builds on the findings of the first paper and further investigates the conceptualization of innovation processes in Information Infrastructures. In particular, the paper addresses the research question of how to analyze and evaluate innovations in complex information infrastructures. The particular issue which is addressed here is the temporal dimension in which innovations unfold. Traditional studies of innovations tend to define compartmentalized phases through which the innovation lives its transformation: from conceptualization, to development, to diffusion, adoption, secondary adoption, and so on.

From the empirical evidence, it emerges that often in II all of these phases coexist and possibly never end, raising the question of the validity of such temporal boundaries. For example, path dependency influences the possible degree of change of the infrastructure. Hence the possibility of change of the infrastructure is at the same time already inscribed in the existing installed base and will influence the possibility of new changes in the future. That is, the temporal boundaries of any innovation stretch from the past to the future trajectory of the infrastructure (*temporal disclosedness*). This heavily influences the design and implementation strategy of changes creating a tension between the constraints of the installed based (path dependency) and the intended change which will affect the future trajectory (path creation).

4.1.3 Paper 3: Fight Risk with Risk: Reflexivity of Risk and Globalization in IS

Reference

Jacucci, E., Grisot, M., Hanseth, O. (2004), "Fight Risk With Risk: Reflexivity of Risk and Globalization in IS", In: Reponen, T., Saarinen, T. (eds.), *Proceedings of the 12th European Conference on Information Systems*, Turku, Finland, June 2004.

Abstract

In this paper, I address the following research question: "How can we understand the nature of risk in IS projects in the context of globalization?" Based on the case study conducted at Rikshospitalet on the development and implementation of an Electronic Patient Record (EPR), the paper contributes to the current discussion on the conceptualization of risk in IS projects. Drawing upon the concept of reflexive modernization (Beck 1999) the paper makes two key

contributions: firstly, it shows the limits of current risk management approaches in understanding the nature of new risks in IS generated by globalization processes; secondly, it suggest a possible theoretical framework for analyzing such nature. The research question is addressed by providing a historical and contingent analysis of the risk management dynamics emerging from the case.

4.1.4 Paper 4: Standardization of Health Information Systems in South Africa: the Challenge of Local Sustainability

Reference

Jacucci, E., Shaw, V., Braa, J. (2006), “Standardization of Health Information Systems in South Africa: the Challenge of Local Sustainability”, Accepted for publication in *The Journal of Information Technology for Development*¹³ (forthcoming).

Abstract

The paper illustrates the infrastructural challenge of creating a sustainable nation-wide Health Information System (HIS) in South Africa from the point of view of a small rural hospital. The overall sustainability of the standard-based HIS is dependent on the quality of data, which is dependent on the skillful use of data at the level of collection. In order for the latter to happen, it is argued, ‘local sustainability’ of the information system at the level of the facility is required. This is even truer for rural hospitals, which run the risk of being otherwise marginalized. The paper draws upon a case study of a rural hospital in South Africa where we document a successful change process where the organization actively and successfully appropriated the national standard. By analyzing factors contributing to the success, the paper contributes to the ongoing discussion on sustainability of HIS in Developing Countries by developing the concept of ‘local sustainability’.

¹³ A previous version has been published in: Abiodun, O. B. (ed.), *Proceedings of the IFIP 9.4 Working Conference on Enhancing Human Resource Development through ICT*, Abuja, Nigeria, May 2005.

4.1.5 Paper 5: *Duality of Control in Large-Scale IS: the Case of the Health Information System in South Africa*

Reference

Jacucci, E. (2005), “Duality of Control in Large-Scale IS: the Case of the Health Information System in South Africa”, In: Schreyögg, G., Sydow, J., Quack, S., Rudolph H. (eds.), *Proceedings of the 21st EGOS Colloquium*, Berlin, Germany, July 2005.

Abstract

The paper addresses the issue of balancing the tension between centralization and decentralization of control in large-scale, standard-based Information Systems (IS) in Developing Countries (DC). Understanding the dynamics of control structures is relevant for improving the chances of success in development and implementation of Health IS in DC. By drawing from the case on the implementation of the Health IS in South Africa, the paper makes two contributions. First, it empirically identifies the two logics of control which create the tension in the system. Secondly, it proposes a model providing an interpretation of how the two logics work by contradicting, interfering, and supporting each other. Through the concept of “duality of control”, the study presented in the paper provides an interpretation of the dynamics of control structures and their relation with centralization and decentralization forces.

4.1.6 Paper 6: *Reflexive Standardization: Side-Effects and Complexity in Standard-Making*

Reference

Hanseth, O., Jacucci, E., Grisot, M., Aanestad, M. (2006), “Reflexive Standardization: Side-Effects and Complexity in Standard-Making”, *Management Information Systems Quarterly*, King, J. L., Lyytinen, K. (guest eds.), Special Issue on Standard-Making, *forthcoming*.

Abstract

In this paper, I address the general question proposed by the call for papers of the MISQ special issue on Standard-Making: “What historical or contingent events and factors influence the creation of ICT standards, and in particular, their success or failure?” Based on the case study at Rikshospitalet on the standardization process of an Electronic Patient Record (EPR), the paper contributes to the current discussion on the conceptualization of standard-making in the field of Information Systems. By drawing upon the concepts of logics of ordering adopted from Actor Network Theory and upon reflexivity and unexpected side-effects adopted from reflexive modernization the paper makes three key contributions: 1) it demonstrates the socio-technical complexity of IS standards and standardization efforts; 2) it reports of an empirical case study that shows how the complexity can generate reflexive processes that undermine standardization aims; and 3), it suggests a theoretical interpretation of standardization complexity by using of ideas from complexity theory and the theory of reflexive modernization. These research questions are addressed by offering an historical and contingent analysis of the complexity dynamics emerging from the case.

4.2 Synthesis of Findings

The papers included in the thesis represent the empirical findings used in the context of this discussion. As mentioned, they all address the study of standardization processes in Information Infrastructure development, but they do so from a variety of perspectives: innovation, risk, sustainability, control and standardization (Table 7).

Table 7 The papers and the links with the observed tensions.

Paper	Perspective	Observed Tension
1. Bootstrapping the EPR Infrastructure	Innovation	Change – Path Dependency
2. Temporal Disclosedness of Innovations	Innovation	Change – Path Dependency
3. Fight Risk With Risk	Risk Management	Local – Global
4. The Challenge of Local Sustainability	Sustainability	Local – Global
5. The Duality of Control in Large-Scale IS	Control	Center – Periphery

6. Reflexive Standardization	Standardization	Control – Side-effects
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Despite the variety of perspectives and themes discussed, there is one common thread which helps to identify a recurrent pattern in each of the papers: the focus on aspects of the standardization process which seem to be matter of continuous negotiation and seem to hamper the achievement of a successful closure of the process. Examples are (see table 7): (1) an implementation process of the EPR continuously plagued by emerging compromises and detours, which do not kill the implementation but constantly adjust its trajectory; (2) a logic of rationalization of the complexity of developing the EPR system which triggers an escalation of scope and resources allocated to the task, increasing its overall complexity; (3) the constant balancing of strategies and principles of the DHIS at the national/provincial and at the hospital level to achieve sustainability; (4) the coexistence and negotiations of two control structures over the development and use of the DHIS; and finally (5) the apparent never-ending reproduction of side-effects of the EPR implementation from the very attempt to reduce them.

The empirical evidence suggests that there is a link between the dynamics of these observed permanent struggles and the unintended effects of standardization. In each of the struggles we can identify a particular type of negotiation, that is, a particular part or aspect of the standardization process, as theorized by deVries. These permanent negotiations represent a form of *tension* between two actors, or between two logics represented by the actors, which unfolds influencing the course of the standardization process. Thus, *tensions* emerged from the empirical evidence as result of “making sense” of the research published so far.

The data is not sufficient to provide a complete taxonomy of tensions, nor to describe all the implications and effects on standardization processes. This, I will suggest, can be matter of further research. However, a quick analysis shows that some of the observed tensions may be extremely long processes of alignment: too long to be considered phases and managed accordingly, but that may eventually come to a closure (the EPR implementation may at some point in the future be declared finished). Other tensions are inherent in processes of standardization (like the duality of control structures or the local-global tension) and will never

stabilize or dissolve: they need instead to be understood and possibly exploited to achieve (e.g.) sustainability.

5 CONTRIBUTIONS AND IMPLICATIONS

5.1 Theoretical Contributions

The research presented in this thesis tries to address the research question presented in the introduction:

- **RQ:** Why are standards and standardization processes in IS project increasingly affected by unintended effects and paradoxes?

This research question was broken down as follows:

- a) How do these side-effects originate? Are there recurring patterns?
- b) What is their relation with the primary aims of standardization, that is the rationalization of coordination?
- c) Are the observed effects specific of a particular class of projects?
- d) How can they be managed?

In the quest for answering these research questions during my research I have repeatedly come across some recurring patterns (question “a”) of negotiations in standardizations which seemed to provide a plausible explanation of the source, cause, or dynamics of the observed effects. While each paper represents a step in a particular direction of investigation to address the main research question, the overall research journey lets emerge a recurring focus on particular aspects of standardization (question “b”). This focus is what I ultimately decided to condense in the analytical concept of *tensions*, that is, particular configurations and unfolding of negotiations which seem to remain open ended and possibly generate unintended effects.

Thus, I will answer the research question (and address at least questions “a” and “b” of its breakdown) by following development along the three main themes which emerged from the research findings: (1) the identification of *tensions* as interesting phenomenon related to the observed effects; (2) the need to find a way to bridge the theoretical gap between micro and macro studies of information infrastructures; (3) the implications for the theorization of technology in the context of modernity.

Each of these aspects will now be discussed in turn and will constitute the main theoretical contribution of the thesis.

Question “c” has already been touched upon in subsection 3.6 of the methodology chapter and will be further developed in subsection 5.1.4, and question “d” will be dealt with in the subsection 5.2 about the practical implications.

5.1.1 Understanding the Tensions in IS Standardization

In this subsection I will address the first theme regarding the need to study tensions emerging during standardization processes. By addressing this issue I will make three points which constitute the first theoretical contribution:

- (1) Tensions are a permanent type of negotiations inherent in standardization processes;
- (2) they are a manifestation of the complexity of standardization and are often the source of unintended effects which can undermine control and closure;
- (3) their understanding is needed to learn how to better address complexity in IS standardization:
 - a. to reduce the negative impacts of side-effects (e.g. see EPR case),
 - b. to exploit them as a source of sustainability (e.g. see HISP case).

I will now discuss each of these points in turn.

(1) Tensions as inherent permanent negotiations in standardization processes

My research journey documented in the six papers included in the thesis shows a multi-faceted analysis of negotiations in standardization processes which appear to be persistent and unsolved. What I identified as “tensions” are not events of interactions between different interested parts which necessarily achieve closure. That is, they are not phases of the standard making processes which produce an agreed upon specification. “Phases” are temporally bound. The identified tensions, instead, have a character of continuity and thus are persistent.

For instance (as discussed in paper 2), the tension between change and path dependency is a continuous struggle between the attempt of introducing innovations and the inertia of the installed base which influences (or even hampers) change. Innovations can have the form of a new component, a new layer of services, or new procedures. What I have characterized as “temporal disclosedness” of innovations aims at showing how change in information infrastructure is performed as mediation between the path dependency of the old installed base and the path creation that such change will cause. Thus change stops being an event frozen in time and becomes instead a continuous readjustment of what can be implemented and what effects this will have on future innovations. As observed, the development and implementation of a complex system like an EPR can thus remain “open”. That is, it does not seem to end but at the same time becomes operative, albeit with limited functionality.

Moreover (as discussed in paper 4 and 5), the tension between central and peripheral interests emerges in the very moment a standard is scaled from a local context to many other contexts forming a “global” infrastructure. In this situation the way peripheral practices are organized is influenced by a standard which centrally coordinates the local contexts. As exemplified in the HISP case in South Africa, interests in the standard can be split between peripheral and central (or local and global) creating the need for negotiations. These negotiations, for instance, have produced an increase in flexibility of the Essential Data Set (EDS, a core part of the standard) to allow better local adaptation, while maintaining strict hierarchical procedures of data reporting. The negotiations become permanent because the central interest will always tend to achieve greater stability and controllability pushing towards a centralized type of system (Walsham 1992).

At the same time, however, the periphery will always ask for more flexibility and thus more control pushing towards a decentralized system (*ibid.*). The resulting system is inevitably in the middle (as observed) and hence a mediation of the interest is continuously happening.

Similarly (as discussed in paper 6), the scaling of a standard from a local context to multiple contexts generates links between the local decisions and decisions regarding the standardization taken with a global scope. For example, the linking of the Norwegian EPR project to the global vendor organization has generated a standardization process of EPR products on a global scale with the aim of creating one global standard EPR product. In this new scenario, the local decisions and risks in Norway have inevitably become influenced-by and become part-of a global network of decision and risk which are now redistributed. Moreover, looking at the use of the EPR in a clinical department allows the emergence of different challenges than when looking at the same EPR, but in the larger context of the regional EPR standardization battle or in the context of the EPR product globalization strategy of the vendor. Both views are legitimate, but the second certainly better helps to understand how local strategic decisions are shaped by non-local (global) events. In this respect, the point made here is perfectly in line with Knut Rolland's point that "[a] fundamental challenge [...] is that local use and local design [...] are increasingly linked to non-local events and structures." (Rolland 2003: p. 70)

(2) Tensions, complexities, and unintended effects

The research findings suggest that the establishment of networks of standards inherently generates such tensions. The study also reveals that these tensions can be considered as sources of the side-effects mentioned in the introduction (page 2): paradoxes, unintended consequences, ambiguity and non-closure of projects. As I have just exemplified, the difficulty of "closing" the EPR development and implementation can be interpreted as a consequence of the tension between a change plan and the path dependency of the installed base. Likewise, the continuous emergence of unexpected problems during the implementation can be related to the continuous attempt to add and integrate systems to achieve better control on work processes and the parallel increasing complexity (and hence of lack of control) generated by the growing number of system. The latter phenomenon is what Kallinikos identifies as the "paradox of control" (Kallinikos 2005).

This evidence calls for a rethinking of assumptions and basic definitions of standardization. For example, the working definition by deVries which I have adopted does not mention this aspect of standardization processes. The basic assumption is that a “successful” standardization process will always come to a definition of specifications which balance interests and which will be stable for a certain amount of time. If we look at the empirical evidence collected here, we can clearly see that closure and common agreements on specifications is rarely completely achieved. We also see that development and implementation processes are infested with emerging problems, unresolved disputes and side-effects. At the same time, however, it is hard to say that the process was a failure. In the hospital in Norway, the EPR is hardly finished and has hardly reached the intended use. Yet the organization has learned and changed as part of this “incomplete” process. The accumulated experience has been turned into new ideas and visions (thus generating path creation). Inevitably, the implementation of the new ideas will produce even more problems and side-effects. Eventually the organization may collapse and we may easily identify a failure. Another possibility, as it happened so far, is that the organization will change and thrive in the pursuit of this permanent battle.

At this point, an objection may be that interpreting the case as a standardization process may not be appropriate. I submit, on the contrary, that standardization is a very effective concept which provides much more explanatory power than simple “development” (as in traditional staged and self-contained “IS development”). It is however evident that our conceptualization of it must be extended to account for the new findings. By focusing on tensions, my contribution aims at further developing a particular new line of research in IS standardization. As mentioned in the literature review, other contributions in this direction can be identified in Timmermans and Berg study on “local-universality” of standards (1997), in Rolland and Monteiro work on local-global relations (2002), and on Mulgans study of the duality of control in telecommunication systems (Mulgans 1991).

(3) Understanding tensions to mitigate complexity

Better understanding tensions in standardization processes can help addressing their complexity and the effects that can be produced.

For example, the second paper (on temporal disclosedness of innovations) shows an example of a shift in strategic thinking and action in the management of the IT infrastructure of Rikshospitalet. The focus changed from project to process, from system to service, from silos of systems to layers or components, from tight to loose coupling, from specialized knowledge to interdisciplinarity, and from compartmentalization of duties to co-responsibility. This, which I called a paradigmatic shift in the management strategy, can be also seen as a shift from focusing on the delivery of self-contained and stable solutions to focusing on a continuous and pro-active management of tensions.

Similarly, in the case of the standardization of the Health Information System in South Africa one of the core issues which is addressed to improve sustainability is balancing the control over the standard specifying the structure and content of the routine health information. Beyond any rhetoric on empowerment the core issue remains the balancing of power and control over resources and, consequently, over information. Also in this case the tension is permanent because the needs, interests, and logics in the various layers of the hierarchy are different. As I state in the fifth paper on the duality of control (paper 5), it is not something that needs to be solved, rather it is something that needs to be designed and exploited because it constitutes the channel of communication and negotiations through which “development” can occur as a dialectic process.

5.1.2 Bridging the micro-macro gap in Information Infrastructure theorization

In this subsection I will address the second theme, regarding the contribution that the study of tensions can give to the need to bridge the micro-macro gap in the theorizing of information infrastructures. In order to do so I will discuss the following points:

- (1) focusing on tensions is a way of seamlessly navigating through the scales in which information infrastructures operate: local-global, center-periphery, actor-system;
- (2) analyzing tensions with the theoretical constructs such as reflexivity, multiplicity and complexity allows to create a theoretical *oligopticon*: not all micro-macro connections can be seen, but those which are identified can be seen well.

(1) Navigating the tensions and the idea of the 'oligopticon'

Recalling the theoretical motivations, there are mainly two reasons why we should seek to bridge the micro and macro gap in information infrastructure study: a practical and a theoretical one. Firstly, the practical emerges from the evidence that the increasing role of standards in IS development implies that local decisions are ever more linked (influenced, constrained, dependent, triggered) to a choreography of other local context and “macro” actors linked to the standard. Hence, any local study of IS development cannot and should not avoid analyzing the links of the local context with the large network of other context affected by the same standard.

Standards can refer, as in the cases presented here, to international medical classification system (ICD10), or to the EPR packages itself. It can refer to CEN TC 251 European standard specifications of meta-architectures of the EPR, or to the HL7 standard adopted in the US. It can also refer to the definition of the Essential Data Set used throughout South Africa seen in the second case study.

Secondly, the theoretical motivation emerged from the fact that infrastructures link micro-macro-meso scales of time, space, and social organization shaping our modern society (Edwards 2003). Moreover, the study of infrastructures as modern technology cannot ignore “[...] the problem of connecting the topics of modernity and technology, and of connecting modernity theory with technology studies[...]”, which, again, translates into the problem of connecting the macro with the micro. The contribution which I here formalize addresses precisely this problem.

As observed in the introduction to the theoretical framework and in line with Latour’s view, bridging the micro-macro gap should occur by focusing on the *connections* between papers, technical artifacts, people, locations, documents, and all the “actors” which represent the locality and globality, the micro and macro, of IS standardization (Latour 2005); that is, not by jumping between different analytical and theoretical frameworks. The tensions identified in the research findings are an analytical vehicle which can be used to follow the unfolding of micro-macro connections. For example, local-global and center-periphery are examples of permanent negotiations. It is sufficient to stick to these ongoing struggles and follow the way events and

decisions are translated and propagate through the network of connections, to understand how interferences and side-effects between the various levels take place.

It thus emerges that bridging the micro and the macro is not a practical but a *theoretical* problem. In reality actors are simultaneously linked to micro and to macro networks. We can identify the micro and the macro by looking at the very same artifact: the EPR as system used in a clinical department, or as part of a hospital II standardization strategy, or as the object of a national standards war, or, finally, as the object of product globalization strategy.

We can use tensions as the analytical unit of analysis: we need theoretical concepts to analyze and interpret them which are able to theorize at the observed multiple levels. I propose three concepts which suit well with the study of links, connections, and unfolding negotiations. The idea is to create a theoretical *oligopticon*, that is a set of perspectives which, while they cannot show (or see) everything, they at least provide a good insight on a number of aspects. As Latour says: “[o]ligoptica [...] do exactly the opposite of panoptica: they see much *too little* to feed the megalomania of the inspector or the paranoia of the inspected but what they see they *see it well* [...]” (Latour: p. 181). The three interesting aspects of the unfolding of tensions in IS standardization which I propose as part of the *oligopticon* are: reflexivity, multiplicity and complexity.

(2) The oligopticon and the theoretical framework

These are just but three possible frames in which to interpret the unfolding of tensions. Yet, as the papers show, they have good explanatory power. I will discuss now each in turn.

The concept of reflexivity helps to show how local events are more and more influenced by non local decisions and events which can generate side-effects. I borrow this concept from a macro theory of modernity developed by Ulrich Beck (Beck 1999), but understanding how reflexivity works implies the need to follow its dynamic regardless of the scale. For example, the more the IT infrastructure at Rikshospitalet is populated with interrelated standards, the more its complexity increases. As a result, implementing local solutions to local problems may generate new problems in other parts of the infrastructure: the implementation of the EPR to substitute paper causes a growth of paper production and a crisis in the archive department; the

implementation of a new integration framework increases fragmentation and requires the implementation of yet another integration framework. All these stories exemplify the relations (negotiations, struggles, contradictions, paradoxes) in standardizations between the actor and the system, the system and the infrastructure, the part and the whole, that is between the micro and the macro.

The concept of multiplicity helps to understand another side of the observed tensions. As said, tensions arise as continuous negotiation between parties involved in the standardization process which have different interest or obey to different logics. The concept of multiplicity, I recall from the theory, helps us view objects in reality as entities which are “more than one but less than many”. In our particular case, the standard “is” as many things as there are actors interested in it. This is in contrast to a view which sees the standard as one single object that can be viewed from different perspectives. Embracing the assumption that reality is such when “enacted” implies that any object (including standards) are as many objects as there are enactments and actors who enact them (Mol & Law 2002).

For example, the EPR “is” different EPRs depending on the level and context in which it is analyzed. There is the EPR standard object at the department level in the context of local use. Then there is the EPR as part of IT infrastructure management practice at Rikshospitalet. Moreover, there is the EPR as object of a standards war at regional and national level in Norway. Finally, there is the EPR (always the same EPR in Rikshospitalet) as part of a larger global marketing plan of the vendor.

In the case in South Africa, the standard defining the Essential Data Set (EDS) in the Health Information System has a different meaning and represent a different logics whether it is seen as part of the local practice of implementing a hospital information system or as part of a rationalization project at the Department Of Health in the Provincial office.

The concept of multiplicity hence helps to bring forth another important aspect of tensions in standardization that further explains their permanent character. The idea of multiplicity points to the inevitable and unsolvable conflicts of logics and orders enacted at different levels (e.g. micro-macro) in standards and IT artifacts in general. If this perspective is hold valid it has wide

implications on how IS standardization and IS development in general should be approached. The very definition of “standardization” would need to be rethought and expanded. The new perspective would be one which does not necessarily aim at solving, simplifying, codifying, stabilizing. It would be a perspective which helps addressing the intricacies, paradoxes and contradictions of IS standardization in II not as exceptions, rather as constituting part of the development process: that is an approach which embraces complexity. This brings us to the discussion of the last perspective of the theoretical framework.

One common characteristic of complex systems theorized by theories of complexity is the interaction among elements through non-linear interdependencies: what John Urry calls ‘complex relationality’ and Perrow ‘interactive complexity’ (Urry 2005; Perrow 1984). The second central aspect is control in complex systems: self-organization takes over centralized control. Regarding the first aspect, focusing on complex relationality helps navigating through the connections and negotiations between actors representing micro or macro interests and contexts. Regarding the second aspect (control), the interactive complexity of tensions can provide an explanation of the source of side-effects and unpredictable outcomes.

For example, the apparently never-ending development and implementation process of the EPR at Rikshospitalet shows how design and development of new components is always mediated by the installed base of systems, practices and standards which demand continuous rethinking and redoing. It is certainly legitimate to argue that eventually the mediation process will end allowing for a completion of the EPR with all planned functionality. This would mean a resolution of the tension between projected (in new developments) and inscribed (in the installed base) possibility of change. However, after almost nine years of delayed implementation a different interpretation may emerge. Any new implementation will start but probably never end: it will live in the form of continuous negotiations, small advancements, retreats and triggering of new developments. The reason behind the persistence of overlapping design/development/implementation processes (not stages!) may be identified in the intrinsic complexity of the interdependencies and interactions among actors in the infrastructure: a system of interdependencies which can be transformed (cultivated or made evolve) but not necessarily simplified.

In the case in South Africa we can interpret the control-periphery tension as the manifestation of control and self-organization mechanisms typical of a complex system (the second central aspect of complex systems). The concept of “local sustainability” and of “duality of control” proposed in the papers underline the need to nurture the local capacity of self-organization and to link these local efforts with central/global logics and organizing principles.

5.1.3 Theorizing technology in the context of Modernity

The third theme concerns the implications for the theorizing of technology in the context of modernity. Here I make and discuss three points:

- (1) studying technology in the context of modernity means that one cannot limit itself to either macro or micro studies: the increased global integration and interdependencies require micro studies of technology to be contextualized within macro dynamics (local implementations cannot be studied as an isolated phenomena anymore) and vice-versa;
- (2) these studies should help to increase our awareness and understanding of the complexities of modern IS development in order to achieve self-transformation through self-criticism;
- (3) modernity as globalization raises the question of which modernity we are talking about.

(1) Connecting technology and modernity

This thesis, through the study of standardization processes in information infrastructure development, reiterates a call to link studies of modernity and technology and exemplifies a possible way to do it. Addressing the issue of theorizing technology and modernity, Philip Brey submits that:

“If modernity is shaped by technology, then the converse also holds: technology is a creation of modernity.” (Brey 2003: p. 33)

However:

“In the current specialized academic landscape, modernity is the object of study of modernity theory, and technology is studied in technology studies. Few works exist that bridge these two fields and that study technology with extensive reference to modernity, or modernity with extensive reference to technology, or that concentrate on both by studying the way in which evolutions within modernity intersect with technological changes.” (*ibid.*: p. 34)

Moreover:

“A key conclusion is that the major obstacle to a future synthesis of modernity theory and technology studies is that technology studies mostly operate at the micro (and meso) level, whereas modernity theory operates at the macrolevel, and it is difficult to link the two.” (*ibid.*: p.35)

Interestingly (information) infrastructures are not only paradigmatic *modern* technologies (hence need to be studied *also* at the macro level) (Edwards 2003), they also materially exist on multiple levels. As this thesis shows, a micro-macro study of infrastructure development can be achieved by simply tracing and documenting the unfolding of negotiations (permanent and non) in standardization processes. In this sense infrastructures are an ideal type of technology to study to advance the understanding of the relation between modernity and technology.

(2) *Beyond fatalism*

This thesis aims at deepening the understanding of apparent contradictory and paradoxical outcomes of standardization processes. However, the negative connotation attributed to such phenomena and the claim that they are “systematic” (being largely produced by tensions) may induce the reader to think that I subscribe to some negative fatalism of modern society: IS development is just getting too complex and the society will eventually self-destruct. On the contrary, this thesis aims at deepening our understanding of the modern world so to become *aware* of its dynamics (e.g. reflexivity) in order to become self-critical and trigger a beneficial change: what Beck calls self-transformation (Beck 1999: p. 152).

I do this, for example, by adopting a wider meaning of “reflexivity” than it is usually attributed. Reflexivity as theorized by Ulrich Beck is a concept which carries a double meaning: one is the meaning of potential reflexive self-destruction of modern logics; the other is the meaning of reflexivity as self-criticism and self-confrontation of the society with its reflexive creation of unintended consequences in order to self-transform itself. Previous works have mainly focused on the first meaning, which has a more negative tone (Hanseth & Braa 2000; Rolland 2003). However, the second meaning of reflexivity is here also underlined. The progressive change in strategy at the IT department of Rikshospitalet may be interpreted as one such instance. Hence the concept of reflexivity helps us identify both the possibly self-destructive character of standardization processes as well as the possible learning and consequent change in logics and strategies that can help coping with and mitigating unintended destructive side-effects.

(3) Multiple modernities and regimes of representation

As shown, this thesis discusses technology and modernity. But what modernity have I represented here? In which context was it theorized? Can the same set of concepts and theories be applied to other contexts? Can I discuss “reflexivity” in the South African context? What is “modernity” to South Africa?

I asked this questions directly to Ulrich Beck¹⁴, who replied that in fact his (hence also Scott Lash’s and Anthony Giddens’) theory of modernity had strong “European” (German to be precise) roots. It is a theory which reflects on “modernity” in that particular society and culture. Understanding that we live in *a* particular type modernity implies that in other contexts there are *different* modernities: *multiple modernities* (Beck 2000; Beck *et al.* 2003; Sachsenmeier & Riedel 2002; Walby 2003).

The critical question which at this point I need to ask myself is what validity my findings from the case based in South Africa have. Is modernity there the same as here? What is the meaning of adopting the same theoretical framework based on the same cultural and philosophical assumptions? Does it make sense that I study work practices performed by the Xhosa people in

¹⁴ Personal conversation, August 2005, Oslo.

a remote area of Eastern Cape interpreting them through the scientific method spawned by Galileo Galilei?

The answer is unclear. That is, I cannot say what sense it makes, nor I can define and probably understand what modernity is for the people in rural areas of Eastern Cape. Nevertheless I can become aware of who I am (my culture and my beliefs) and of what I am doing. For instance, I can become aware that I am applying a *regime of representation* (Escobar 1994), that is, a set of ideas, a framework of values, a particular ontology and epistemology to represent and discuss the meaning of what I experience.¹⁵

The study on “sustainability” is a perfect example of the regime of representation which I applied to the South African case. This is a concept which was created by a Norwegian prime minister (Brundtland 1987) and has become a field of research to study how to create durable and self-sustaining economies in developing countries. But looking closer, it is a concept created by Europeans to address a problem created by Europeans (or western countries): environmental pollutions. So, why should we apply this concept when looking at an information system in a rural area of the Transkei in South Africa? What can this tell us? Am I performing an “intellectual colonization” destroying and misreading the richness of local cultures and values?

My point and conclusion is that western research in (so called) developing countries must become *aware* of its bias and its limitations. Moreover, it should become innovative in diversifying the perspectives on the object of study to account for the *multiple rationalities* which populate different contexts (Avgerou 2000).

5.1.4 Limitations

Positioning

What more can I say now about IS standardization and how does this extend our theorizing of it? This study moved from the empirical evidence that (1) standardization processes in IS development are ever more important, (2) that in certain circumstances they may not reach the expected outcome resulting either in continuous negotiations or in unpredicted side-effects.

¹⁵ This point is in line with an ongoing discussion in the research field studying IS in developing countries (see for instance Avgerou 2000; Walsham 2005).

Thus one contribution of this thesis is to raise the attention on the increasing pervasiveness of standards and standardization processes and hence on the need to adapt research and education in IS to include these aspects. This in a way is a direct, important but trivial contribution. The more ambitious contribution I am aiming at is to investigate and theorize about the complexities which accompany the increasing role of standardizations.

In other words, “standardization” may be becoming a more appropriate concept than “development” to analyze how IS evolves. The direct implications may result in a new breed of methodologies and approaches to IS which are rationally constructed around a different paradigm (standardization) which takes into consideration more or different factors than traditional development (more attention to inertia, negotiations between parts, stability-flexibility balance and so on). Such an outcome would in fact be just a variation of what was existing before, while the basic assumptions and principles (at the base of modern development methodologies) would remain the same: divide-et-impera, functional simplification (Kallinikos 2005), and control (Beniger 1989; Mulgan 1991).

What if, instead, the acceleration and ongoing global amplification of standardizations and integration processes has been perpetuated to an extent that it actually starts to undermine its own stability? What if the very processes of standardization which aim at improving efficiency, effectiveness and thus rationalization and control, end up creating a degree of complexity which ultimately hampers these very aims? This is what Beck’s reflexive modernization is attempting to theorize. It then becomes relevant to better understand how these effects originate, how their mechanism can be interpreted, and in which particular conditions they are generated. The findings from such a research may suggest to rethink some of the foundations and basic assumptions of current IS development methodologies: e.g. embracing complexity, managing tensions, and control devolution (Hanseth *et al.* 2001).

As mentioned in the literature review, this work refers to and builds on discussions on standardization which focus on the relationship between local-universal (Timmermans & Berg 1997), or local-global (Rolland & Monteiro 2002). Moreover it is aligned with a body of literature which views standardization as part of the development of a larger socio-technical information

infrastructure (Hanseth & Lyytinen 2004; Star & Ruhleder 1996). In particular, this thesis partly builds on and extends Knut Rolland's study of local-global relationships in Information Infrastructure (Rolland 2003). I will now explain how it extends this body of literature and how it contributes to the IS field in general.

Rolland observed and underlined the importance and persistence of local-global tensions. His study focuses on design and use and (among other aspects) discusses reflexivity as one example of manifestation of the local-global tension. This thesis, however, extends his work in many directions: (1) it explores other tensions, or better, it explores some of the "multiplicity" of such tensions; (2) it focuses on logics and strategies rather than on use and situated practices; (3) and it adopts and applies the wider and more complete meaning of "reflexivity" beyond the usually adopted negative connotation (as side-effect, or boomerang effect).

More in general, the thesis contributes to the research agenda on studies of Information Infrastructure which developed throughout years of cooperation between the Department of Informatics at the University of Oslo and the Department of Information Systems at the London School of Economics. The research agenda aims at exploring the limits of modern logics of standardization and its relation with theories of Modernity.

In conclusion, locally this thesis brings on and critically extends the work on theorization of II development. More generally, the thesis identifies particular aspects of IS standardization (the management of tensions) which demand the rethinking of basic assumptions behind traditional IS development approaches by means of embracing and addressing its increasing reflexivity, multiplicity and complexity.

Generalizability

How general are my findings? Do they apply to all standardization processes? My answer is yes. What I have observed and theorized certainly applies to any type of process where a common agreement is produced as the result of negotiations between multiple parties with different interests. However, I am not claiming that what I have here formalized is what standardization processes are made of. Instead, I am proposing a particular way of looking at (that is interpreting) them which can provide a greater explanatory power than other approaches. I

submit that focusing on permanent negotiations and interpreting them as tensions can help understand the source and dynamics of (at least some) side-effects. In this sense, my findings and my thesis is highly general.

Another, more practical, question is: in which contexts does it make more sense to adopt this perspective? My findings suggest that tensions are ever more important (1) the larger the infrastructure and (2) the more heterogeneous its material. Regarding the second point, the evidence show that the less technical and confined the standard, the more negotiations remain open. For instance, the EPR can be itself seen as a standard and its development and implementation as a standardization process. However, when we look closer, we see that the EPR is more a package of standards (Fujimura 1992) made of technical and formal parts as well as less technical and more informal parts such as work procedures and departmental rules. Likewise, in the South Africa case, the EDS can be seen as a specification itself. However, what is really standardized is not the EDS alone but the whole way of working and thinking in numerous health organization.

5.2 Practical Implications

The research presented in this thesis moved from a first rather practical question: Why are standards and standardization processes in IS project increasingly affected by unintended effects and paradoxes? This question emerged from the evidence that a large number of IS projects struggle to reach successful completion (BCS 2004; Ciborra 2000; Lyytinen 1987). More specifically, large scale clinical information systems have proven to be extremely difficult to implement, challenging in the years new methodological approaches and standardization attempts (Ellingsen & Monteiro 2002; Berg & Goorman 1999). For example, the trajectory of the EPR system at Rikshospitalet (and in Norway) analyzed in this thesis represent such a paradox where the attempt to increase standardization seemed to produce greater complexity.

I have shown from a theoretical point of view how standardization may act reflexively by (1) generating side-effects through new and unintended paths and connections (2) generating the need for ever more standardization by increasing the overall complexity of the (connected) system. The way I proposed to look at these effects is by focusing on *tensions* emerging from the

standardization processes. What I will try to do now is to translate this theoretical contribution into more tangible recommendations for managers engaged in the day to day practice of standardizing IS in organizations. The targeted audience includes CIOs and IT project managers, and the contexts to which I will refer to are large organizations with large installed bases, high degree of variety of organizational units, and high speed of technological change, such as the healthcare sector and, in particular, specialized hospitals and national health systems.

I will articulate the recommendations in two steps: (1) understanding complexity; (2) managing tensions.

5.2.1 Understanding Complexity

Paradoxes, side-effects, and non closure of projects are commonly perceived as manifestations of the complexity of the task undertaken. My theoretical analysis (through the use of concepts such as reflexivity, multiplicity, and complexity) helps precisely to dissect and analyze some aspects of the reality of IS standardization which emerges as complex.

The first step I propose to practitioners is to widen their understanding of complexity, beyond the narrow common definition as “something which cannot be controlled”. Phenomenologically it can be argued that a system “is” complex solely in relation to our attempt to control it. Yet, complexity should not be seen as an extensive and objective property of a phenomenon. Rather as the result of our interpretation stemming from our interaction with it. However, complexity as the result of interpretation and interaction is more than simple *perception*: measuring and counting the number of systems, observing the diversity, measuring the speed of technological change. A phenomenological interpretation of complexity, which I am proposing, extends to other existential relations, such as *circumspection* and *understanding*. *Circumspection* refers to our engagement with the practical problem solving activities (e.g. through IT systems or within IS). *Understanding* refers to our becoming intimately familiar with the reality and dynamics of the IS. In one word, understanding complexity of an IS means *caring* for it (Ciborra 2002).

The basic problem in most managerial literature (e.g. Broadbent & Weill 1998) is that the analysis of IT infrastructure (and of reality in general) is often limited to *perception* (Ciborra 1997): that is to the mere measurement, categorization, and labeling of an objective reality. Limiting the

analysis to the perception allows easily abstracting and de-contextualizing the observations so to make them general. What is lost, however, is the very essence of what makes the IT infrastructure live and change: the *care* that people put in their everyday work.

For instance, an obvious way to analyze complexity is considering the following dimensions: (1) analyzing the history and the inertia of the IS; (2) analyzing the strong and the weak technical and organizational links between systems and between organizational units; (3) understanding the level of diversity in the various organizational units; (4) understanding the speed of change of technology and how this affects the generation of new projects; (5) understanding the different logics at play and the different interests at stake represented by the actors involved in the standardization process. The message I convey is that a richer insight is gained when simple measurement of these dimensions (*perception*) is complemented with the understanding of the particular context and the everyday struggle managers live during the standardization process (*circumspection* and *understanding*).

For example, the crisis in the archive department at Rikshospitalet (paper 6), as the result of (among other things) the increased consumption of paper and fragmented updating practices related to the introduction of the EPR, can be seen as a manifestation of the complexity of the IT infrastructure. A first understanding may stop at a deterministic representation (*perception*) of chain of causes which created the crisis (the interlinking of systems and practices which produced unintended side-effects). However, a managerial intervention (the topic of discussion here) requires a wider and deeper understanding of the complexity also on other levels: the level of the *multiplicity* of interests of the different units (including the archive department and IT department), the ambitions and concerns of the people in it, the ambition of the CIO, and so on. These aspects all played a role in the chain of events which created the crisis at the archive, and which influenced the decision to address it with yet a new IT project: the scanning project. An effective intervention requires an understanding also of these aspects, which in turn implies becoming *familiar* with people, their interests, their aspirations, and their frustrations.

This conclusion is even more relevant in the case of IS projects in developing countries, such as the standardization of the District Health Information System (DHIS) in South Africa (see paper

4 and 5). The complexity arising from the possible sense of impotence against the difficulties of starting up a working information system can only be understood by “throwing ourselves” in the particular situation. That is by *caring* for the culture and values of people with a different culture and philosophical background. The real challenge is to learn to think in and continuously translate between two different worlds of logics and values, or between *multiple rationalities*. For instance, operating in the Transkei region in the Eastern Cape Province, besides technical (engineering, managerial, medical) skills, requires a certain sensitivity and understanding of the Xhosa people, their history, the heritage of prejudices and attitudes from the apart-heid and from centuries of colonial culture.

Approaching and understanding complexity in this wider sense (beyond simple perception and by *caring* for the people and artifacts under analysis) is a precondition to the second practical implication I will highlight: the management of *tensions*.

5.2.2 Managing Tensions

The pivotal concept of this thesis are *tensions* in standardization processes. I have proposed these as important aspects of standardization which can (at least partly) explain the dynamics of unwanted effects such as paradoxes and side-effects. Throughout my research I have identified and studied a number of tensions and put them in relation with existing literature. While it is beyond the scope of this thesis to provide a complete taxonomy (and it rather can be the subject of further research) I will here synthesize a list of “lessons learned” and advice related to each of the identified tensions which I think can have a practical relevance (see Table 8).

Each advice assumes that the practitioner approaches the context with the aim of gaining a deep understanding, in the fashion I just illustrated in the subsection above. The tensions I analyzed all represent permanent or semi-permanent types of struggles or negotiations between actors involved in the standardization process. They also represent different degrees and manifestations of the complexity of the process. Some of them (like center-periphery or local-global) are inherent in the process. Other (like control-side effects) may manifest to a greater or lesser extent. From a practical point of view they all are aspects of the standardization process and

should not necessarily be avoided or eliminated. On the contrary, their understanding and (possibly) active management can benefit the outcome of the standardization.

Table 8 Lessons learned from the two case studies in relation to the observed tensions.

Tensions	Advice	Examples from the cases
Change – Path dependency	-Focus on process vs. project -Focus on short term vs. long term -Standardize by layers and modules vs. silos -Accept non-closure if too difficult to reach vs. announcing failure	Change of IT department strategy at Rikshospitalet: from a solution delivery paradigm to a service provision paradigm. Process focus, incremental innovation (layers and modules) and flexibility through interdisciplinarity.
Local – Global	-Balance flexibility and stability of standard through re-negotiations -Empower local contexts in negotiations to increase acceptance	Relation between local and global sustainability of the DHIS standard in South Africa
Center – Periphery	-Learn to think and act in multiple logics -Understand and manage the politics (technology is never a-political)	Dual control logics reflected in the need to have dual management logics at each level in the DHIS implementation
Control – Side effects	-Do not necessarily react to side-effects with increased control -Loose coupling as alternative strategy -Re-caliber control goals and scope	Change of IT department strategy at Rikshospitalet: portal strategy, loose coupling, process and service orientation. Side-effects become matter of daily management.

What I have presented here is a summary of some practical implications drawn from the experiences of the two cases which I have studied. In this sense, as mentioned, they do not represent universal solutions. That is, the advices are not to be considered as recipes to be applied to any context, rather as aspects on which the managers need to focus in order to decide (case by case) what actions to take. For instance, it is not always the case that the inertia of the installed base is so strong to completely redefine (and possibly disintegrate) a new infrastructural innovation, like the EPR in one of the two cases, with the outcome that a project/innovation focus becomes meaningless (the EPR simply dissolves in the trajectory of the infrastructure). However, what I could observe is that in both cases (which to some extent can be considered successes or at least non-failures) the managerial approach adopted when confronted with paradoxes and side-effects (that is when confronted with the complexities of technology) was of relaxation rather than of tightening of the control on technology: what Claudio Ciborra called “releasement” or *Gelassenheit* towards technology (Ciborra 2002). I would like to align the

practical implications of my thesis to this principle: understanding and managing *tensions* in standardization process can be viewed as a way of embracing some aspects of its complexity thus renouncing the *modern* temptation of trying to simplify it at all costs in the name of an ideal rationalization.

“Coming full circle to the phenomenological underpinning of a specific [IT project] we have turned the initial management agenda, based on notions such as strategic intent, planning, alignment, and control, into a quite different one that highlights releasement, valuing fluctuations, openness to mystery, and sudden moments of vision.” (Ciborra 2002: p. 78)

6 CONCLUSIONS

This thesis has presented an interpretive study of standardization processes related to the development and implementation of Information Systems. Standards and standardization processes are ever more important and pervasive in ISs. Standards range from technical specifications of communication protocols to informal organizational agreements and guidelines. Their scope ranges from the boundaries of a small organizational unit to international standardization committees. Today the development of any information system is made of, based on, related or linked to standards. The development process itself can be seen as a standardization process.

This thesis thus tries to deepen our understanding of the dynamics of IS development as standardization. In particular it tries to address a particular class of problems which manifest as paradoxes, side-effects, and non-closure of standardization projects (BCS 2004). Standards are meant to reduce variety and optimize coordination, or, in one word, simplify complexity. However, paradoxically, the opposite can also be observed as well: the more we standardize, the more we are able to connect “worlds”, hence the more we increase complexity and fragmentation, which in turn creates greater need to standardize (Ciborra 2000). On another front, the more we push standardization to involve organizational (beyond purely technical) aspects, the more we seem to loose control over the outcome of the process and we get caught into lengthy negotiation processes.

My research aims at dwelling into this class of problems with the attempt to identify theoretical as well as practical issues which can provide a relevant explanation of the observed dynamics. Based on an empirical base constructed over two case studies based in the healthcare sector in Norway and in South Africa, I conduct an analysis of standardization processes and formalize a set of theoretical and practical implications.

From the theoretical point of view, I submit that the study of standardization cannot escape the need to complement studies conducted at different levels of technology development and use. In

practice this means complementing (e.g.) social studies of technology (such as SCOT and ANT) or economic studies (such as concepts like path dependency, lock-in, network externalities) with (e.g.) studies of technology in the context of modernity (such as Giddens and Beck). In fact any standard can be separately analyzed at all these levels, but none of levels alone is sufficient to account for all its dynamics. In order to address this shortcoming I propose to focus on a particular aspect of standardization: *tensions*. That is, I propose to study the nature and dynamics of certain types of permanent negotiations inherent or emerging in standardization processes which can help linking the multiple levels in which they unfold. Examples of such tensions are: local-global, center-periphery, change-path dependency, and control-side effects. The study of these tensions, as I show from my findings, sheds some light on the dynamics of production of paradoxes and side-effects observed in the case studies. While I use *tensions* as unit of analysis, I conduct the analysis with the help of three theoretical concepts (reflexivity, multiplicity, and complexity) which have the particular characteristic of being “scale independent”. My theoretical contribution is thus threefold: (1) I focus the attention on and develop the analytical concept of *tension*; (2) I use this analytical concept and the theoretical framework to provide an example of how micro and macro levels of theorization of standardization processes can be pursued; and (3) in particular I discuss the need of such an approach when studying standards in the context of modernity and address the need to increase our awareness of the *multiple modernities* in which technology is created and appropriated.

From the practical point of view I suggest to address the problem of paradoxes and side-effects emerging from standardization processes in two steps: first to widen our understanding of the complexity of the situation under analysis by complementing our *perception* of complexity with our *caring* for the people and systems part of the standardization process; second, with this wider approach, to address the *tensions* by focusing our analysis and decision making on aspects which can minimize the negative outcome of the unfolding of the tensions and (in some cases) which can maximize their beneficial effects. In relation to this provide a list of such tensions and aspects as the result of my findings.

REFERENCES

- Abbate, J. (1999), *Inventing the Internet*, Cambridge, Massachusetts, MIT Press.
- Adler, P., Adler, P. (1994), "Observational Techniques", in Denzin N.K. *et al.* (eds.), *Handbook of Qualitative Research*, Thousand Oaks, London, Sage Publications.
- Akrich, M. and Latour, B. (1992) A summary of a convenient vocabulary for the semiotics of human and nonhuman assemblies, In Bijker, W. E. and Law, J. (editors) *Shaping technology/building society*. MIT Press, pp. 259 – 264.
- ANC, (1994a), *A National Health Plan for South Africa*, African National Congress, Johannesburg, South Africa.
- ANC, (1994b), *The Reconstruction and Development Programme*, African National Congress, Johannesburg, South Africa.
- Anderson, P. (1999), "Complexity Theory and Organization Science", *Organization Science*, Vol. 10, No. 3, pp. 216-232.
- Anderson, P., Meyer, A., Eisenhardt, K., Carley, K., Prettigrew, A. (1999), "Introduction to the Special Issue: Applications of Complexity Theory to Organization Science", *Organization Science*, Vol. 10, No. 3, May-June 1999, pp. 223-236.
- Antonelli, C. (1992), "The economic theory of information networks". In *The Economics of Information Networks*, ed. C. Antonelli, North-Holland.
- Argyris, C., Schon, D. (1995), *Organizational Learning – Theory Method and Practice*, Addison Wesley.
- Arthur, W.B. (1989) "Competing technologies, increasing returns, and lock in by historical events", *Economic Journal* 99: 116-131.

- Arthur, W.B. (1994), *Increasing Returns and Path Dependence in the Economy*, The University of Michigan Press.
- Arthur, W. B., Durlauf, S. N., Lane D. A. (1997), *The Economy as an Evolving Complex System II*, Santa Fe Institute Studies in the Sciences of Complexity, Addison Wesley.
- Avgerou, C. (2000), "Recognizing Alternative Rationalities in the Deployment of Information Systems", *Electronic Journal on Information Systems in Developing Countries*, Vol. 3, No. 7, pp. 1-15.
- BCS (2004), *The Challenges of Complex IT Projects*, The British Computer Society, Royal Academy of Engineering. Accessible at: <http://www.bcs.org/NR/rdonlyres/3B36137E-C5FE-487B-A18B-4D7281D88EF7/0/complexity.pdf>, (last accessed 15 December 2005)
- Beck, U. (1992), *Risk Society – Towards a New Modernity*, Longon: Sage.
- Beck, U., "The Reinvention Of Politics: Towards a Theory of Reflexive Modernization" in Beck, U., Giddens, A., Lash, S., *Reflexive Modernization. Politics, Tradition and Aesthetics in the Modern Social Order*, Polity Press, 1994.
- Beck, U. (1999a), *What is Globalization*, Polity Press.
- Beck, U. (1999b), *World Risk Society*, Polity Press.
- Beck, U. (2000), "The cosmopolitan perspective: sociology of the second age of modernity", *British Journal of Sociology*, Vol. 51, No. 1, pp. 79-105.
- Beck, U. (2003), "The Theory of Reflexive Modernization", *Theory, Culture & Society*, Vol 20, No. 2, pp. 1-33.
- Beck, U., Giddens, A., Lash, S., *Reflexive Modernization. Politics, Tradition and Aesthetics in the Modern Social Order*, Polity Press, 1994.

- Beniger, J.R. (1989), *The Control Revolution: Technological and Economic Origins of the Information Society*, Harvard University Press.
- Berg, M., Goorman, E. (1999), "The contextual nature of medical information", *International Journal of Medical Informatics*, Vol. 56, pp. 51-60.
- Berg, M., Timmermans, S. (2000), "Orders and their Others: On the Constitution of Universalities in Medical Work", *Configurations*, Vol. 8, pp. 31-61.
- Berg, M., Touissant, P. (2003), "The mantra of modelling and the forgotten powers of paper: A sociotechnical view of the development of process-oriented ICT in health care", *International Journal of Medical Informatics*, Vol. 69, No. 2-3, pp. 223-34.
- Berrel, S.M., Farrell, J. (1994), "Choosing How to Compete: Strategies and Tactics in Standardization", *Journal of Economic Perspectives*, Vol. 8, No. 2, Spring 1994, pp. 117-131.
- Bijker, W.E. (1993), "Do not despair: There is life after constructivism", *Science, Technology, & Human Values*, Vol.18, pp.113-38.
- Bijker, W.E., Hughes, T.P., Pinch, T. (1987), *The social construction of technological systems*. Cambridge, MA: MIT Press.
- Boddewyn, J.J., Soehl, R., Picard, J. (1986), "Standardization in International Marketing: Is Ted Levitt in Fact Right?", *Business Horizons*, November-December, 1986.
- Boland, R.J. (1985), "Phenomenology: a preferred approach to research on information systems", In E. Mumford *et al.* (Eds.), *Research Methods in Information Systems*, Elsevier Science Publishers.
- Boland, R. J., Day, W. F. (1989), "The Experience of System Design: a Hermeneutic of Organizational Action", *Scandinavian Journal of Management*, Vol. 5, No. 2, pp. 87-104.

- Boland, R.J. (1991), "Information System Use as a Hermeneutic Process", In: H.-E. Nissen, H.K. Klein & R. Hirshheim (Eds.), *Contemporary Approaches and Emergent Traditions*, Elsevier Publishers.
- Bowker, G.C., Star, S.L. (1999), *Sorting Things Out*, The MIT Press.
- Braa, J., Hedberg, C. (2002), "The Struggle for District-Based Health Information Systems in South Africa", *The Information Society*, Vol. 18:113-127.
- Braa, J., Monteiro, E., Sahay, S. (2004), "Networks of Action: Sustainable Health Information Systems Across Developing Countries", *MIS Quarterly*, Vol. 28, No. 3, 337-362, September 2004.
- Branscomb, L.M., Kahin, B. (1995), "Standards Processes and Objectives for the National Information Infrastructure", In: B. Kahin & J. Abbate (Eds.), *Standards Policy for Information Infrastructure*, The MIT Press.
- Brey, P. (2003), "Theorizing Modernity and Technology", In T.J. Misa P. Brey and A. Feenberg (eds.), *Modernity and Technology*, The MIT Press, Cambridge Massachusetts.
- Broadbent, M., Weill, P. (1993), "Improving Business and Information Strategy Alignment: Learning from the Banking Industry", *IBM Systems Journal*, Vol. 32, No. 1.
- Broadbent, M., Weill, P. (1998), *Leveraging the New Infrastructure: How Market Leaders Capitalize on Information*, Harvard Business School Press.
- Brundtland, G.H. (ed.) (1987), *Our Common Future: The World Commission on Environment and Development*, Oxford University Press, Oxford, UK.
- Brunsson, N., Jacobsson, B. (2000), *A World of Standards*, Oxford University Press.
- Brynjolfsson, E., Kemerer, C.F. (1996), "Network Externalities in Microcomputer Software: An Econometric Analysis of the Spreadsheet Market", *Management Science*, Vol. 42, No. 12.

- Bunduchi, R., Graham, I., Smart, A., Williams, R. (2005), "The Tensions Shaping the Emergence of Standard Bodies: The Case of a National Health Informatics Standards Body", *Prometheus*, Vol. 23, No. 2.
- Callon, M. (1991), "Techno-economic networks and irreversibility". In *A sociology of monsters: Essays on power, technology and domination*, ed. By J. Law, 132-61. London: Routledge.
- Carr, N. (2004), *Does IT Matter?: Information Technology and the Corrosion of Competitive Advantage*, Harvard Business School Press.
- Castells, M. (1996), *The Rise of the Network Society: The Information Age: Rise of the Network Society Vol 1 (The Information Age)*, Blackwell.
- Ciborra, C.U. (1997), "De profundis? Deconstructing the concept of strategic alignment", *Scandinavian Journal of Information Systems*, Vol. 9, No. 1, pp. 67-82.
- Ciborra, C. (2002), *The Labyrinths of Information: Challenging the Wisdom of Systems*, Oxford University Press.
- Ciborra, C., Braa, K., Cordella, A., Dahlbom, B., Failla, A., Hanseth, O., Hepsø, V., Ljungberg, J., Monteiro, E., Simon, K. (2000), *From Control to Drift. The Dynamics of Corporate Information Infrastructures*, Oxford University Press.
- Ciborra, C. U., Hanseth, O. (1998), "From tool to Gestell: Agendas for managing the information infrastructure", *Information Technology & People*, Vol. 11, No. 4, pp. 305-327.
- Ciborra, C. and Osei-Joehene, D. (2003), "Corporate ICT Infrastructures and Risk", *Proceedings of the European Conference of Information Systems*, Naples, June 2003.
- Cilliers, P. (1998), *Complexity and Postmodernism: Understanding Complex Systems*, Routledge.
- Damsgaard, J., Lyytinen, K. (2001), "The Role of Intermediating Institutions in the Diffusion of Electronic Data Interchange (EDI): How Industry Associations Intervened in Denmark, Finland, and Hong Kong", *The Information Society*, Vol. 17, pp. 195-210.

- Davenport, T.H. (1998), "Putting the enterprise into the enterprise system", *Harvard Business Review*, July-August, pp. 121-131.
- Davenport, T.H. (2000), *Mission Critical: Realizing the Promises of Enterprise Systems*, Harvard Business School Press.
- David, P.A. (1985), "Clio and the Economics of QWERTY", *American Economic Review*, 75 (2, May), pp.332-336.
- David, P.A. (1990), "The Economics of Compatibility Standards: an Introduction to recent Research", *Economy Innovation & New Technologies*, Vol. 1, pp. 3-41.
- David, P.A., Bunn, J.A. (1988), "The Economics of Gateway Technologies and Network Evolution: Lessons from Electricity Supply History", *Information Economics and Policy*, Vol. 3, pp. 165-202.
- David, P., and Greenstein, S. (1990), "The Economics of Compatibility Standards: An Introduction to recent research", *Econ. Innov. New Techn.*, Vol. 1, pp.3-41.
- Desai, A. (2005), "Special Issue: Adaptive Complex Enterprises", *Communications of the ACM*, Vol. 48, No. 5.
- deVries, H. J. (2003), *Standardization: A Business Approach to the Role of National Standardization Organizations*. Kluwer Academic Publishers.
- Dosi, G. (1982), "Technological paradigms and technological trajectories", *Research Policy*, Vol. 11, pp.147-162.
- Edwards, P. N. (2003), "Infrastructure and Modernity: Force, Time and Social Organization in the History of Sociotechnical Systems", In T.J. Misa P. Brey and A. Feenberg (eds.), *Modernity and Technology*, The MIT Press, Cambridge Massachusetts.
- Eisenhardt, K.M. (1989), "Building Theories from Case Study Research", *Academy of Management Review*, Vol. 14, No. 4, pp. 532-550.

- Escobar, A. (1995), *Encountering Development: the making and unmaking of the third world*, Princeton.
- Ellingsen, G. (2004), "Tightrope Walking: Standardization Meets Local Work-Practice in a Hospital", *Journal of IT Standards & Standardization Research*, Vol. 2, No. 1, pp. 1-22, Jan-Jun 2004.
- Ellingsen, G., Monteiro, E. (2002), "Big is beautiful: Electronic patient records in large Norwegian hospitals 1980-2001", *Methods of Information in Medicine*, 2002, ISSN: 0026-1270.
- Farrell, J., Saloner, G. (1985), "Standardization, Compatibility, and Innovation", *The RAND Journal of Economics*, Vol. 16, No. 1, pp. 70-83.
- Farrell, J., Saloner, G. (1986), "Installed Base and Compatibility: Innovation, Product Preannouncements, and Predation", *The American Economic Review*, Vol. 76, No. 5.
- Farrell, J., Saloner, G. (1992), "Conerters, Compatibility, and the Control of Interfaces", *The Journal of Industrial Economics*, Vol. 40, No. 1.
- Fomin, V., Keil, T. (2000), "Standardization: bridging the gap between economic and social theory", *Proceedings of ICIS 2000*, Bisbane, Australia, 2000.
- Fujimura, J.H. (1992), "Crafting Science: Standardized packages, boundary objects, and "translation"". In A. Pickering (Ed.), *Science as Practice and Culture*, 168-211. Chicago: University of Chicago Press.
- Gandal, N. (2002), "Compatibility, Standardization, and Network Effects: Some Policy Implications", *Oxford Review of Economic Policy*, Vol. 18, No. 1.
- Garud, R., Karnøe, P. (2001), *Path Dependence and Creation*, Lawrence Erlbaum Associates Publisher.
- Giddens, A. (1990), *The Consequences of Modernity*, Stanford University Press.

- Graham, I., Spinardi, G., Williams, R., Webster, J. (1995), "The Dynamics of EDI Standard Development", *Technology Analysis & Strategic Management*, Vol. 7, No. 1, pp. 3-20.
- Grisot, Miria (2004), "Integrating knowledge across disciplines: a case study from heart transplantation", in *The Fifth European Conference on Organizational Knowledge, Learning and Capabilities*, Innsbruck, Austria.
- Hammer, D., Wildavsky, A. (1989), "The Open-Ended, Semistructured Interview, An (almost) Operational Guide", pp. 57-101, in Wildavsky A. (Ed.), *Craftways: On the Organization of Scholarly Work*, New Brunswick, NJ, Transaction.
- Hanseth, O., and Braa, K. (2001), "Hunting for the treasure at the end of the rainbow. Standardizing corporate IT infrastructure". *Computer Supported Cooperative Work (CSCW)*, Vol. 10 Nos. 3-4, pp. 261-292.
- Hanseth, O., Braa, K. (2000), "Globalization and 'Risk Society'". In Ciborra, C., Braa, K., Cordella, A., Dahlbom, B., Failla, A., Hanseth, O., Hepsø, V., Ljungberg, J., Monteiro, E., Simon, K. (Eds.), *From Control to Drift. The Dynamics of Corporate Information Infrastructures*, Oxford University Press., pages 41-55.
- Hanseth, O., Ciborra, C., Braa, K. (2001), "The Control Devolution. ERP and the Side Effects of Globalization", *The Data base for advances in information systems. Special issue: Critical Analysis of ERP systems: The Macro Level*. (32: 4), pp. 34-46.
- Hanseth, O., and Lyytinen, K. (2004), "Theorizing about the Design of Information Infrastructures: Design Kernel Theories and Principles," *Sprouts: Working Papers on Information, Environments Systems and Organizations*, Vol. 4, Fall 2004, Article 12. <http://weatherhead.cwru.edu/sprouts/2004/040412.pdf>
- Hanseth, O., Monteiro, E., Hatling, H. (1996), "Developing information infrastructure: The tension between standardization and flexibility", *Science, Technology and Human Values*. Vol. 21 No. 4, Fall 1996, 407-426.

- Hanseth, O., Thoresen, K. and Winner, L. (1994), "The Politics of Networking Technology in Health Care", *Computer Supported Cooperative Work (CSCW)*, 2: 109-30.
- Heidegger, M. (1962), *Being and Time*, Blackwell Publisher.
- Heidegger, M. (1977), *The Question Concerning Technology and Other Essays*, Harper Torchbook.
- Henderson, J.C., Venkatraman, N. (1993), "Strategic Alignment: Leveraging Information Technology for Transforming Organizations", *IBM Systems Journal*, Vol. 32, No. 1.
- Holland, J.H. (1995), *Hidden Order*, Addison-Wesley, Reading, MA.
- Ives, B., Jarvenpaa, S.L. (1991), "Applications of Global Information Technology: Key Issues for Management", *MIS Quarterly*, March 1991.
- Jacucci, E., Hanseth, O., Lyytinen, K. (2006), "Introduction: Taking Complexity Seriously in IS Research", In: E. Jacucci, O. Hanseth and K. Lyytinen (Guest eds.), *Information Technology & People* special issue on "Complexity and IT Design and Evolution", Vol. 19, No. 1.
- Jørgensen, U., Sørensen O.H. (1999), "Arenas of Development – A Space Populated by Actor-worlds, Artefacts, and Surprises", *Technology Analysis & Strategic Management*, Vol. 11, No. 3.
- Kahin, B., Abbate, J. (1995), *Standards Policy for Information Infrastructure*, The MIT Press, Cambridge, Massachusetts.
- Kallinikos, J. (1995), "The architecture of the invisible: technology as representation", *Organizations*, Vol. 2, No. 1.
- Kallinikos, J. (2005), "The order of technology: complexity and control in a connected world", *Information and Organization*, Vol. 15, pp. 185-202.
- Kallinkos, J. (2006), "Information out of information: on the self-referential dynamics of information growth", *Information Technology & People*, Vol. 19, No. 1.

- Katz, M.L., Shapiro, C. (1985), "Network Externalities, Competition, and Compatibility", *The American Economic Review*, Vol. 75, No. 3.
- Kauffman, S.A. (1993), *The Origins of Order*, Oxford University Press, New York.
- King, J. L., Lyytinen, K. (Eds.) (2006), Special Issue on "Standard-making: A Critical Research Frontier for Information Systems," *Management Information Systems Quarterly*, (Forthcoming)
- Klein, G.O. (2002), "Standardization of Health Informatics – Results and challenges", *Yearbook of Medical Informatics 2000*, pp. 103-114.
- Klein, H.K., and Myers, M.D. (1999), "A set of principles for conducting and evaluating interpretive field studies in information systems", *MIS Quarterly*, vol.23, no.1, pp.67-93.
- Kling, R., Scacchi, W. (1982), "The Web of Computing: Computer Technology as Social Organization", *Advances in Computers*, Vol. 21, pp. 1-90.
- Kosanke, K. (2005), "Standardization in Enterprise Inter- and Intraorganizational Integration", *Journal of IT Standards & Standardization Research*, Vol. 3, No. 2, pp. 42-50.
- Langley, A. (1999), "Strategies for Theorizing from Process Data", *Academy of Management Review*, Vol. 24, No. 4, pp. 691-710.
- Latour, B. (1987), *Science in Action*, Open University Press.
- Latour, B. (2005), *Reassembling the Social: An Introduction to Actor-Network-Theory*, Oxford University Press.
- Law, J. (1992), "Notes on the theory of the actor-network: ordering, strategy, and heterogeneity", *Systems Practise*, 5(4):379 – 393.
- Law, J. (1999), "After ANT: complexity, naming and topology", in J. Law & J. Hassard eds., *Actor Network Theory and After*, Blackwell Publishers.

- Law, J. (2002), *Aircraft Stories: decentering the object in technoscience*, Duke University Press.
- Law, J. (2004), *After Method: mess in social science research*, Routledge.
- Law, J., Bijker, W.E. (1992), "Postscript: Technology, stability and social theory". In *Shaping technology/building society*, ed. by W.E. Bijker and J. Law, 290-308. Cambridge, MA. MIT Press, 1992.
- Law, J., Hassard, J. (1999), *Actor Network Theory and after*, Blackwell Publisher.
- Law, J., and Urry J. (2004), "Enacting the Social", *Economy and Society*, Vol. 33, No. 3, 390-410.
- Lee, A. (1999), "Inaugural Editor's Comment", *Management Information Systems Quarterly*, Vol. 23, No. 1, March 1999.
- Lee, A.S., Baskerville, R.L. (2003), "Generalizing Generalizability in Information Systems Research", *Information Systems Research*, Vol. 14, No. 3, September 2003, pp. 221-243.
- Leiner, B.M., Cerf, V.G., Clark, D.D., Kahn, R.E., Kleinrock, L., Lynch, D.C., Postel, J., Roberts, L.G., Wolff, S.S. (1997), "The Past and Future History of the Internet", *Communications of the ACM*, Vol. 40, No. 2, pp. 102-108.
- Levitt, T. (1983), "The Globalization of Markets", *Harvard Business Review*, Vol. 61, May-June, pp. 92-102.
- Liebowitz, S.J., Margolis, S.E. (1995), "Path Dependence, Lock-In, and History", *The Journal of Law, Economics, & Organization*, Vol. 11, No. 1.
- Lyytinen, K. (1987) "A Taxonomic Perspective of Information Systems Development: Theoretical constructs and recommendations". In Boland, R. J. og Hirschheim, R. A. (red.): *Critical Issues in Information Systems Research*. John Wiley & Sons Limited.

- McKelvey, B. (2004a), "Toward a 0th law of thermodynamics: Order-creation complexity dynamics from physics & biology to bioeconomics", *Journal of Bioeconomics*, Vol. 6 No. 1, pp.65-96.
- McKelvey, B. (2004b), "Towards a Complexity science of entrepreneurship", *Journal of Business Venturing*, Vol. 19, No. 3, pp. 313-341.
- Mingers, J. (1984), "Subjectivism and soft systems methodology – a critique", *Journal of Applied Systems Analysis*, Vol. 11.
- Mintzberg, H. (1992), *Structure in Fives: Designing Effective Organizations*, Prentice Hall.
- Misa, T.J., Brey, P., Feenberg, A. (2003), *Modernity and Technology*, The MIT Press, Cambridge Massachussets.
- Mitleton-Kelly, E. (2003), *Complex Systems and Evolutionary Perspectives of Organizations*, London: Elsevier.
- Mol, A. (2002), *The Body Multiple: Ontology in Medical Practice*, Durham, NC and London: Duke University Press.
- Mol, A., Law, J. (2002), "Complexities: An Introduction", in J. Law & A. Mol eds., *Complexities: social studies of knowledge practices*, Duke University Press.
- Monteiro, E., (2000), "Actor-network theory", In: C. Ciborra (ed.), *From control to drift. The dynamics of corporate information infrastructure*, Oxford Univ. Press, 2000, pp. 71 - 83.
- Monteiro, E., Hanseth, O. (1995) "Social shaping of information infrastructure: on being specific about the technology", In Orlikowski, W., Walsham, G., Jones, M.R. and DeGross, J.I. editors *Information technology and changes in organizational work*, Chapman & Hall, pp. 325 — 343.
- Mulgan G.J., (1991), *Communication and Control*, Polity Press.

- Orlikowski, W.J., Iacono, C.S. (2001), “Desperately Seeking the “IT” in IT Research – A Call to the Theorizing of the IT Artifact”, *Information Systems Research*, Vol. 12, No. 2.
- Perrow, C. (1984), *Normal Accidents: Living with High-Risk Technologies*, Princeton University Press.
- Pollock, N., Williams, R. (*forthcoming*), “Global Software and its Provenance: Generification Work in the Production of Organizational Software Packages”, *Social Studies of Science*, (*forthcoming*).
- Pollock, N., Williams, R., Procter, R. (2003), “Fitting Standard Packages to Non-standard Organizations: The ‘Biography’ of an Enterprise-wide System”, *Technology Analysis & Strategic Management*, Vol. 15, No. 3, September 2003.
- Rolland, K.H. (2003), *Re-inventing Information Infrastructure in Situated Practices of Use: An Interpretive Case Study of Information Technology and Work Transformation in a Global Company*, PhD. Thesis, University of Oslo, Oslo, Norway.
- Rolland K. H., Monteiro E., (2002), “Balancing the Local and the Global in Infrastructural Information Systems”, *The Information Society*, Vol. 18:87-100.
- Sachsenmaier, D., Riedel, J., with Eisenstadt, S. N. (2002), *Reflections on Multiple Modernities*, Brill.
- Schmidt, S.K., and Werle, R. (1992), “The development of compatibility standards in telecommunication: conceptual framework and theoretical perspective”. In *New technology at the outset: social forces in the shaping of technological innovations*, ed. By M. Dierkes and U. Hoffmann, New York: Campus Verlag, pp. 301-26.
- Schmidt, S.K., and Werle, R. (1998), *Coordinating Technology*, MIT Press.
- Schneberger, S.L., McLean, E.R. (2003), “The Complexity Cross – Implications for Practice”, *Communications of the ACM*, Vol. 46, No. 9, pp. 216-225.
- Shapiro, C., Varian, H. (1999), *Information Rules*, Harvard Business School Press.

- Shaw, V., Jacucci, E., Braa, J. (2005), "The Evolution of a Framework for Assessing Hospital Information Systems in South Africa", In: Abiodun, O. B. (ed.), *Proceedings of the IFIP 9.4 Working Conference on Enhancing Human Resource Development through ICT*, Abuja, Nigeria, May 2005.
- Simon, H. (1962), "The Architecture of Complexity", *Proceedings of the American Philosophical Society*, Vol. 106, No. 6, December 1962.
- Stacey, R.D. (1995), "The Science of Complexity: An Alternative Perspective for Strategic Change Processes", *Strategic Management Journal*, Vol. 16, No. 6, pp. 477-495.
- Star, S.L. (1999), "The Ethnography of Infrastructure", *American Behavioral Scientist*, Col. 43 No.3, pp 377- 391. New York: Sage Publications, Inc.
- Star, S.L., Ruhleder, K. (1996), "Steps Toward an Ecology of Infrastructure: Design and Access for Large Information Spaces", *Information Systems Research*, Vol. 7, No. 1, March 1996.
- Strand, J. (2005), "Applications Outsourcing: the Standardization Challenges of Global Contractors", *Master Thesis*, Department of Informatics, University of Oslo, Norway.
- Strauss, A. (1993), *Continual Permutation of Action*, New York.
- Thietart, R.A., Forgues, B. (1995), "Chaos Theory and Organization", *Organization Science*, Vol. 6, No. 1, pp. 19-31.
- Timmermans, S., and Berg, M. (1997), "Standardization in Action: Achieving Local Universality through Medical Protocols", *Social Studies of Science*, Vol. 27, pp.273-305.
- Timmermans, S., Berg, M. (2003), *The Gold Standard: The Challenge of Evidence-based Medicine and Standardization in Healthcare*, Temple University Press.
- Urry, J. (2003), *Global Complexity*, Polity Press.

- Urry, J. (2005), "The Complexities of the Global", *Theory, Culture & Society*, Vol. 22, No. 5, pp. 235-254.
- U.S. Congress (1992), *Global Standards: Building Blocks for the Future*, Office of Technology Assessment, TCT-512, Washington DC, U.S. Government Printing Office, March 1992.
- Walby, S. (2003), "Modernities/Globalization/Complexities", published by the Department of Sociology, Lancaster University, at www.lancs.ac.uk/fss/sociology/papers/walby-modernitiesglobalisationcomplexities.pdf.
- Walsham G., (1992), "Decentralization of Information Systems in DC's: Power to the People?", in *Social Implications of Computers in Developing Countries*, S.C. Bhatnagar and M. Odedra (eds.), Tata McGraw Hill, India.
- Walsham, G. (1993), *Interpreting Information Systems in Organizations*, Wiley, 1993.
- Walsham, G. (1995a), "The Emergence of Interpretivism in IS Research", *Information Systems Research*, Vol. 6, No. 4, pp. 376-395.
- Walsham, G. (1995b), "Interpretive case study in IS research: nature and method", *European Journal of Information Systems*, Vol.4, 1995, pp.74-81.
- Walsham, G. (1997), "Actor-Network Theory and IS research: Current status and future prospects," in A. S. Lee, J. Liebenau, and J. I. DeGross (Eds.) *Information systems and qualitative research*, London: Chapman and Hall, pp. 466-480.
- Walsham, G. (2002), "Interpretive Case Studies in IS Research; Nature and Method", in Myers M. and Avison D. (Eds.), *Qualitative Research in Information Systems*, Sage Publications.
- Walsham, G. (2005), "Development, global futures and IS research: a polemic", *Journal of Strategic Information Systems*, Vol. 14, p. 5-15.
- Walsham, G., Symons, V., Waema, T. (1988), "Information Systems as Social Systems: Implications for Developing Countries", *Information Technology for Development*, Vol. 3, No. 3.

- Walters, P.G.P., Toyne, B. (1989), "Product Modification and Standardization in International Markets: Strategic Options and Facilitating Policies", *Columbia Journal of World Business*, Winter 1989.
- Weber, M. (1958), *The Protestant Ethic and the Spirit of Capitalism*, New York: Scribner's. First published in 1905.
- Webster, F. (1995), *Theories of the Information Society*, Routledge.
- West, L. (2003) "The Role of Standards in the Creation and Use of Information Systems", in *Proceedings of the Workshop on Standard Making: A Critical Research Frontier for Information Systems*, John L. King and Kalle Lyytinen, (eds.), Seattle, WA, December 12-14, 2003, pp. (314-326), <http://www.si.umich.edu/misq-stds/proceedings>.
- WHO, (2000), *Design and Implementation of Health Information Systems*, World Health Organization, Geneva, Switzerland.
- Whyte, W.F. (1997), *Creative Problem Solving in the Field*, Altamira Press, Sage Publications.
- Williams R., Bunduchi, M.G., Graham, I., Pollock, R., Procter, R., Voss, A. (2004), "Understanding the Evolution of Standards: Alignment and Reconfiguration in Standards Development and Implementation Arenas", *Proceedings of the 4S/EASST Conference*, Paris, August 27-29, 2004.
- Wintherheik, B.R., Vikkelso, S. (2005), "ICT and Integrated Care: Some Dilemmas of Standardizing Inter-Organizational Communication", *Computer Supported Cooperative Work*, Vol. 14, No. 1, pp. 43-67.
- Xia, W. and Lee, G. (2004), "Grasping the complexity of IS development projects", *Communications of the ACM*, Vol. 47 No. 5, pp.68-74.
- Yin, R.K. (1989), *Case Study Research – Design and Methods*, Newbury Park, California, Sage Publications.

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¹ In 2002 I have changed my last name from Iacucci to Jacucci.



Bootstrapping the Electronic Patient Record Infrastructure

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Abstract. The development and implementation of Electronic Patient Records (EPR) in Hospitals have been challenging tasks in the last thirty years. EPR is a complex artifact which is supposed to change complex practices in Hospitals. The complexity of the task is increased by the criticality of the work which is pursued and by the interconnectedness of social, technical, and organizational actors. Thus the implementation of the EPR in a Hospital can hardly be categorized as one of a series of sequential phases of the innovation process. Accordingly, a different perspective on the implementation process and tactics is required. By presenting the case of the implementation of an EPR at a Hospital in Norway, the paper attempts to validate the perspective on EPR implementation as a bootstrapping process of an Information Infrastructure.

1 Introduction

In the last decade in Norway most Hospitals have adopted IT solutions as EPR systems (Ellingsen and Monteiro 2001; Lærum et al. 2001). Their diffusion is frequently pushed by a vision of considerable time and cost savings, of increased quality of health work, and of a seamless integration with the existing local systems. On the other hand the high complexity of the technology and possibly not adequate implementation strategies have led to failures (Ellingsen and Monteiro *forthcoming*; Berg 2001). Moreover, EPR systems have often been seen as mere technical artifacts and this has limited developers' and implementers' vision of their real complexity. More recently EPRs have been studied from a socio-technical perspective widening the scope of analysis, design, and intervention from that of a system to that of a (actor-) network perspective (Berg et al. 1998; Berg 1999).

The degree of complexity and heterogeneity of this technology resembles the one of an Information Infrastructure (Monteiro and Hanseth 1995; Ciborra 2000). According to this framework, the EPR (as

Information Infrastructure) is an *enabling, shared, open, heterogeneous socio-technical network* built on an *installed base* (Aanestad et al. *forthcoming*). An infrastructural interpretation of the EPR implies its understanding as layers on an already existing installed base of technologies, processes, people, standards and knowledge. In this view the implementation process is considered to be more than simply changes in work practices and routines, which are required when shifting from a paper-based record to an electronic solution.

The aim of this paper is to show how the concept of *bootstrapping*, already recognized as valuable in understanding the development of Information Infrastructures (Hanseth and Aanestad *forthcoming*), can bring new insights to the understanding of the innovation process related to the implementation of a new technology. Specifically, the case analyzed is the implementation process of a new EPR system into a major Norwegian Hospital. The paper presents first a critical literature review of main assumptions in innovation theory, proposes a new framework building on the concept of cultivation, and analyses the case in the light of bootstrapping.

2 Theoretical Framework

2.1 From Diffusion of Innovation to Cultivation

Diffusion, adoption and implementation have always been considered both problematic and important phases in the lifecycle of an Information System (IS) (O'Callaghan 1998). Much research has been done on these issues, yet the research field needs further investigation (Fowler 1995). In the literature there is no unique definition of terms as 'diffusion', 'adoption', 'implementation', and 'innovation' and many different perspective have been adopted (e.g. O'Callaghan 1998; Rogers 1995; Swanson E.B. 2001). Generally, with the term 'diffusion' it is understood the process by which an innovation (a new product or service) is "[...] communicated through certain channels over time among the members of a social system [...]" (Rogers 1995, pp. 5-6). 'Adoption' refers to the decision of the member to adopt or reject the proposed innovation. Finally, 'implementation' occurs when an individual (or the decision unit) puts the innovation into use (Rogers 1995). Several studies both quantitative and qualitative have been conducted focusing on the interdependencies of organizational and technological characteristics and with the aim of generating models for intervention (see for example: Kautz and Heje 1995; Rogers 1995).

It might be argued that within the Diffusion Of Innovation (DOI) IS research field, much of the theories in use are not properly considering the socio-organizational dimension. Rogers, for instance, considers the organizational implications of the introduction of a new technology, but his view of the innovation process is quite unproblematic. He argues that an innovation process should be achieved with the completion of five phases (Rogers 1995). This process is divided in two broad activities: (1) the "initiation"; and (2) the "implementation". The initiation activity is composed by the "agenda-setting" and the "matching" phase. In this two phases information is gathered, the innovation conceptualized and the adoption planned. At the end of this activity the decision about the adoption is taken. Eventually, the adoption takes place in the second broad activity, which consists of a "redefining/restructuring" phase, the "clarifying" phase, and the "routinizing" phase. In the first of these three phases the innovation and the organization are mutually adapted. In the second phase the

“[...] relationship between the organization and the innovation is defined more clearly”. In the last phase the “[...] innovation becomes an ongoing element in the organization’s activities [...]” and loses identity (Rogers 1995, p. 392). Rogers’ approach to the adoption of a new technology in the organization has been criticized of being too simplistic and not providing a sufficiently detailed account on the nature of the “relationship” between innovation and organization and their mutual adaptation (Robertson et al. 1995).

Alternative approaches to innovation have been developed in the literature that deals with innovation processes related to the introduction of complex technologies. These alternative approaches develop from a major critique moved to the DOI (Diffusion Of Innovation) IS research field that points at limitations when dealing with complex and networked technologies, such as EDI (Electronic Data Interchange) (Lyytinen and Damsgaard 2001). Lyytinen and Damsgaard argue that this view of IT risks being too simplistic and rigid. A suited alternative framework to the “diffusion theory” for the understanding of IT innovation processes is Actor Network Theory (ANT) that interprets ‘technology transfer’ as ‘translation processes’, namely a process of continuous negotiation and alignment of interests (McMaster et al. 1997; Latour 1987).

Monteiro and Hepsø discuss diffusion in relation to an infrastructure technology, pointing at the articulation of the process of diffusion when dealing with such complex network technologies (Monteiro and Hepsø 1998). They explicitly discuss four aspect of the process: the socio-technical negotiations that are implied in the nature of diffusion; the need for continuous re-appropriation and re-confirmation of the infrastructure which shows in forms of gray, invisible work; the drifting of the infrastructure showed by the presence of episodic opportunities that are improvised and bundled to align them with the installed base; and the use of gateways as drastic measure to forge compromises or side-step confrontations. This analysis emphasizes how the more ISs become similar to infrastructures, the more the concept of innovation diffusion drifts from one of a process bound in time and space, to one of an ongoing process of negotiations. Furthermore, this shift from a ‘systems’ theory to an ‘infrastructure’ theory calls for a new perspective on the nature of innovation. The answer we propose may be found in a view on innovation as an ongoing process of ‘cultivation’ (Hanseth 2002).

In the following section we will describe in greater detail the concept of cultivation and the process of bootstrapping in the framework of IT as Information Infrastructure.

2.2 Information Infrastructures Cultivation and Bootstrapping

To view ISs as Information Infrastructures (II) is to acknowledge their increasing complexity in terms of technical as well as social entities. IIs have much in common with the traditional understanding of infrastructures as large, underlying structures enabling different functions in various contexts, for instance railroads, sewerage system, electrical and communication networks. The common tendency is to ignore them and take them for granted until breakdowns attract our attention. A peculiarity of IIs is their nature of being heterogeneous networks: an II in fact consists of multiple interdependent elements interconnected in a socio-technical network. Each element plays a role by influencing and being influenced by other elements, so that it is not possible to change a part of the network without affecting all the other parts. The heterogeneous character lies in that elements can be humans, artifacts, organizations, institutions, standards and so on. In ANT terminology, an II constitutes an aligned actor network, as excellently analyzed and described by Monteiro (Monteiro 2000).

Given the high degree of complexity embedded in an II, how can an II be ‘designed’, ‘changed’, and in general ‘innovated’? A central concept in II is that of the ‘evolving installed base’ as emphasized by Hanseth (Hanseth, 2002). Therefore to be engaged in a process of change of an II, implies having to deal with the existing installed base of users, standards, technical components, work practices. Cultivation is a metaphor that suites such view of “[...] the installed base as a sort of a living organism that can be cultivated, rather than some dead material to be designed” (Hanseth 2002). Cultivation implies that the evolving socio-technical network cannot be fully controlled, but designers do have influence in the change processes. In this framework, the implementation of a ‘new’ information system implies leveraging the installed base of the existing infrastructure and therefore inducing a growth in the size of the network. This requires also initiating an alignment process from and with the new system that may imply a migration of users of a previous system and a shift from practices in use to new ones. This process can be explained in the light of a ‘bootstrapping logic’.

Hanseth and Aanestad explore the idea of bootstrapping observing the process of development of an II for Telemedicine (Hanseth and Aanestad *forthcoming*). They explain how the logic behind it, is of a careful and incremental process of mutual alignment of a new technology to the installed base. In this way an II is developed through progressively facilitating the migration of the installed base to the use of a new technology (and consequently of new work-practices) by supporting a careful process of translations. In this context, the term bootstrapping emphasizes the exploitation of the mechanisms, such as positive externalities, that make networks increasingly attractive as they grow. This leads to the need for guidelines on how to facilitate this exploitation in a design-as-bootstrapping perspective. Hanseth and Aanestad argue that this is possible as they identify tactics for initiating the bootstrapping process (Hanseth and Aanestad *forthcoming*; Hanseth *forthcoming*). Such tactics can be summarized and categorized as follows:

- 1) *Use*: Target the users for which the infrastructure (the new system) is useful even with a small number (i.e. installed base) of other users
- 2) *Use*: Start with motivated and knowledgeable users
- 3) *Use*: Start from a use area which is low in complexity and criticality and which does not require radical organizational change
- 4) *Design*: Design the solution so that it is useful for some users without an existing installed base
- 5) *Design*: The infrastructure (or new system as part of it) should be as simple, as cheap, and as flexible as possible. Subsequently move to more complex solutions
- 6) *Design*: Build on an installed base as far as possible
- 7) *Design*: Increase usefulness of the ‘new’ infrastructure by establishing gateways to already existing infrastructures

This logic is based also on the underlying recognition that often implementation and in general innovation processes grow outside of a central control and live their own life. On the contrary, attempts to centralize control of the innovation can result in failures (Ciborra 2000).

The guidelines above, far from being complete and prescriptive, do contribute to the understanding of how to approach complex socio-technical networks such as II. We will use them in the analysis of the case that presents the implementation process of an Electronic Patient Record as new layer of the Hospital’s II. We will illustrate how this can be interpreted as a case of bootstrapping, and how this perspective is valuable in analyzing how this process of innovation takes place.

3 Research Methodology

The research adopts an interpretive approach to case study (Walsham 1993; Walsham 1995). The empirical data has been collected using qualitative methods, namely recorded semi-structured interviews, reading of documents, and reading of e-mail exchange.

The field-site is Rikshospitalet (a Hospital in Oslo, Norway), where the implementation of a new EPR system is taking place. The Hospital counts 17 different clinical departments and several other service departments. Among the service departments is the IT department which is in charge of the implementation of the EPR. The fieldwork aimed at analyzing the implementation process both observing the process going on in the clinical departments, and understanding the perspective, actions and plans of the IT department. Among the departments, a sample of three clinical departments has been chosen for in depth study: the Rheumatology department, the Dermatology department, and the Pediatric Cardiology department.

This sample has been selected with the purpose of analyzing the implementation in departments which had both different clinical characteristics, as well as a different implementation stage. In particular, the Rheumatology department experienced the implementation of the EPR very early in the project (in 1997) and can be considered to be now an experienced user. The Pediatric Cardiology department has experienced the implementation only in spring 2002, and it can therefore be considered a new user. The Dermatology department represents a middle stance, having experienced the implementation in 2001. Furthermore, the three departments offer an interesting variety of characteristics which allow studying the effect of the implementation in various directions.

The interviews in the clinical departments involved seven doctors and four assistants. Numerous meetings and seminars were held with the responsible of organizational change of the EPR implementation project in the IT department of the Hospital. One interview was also made with the responsible for training of the users, in the IT department.

All interviews have been recorded on MiniDisc and transcribed into detailed report. The reports have circulated among the researchers of the group and frequent discussions have been made on the collected data.

Moreover, the EPR system “rationale” document has been analyzed. E-mail exchange between the IT department and three clinical departments about complaints and negotiation of integration of the EPR with local systems have been analyzed. Finally, reports from fieldwork performed by Master students of the same institutions to which the authors are affiliated have been analyzed. The reports were made in 1996 (the beginning of the EPR implementation) and in 1998. The fieldwork concerned various aspects of the implementation of the EPR and a detailed analysis of the clinical departments were the interviews were held.

The research project started in October 2001 and is set on a long term basis. Fieldwork is still ongoing and the fieldwork range will be enlarged to new departments and new analysis approaches will be introduced.

4 The Case: EPR Implementation at Rikshospitalet in Norway

4.1 Background

Rikshospitalet is a Hospital in Oslo (Norway) that counts approx. 4500 employees of which around 3500 have been targeted as users of the new EPR.

The EPR implementation started in 1996 as part of a national project involving 5 university based Hospitals. The history of this large project has been documented and analyzed by Ellingsen and Monteiro (Ellingsen and Monteiro 2001). They rightly point at the complexity of the history of EPRs in terms of competing agendas and range of actors, and to the tendency in Norway to privilege large comprehensive initiative, rather than small scale, bottom up evolutionary approaches. The case we study is of large scale for what concerns the size of the hospitals as well as the number and heterogeneity of actors involved. The project has started with grand visions as it is guided by a “rationale” of the system as one that should “[...] enable major organizational changes (but not require or impose them!) [...]”, and it “[...] should support all basic information processing activities required by health care professionals, at least as well and as fast as the current paper-based record system [...]”. Moreover should it be “[...] simple and fast to learn and use in daily work [...]”.

The design philosophy of the system is to have an EPR which implements a “Paper Record metaphor” so that the forms on the screen look exactly as they were used to be on paper and very familiar to users. However the EPR is supposed to be more than its paper counterpart and be used as a multipurpose tool to support patient care and improve its quality; to enhance the productivity of health care professionals and reduce administrative cost associated with health care delivery; to support clinical and health services research.

As from the initial plan, the final product should have been delivered in December 1999 and the project ceased. At the present, spring 2002, the project is not yet closed and the final product has not yet been delivered.

In the first months of 2002 Hospitals’ goals and strategies and consequently the logic behind the implementation process have been significantly influenced by a new national health-policy. The new policy resulted in a general shift in the priorities of the health care sector from quality of the service to costs savings and efficiency. As a result the management of Rikshospitalet decided to be more involved in the EPR project and it is boosting its accomplishment by means of financial and structural resources. The administration department of the Hospital, once marginally interested in the EPR implementation, has now taken a more active role. The motivation for the implementation and the commitment to its success has sensibly increased.

As a result, the adoption rate of the EPR that has been extremely slow in the time frame 1997-2001 increased sensibly during the spring 2002. In the 1997-2001 period only 6 clinical departments have been involved in the implementation, and at the end of 2001 the system was used by approx. 400 users. At present, in less than four months, the actual users of the system are over 1500 (data from end of April 2002). The aim is to complete the implementation within year 2002.

4.2 The IT Department Perspective

The IT department has been actively involved in the implementation since 1996. Initially they decided to adopt an in-depth implementation strategy focusing on one department at the time. On the agenda for the implementation for each department the items were: (1) upgrading of the technical infrastructure, if required; (2) installation of the package; (3) customization to local needs; (4) integration with local systems. This first strategy proved to be problematic both in terms of planning and in terms of resources. Particularly during step (3) and (4) the complexity always increased and the process critically slowed down. Moreover in the period between 1996 and 2001 personnel and financial resources were lacking and consequently it was difficult to properly face the complexity of new arising problems. At the beginning of year 2002 only about 400 users out of 3500 were reached.

The availability of resources and a different strategy helped the implementation to take off in early spring 2002, reaching in May more than half of the target users (about 1700). The new strategy consisted in reaching as soon as possible all the departments with a big-bang implementation, but limiting it to items 1 and 2 and leaving customization and integration next. Basically this meant to implement a thin layer of functionality with which the users could start working, and leave more complex functionality and customizations for later stages.

When going into a department to start the implementation, the personnel of the IT department checks first the status of the existing technical infrastructure in terms of computer and networking power and provide upgrading where necessary. Subsequently, the implementation takes place and a reference person (among the users) is chosen as primary contact for the communications between the Clinical and the IT department. Each department is then closely followed for a period of two months in order to overcome technical and use breakdowns.

Compared to the period 1996-2001, the increased resources available allow building a redundant support infrastructure of people and tools that appears to be sufficient for the time being to handle any problem.

The implementation was always preceded by an introductory course of 4 hours. During this training the basic functionality of the system are shown and possibilities for limited but substantial personal customization is demonstrated. Lately most of the doctors have attended the course, although some of them managed to learn to use the system by themselves. For nurses and assistants in some cases a pre-course on basic knowledge about computers was needed. No other training is planned after this session.

4.3 The Clinical Departments Perspective

Overall, in the clinical departments we have selected, the situation we found is quite positive.

4.3.1 The Rheumatology Department

The Rheumatology department has started to use the system in 1997. As today, the impression is that the system is smoothly part of users' daily work practices. Still they had to shift from the Electronic to the Paper Patient record, since the records from departments which did not adopt the system yet were not available electronically. Surgeons pointed out that their notes in paper records were easy to browse because they had a different color and thus easy to find. In the electronic version this trick is not available, and they have to use search queries for retrieving the data.

Significant benefits in time saving and quality of work are underlined by all the interviewees. Still, the need to refer to the paper record for viewing notes about the treatment from other departments which are not on the EPR, do cause occasional problems.

Some need for coordination with other departments for interdisciplinary treatment is shown and in some cases limits or new development opportunities of the EPR are drawn. Some of these practices, which require a certain kind of workflow, are usually supported by the use of the e-mail and phone. In other cases, such as the treatment of patients by Physiotherapists after a surgical operation, the interaction and the paper work is not yet supported by the EPR. Additionally, in this latter case the need for drawings in the communication between the departments is currently not supported.

4.3.2 The Pediatric Cardiology Department

The Pediatric Cardiology department is a relatively small department and has started to use the EPR very recently, in late February 2002. Here a local system called Berte, is in use since 1990 basically a local patient record system, so that some of the functionalities of the two systems are overlapping. It is currently planned to integrate Berte with the new EPR through a kind of gateway. For the moment the gateway is the mind of the users that have to switch from one system to the other in their practices. At present, the picture that emerges is that the EPR will hardly be as good and as customizable as the local system is for the specific tasks of this department. On the contrary, it appears that the EPR, far from being an all-encompassing standard, will be integrated gradually with existing local practices and systems.

The Pediatric Cardiology department has limited but focused needs for inter-departmental cooperation, mainly with the Cardiology department. Often the paper record contains drawings and sketches which are currently not supported in the EPR but can be scanned into the local system. The local system, as locally developed by the doctors themselves, has inscribed very peculiar codes which allow a doctor to tell the whole history of a patient in terms of diagnoses, operations, results, and further diagnoses in one single line. An example of that is the following:

“Ca A-Rep, Hypop IMV, VAost, Re-cast (Shone-kompl) Op-coss, Graftstenose”

The interviewee argued that this is somehow a local language but basically any Pediatric Cardiologist in the world should be able to translate it into plain words. The possibility to customize the local system to very particular needs and work-practices significantly increased the quality of the treatment. It remains to see whether and how the local and the EPR system can be integrated.

4.3.3 The Dermatology Department

The fieldwork at the Dermatology department is still at an early stage, but there are instances that it might be a similar case as the Rheumatology department.

4.3.4 Integration of Local Systems

Similar negotiations (or small standards wars) as the one described above from the Pediatric Cardiology department are under observation. From the meetings and e-mail exchanges what emerges is the ‘fear’ of users of local systems to lose the richness and quality of their system to gain an interconnected but less effective system (the EPR). Most negotiations are still in an early stage, but the intention of the IT department is of respecting and integrating local realities. To this respect, the openness of the EPR as a system and its adaptability are paramount.

In all three departments, a common need is the integration of the EPR with Hospital wide clinical systems such as the Laboratory Results system (for fluid analysis) and the X-Ray system.

The research is in progress and many more aspects need to be studied more in depth.

5 Discussion

An infrastructural perspective on EPR allows further investigation on the implementation of such infrastructure in terms of bootstrapping of a 'new' installed base. We submit that the implementation process described above can be consistently interpreted as a phenomenon of bootstrapping. To show this we will go through the main characteristics of a bootstrapping strategy and compare them with the implementation strategies presented in the case.

5.1 Alignment, Migration, and Translation

The development history of the EPR as a system to be used in Norwegian Hospitals shows how users have been actively involved in the process thus facilitating the alignment of user needs and system capabilities. The result is a system which basically supports the already existing work-practices and which is requiring little organizational change. The migration to the Electronic version of the Patient Record is therefore facilitated and no major problems have been identified so far. The translation of the users' interests and needs happened both in the development phase and in the implementation phase. There are still negotiations going about customizations and systems integration. They are seen as necessary and useful steps towards the completion of the alignment.

There are nevertheless two open issues which need to be further investigated: (1) the transition and adaptation of 'all' of the practices which are currently supported by the paper record in a totally digitalized and automated environment; (2) the possibility to use the system to support new organizational and work arrangements. Concerning the first point, it is still to be seen whether a complete transition to the Electronic Record is possible and thus if the paper version can be completely and efficiently substituted. Regarding the second point, the careful alignment of the system with the current organizational practices can be a short term benefit (in terms of acceptance of the system) but can also constitute a limitation if the system is not open and plastic enough to evolve in new forms (e.g. going beyond the easy but limiting paper metaphor of the interface). The EPR is a connecting network which (similarly to the Internet) is opening new unforeseen possibilities of development.

5.2 Implementation Tactics

In this section we will discuss each point listed in the theoretical chapter regarding tactics for implementing the bootstrapping.

5.2.1 Users

- 1) *Initial users*: The infrastructure is immediately useful for the user in each department, even if other departments are not attached to it. Major reason being that doctors in a department mainly work on the part of the patient record created by the same department they belong to.

- 2) *Motivation*: Motivation is present in both management and users. It is important to note that motivation for further adoption does not incur in early phases. The benefits for one department of having all departments on the EPR are visible only once the system is first internalized in the department. Additionally, new users are not always motivated but forced from management and from rules and laws. In a way the motivation of the management is inscribed in the implementation process by forcing it. In other words, departments have no choice.
- 3) *Low Complexity and Criticality*: Each clinical department is in some ways complex and critical. Nevertheless an intentional choice of starting from relatively less critical departments has been made. The approach of postponing customization and local integration has also reduced the complexity of the tasks to be initially supported by the EPR.

5.2.2 Design

- 4) *Design for few users*: This is related to point 1. The system runs well and is useful even if implemented in one department. Yet, the following condition must be satisfied: all the users of that department must migrate to the system simultaneously.
- 5) *Simplicity and flexibility*: Far from being cheap, the system (as part of the II) is nevertheless very easy to learn. Its flexibility still needs to be tested, both in technical terms and in the way it can support new (and unplanned) ways of working.
- 6) *Build on Installed Base*: The development and implementation history of the system and the philosophy behind it are a clear statement of the interest of ‘respecting’ and leveraging the existing installed base of users, practices and systems.
- 7) *Gateways*: The vision of one single and complete system for all the departments and practices is certainly changing to a more open vision of modularity and integration. The EPR is currently under scrutiny with regards of its ability to be integrated with other systems inside and outside the Hospital.

6 Conclusions

In the case of the implementation and adoption of an EPR a different framework from the traditional “system” perspective is provided. Due to its complexity and the complexity of the environment in which it is introduced, the EPR is better seen as part of a socio-technical actor network. This concept can be further developed to comprehend the conceptual framework of Information Infrastructures. In this case the implementation and adoption process and the organizational change process related to it, can be interpreted as bootstrapping of a ‘new’ installed base of an existing infrastructure.

The view of the EPR as an integrated part of a larger Information Infrastructure opens up a new perspective on the whole innovation process. Accordingly, the classical phases of design, development, diffusion, adoption, and implementation merge into an ongoing process of alignment and translation. The first step into an infrastructural innovation can be achieved through a bootstrapping logic. But this process can be hardly matched in one of the mentioned innovation categories. The case shows that so far this logic can be recognized in the current implementation process. Nevertheless, the further development of the infrastructure, that is its cultivation, will stress

the ability of the implemented system (the EPR) to adapt and evolve, i.e. to align, with the evolving installed base.

The bootstrapping process and, more generally, the concept of cultivation open up a totally new perspective on the nature and the dynamics of the innovation process. Further research is needed in order to relate these new concepts with the traditional vision of innovation.

The research presented is still in an early phase and what has been reported here represents preliminary analysis of the data collected so far.

7 References

- Aanestad M., Grisot M., Nilsson A., (*forthcoming*), Electronic Patient Records – an Information Infrastructure for health care, Proceedings of the 25th edition of IRIS, Denmark
- Berg M., (1999), *Patient Care Information Systems and Health Care Work: A Sociotechnical Approach*, International Journal of Medical Informatics, 55, pp 87 -101.
- Berg M., (2001), *Implementing Information Systems in Health Care Organizations: Myths and Challenges*, International Journal of Medical Informatics
- Berg M., Langenberg C., Berg I., Kwakkernaat J., (1998), *Considerations for sociotechnical design: experiences with an electronic patient record in a clinical context*, International Journal of Medical Informatics 52 (1998), pp 243-251.
- Ciborra C., (2000), *From Control to Drift The Dynamics of Corporate Information Infrastructures*, Oxford University Press
- Ellingsen G. and Monteiro E., (*forthcoming*), A patchwork planet. Integration and cooperation in hospitals, Computer supported cooperative work: the journal, (In press)
- Ellingsen G., Monteiro E., (2001), “Big is beautiful: electronic patient records in large hospitals in Norway 1980s-2000”, International Conference on IT in Healthcare, September 2001, Rotterdam, Netherlands
- Fowler, P. (1995), *The challenge of information technology transfer and diffusion*, in Kautz K. and Heje J.P. (eds.), “Diffusion and Adoption of Information Technology”, IFIP, Chapman & Hall
- Hanseth O., (2002), *From Systems and Tools to Networks and Infrastructures – from design to cultivation. Towards a theory of ICT solutions and its design methodology implications*, working paper downloadable at: <http://www.ifi.uio.no/~oleha/Publications/> , last accessed 4/6/2002
- Hanseth O., Aanestad M., (*forthcoming*), *Bootstrapping networks, communities and infrastructures. On the evolution of ICT solutions in health care*, Methods of Information in Medicine
- Kautz K., Heje J.P., (1995), *Diffusion and Adoption of Information Technology*, IFIP, Chapman & Hall
- Latour B., (1987), *Science in Action*, Open University Press
- Lyytinen K., Damsgaard J., (2001), *What's wrong with the Diffusion of Innovation Theory?*, in “Diffusing Software Product and Process Innovations”, Ardis M. A. and Marcolin B. L. eds., Kluwer Academic Publishing
- Lærum H., Ellingsen G., Faxvaag A., (2001), *Doctors' use of electronic medical record systems in hospitals: cross sectional survey*, British Medical Journal, volume 323, 8 December 2001.
- McMaster T., Vidgen R.T. and Wastell D.G., (1997), *Technology Transfer – Diffusion or Translation?*, in “Facilitating Technology Transfer through Partnerships”, McMaster T. et al. eds., Chapman & Hall
- Monteiro E., (2000), *Actor-Network Theory and Information Infrastructure*, in Ciborra C. (ed.), “From Control to Drift: the Dynamics of Corporate Information Infrastructures”, Oxford University Press

- Monteiro E., and Hanseth O., (1995), *Social shaping of information infrastructure: on being specific about the technology*, in Orlikowski, Wanda J., Geoff Walsham, Matthew R. Jones and Janice I DeGross. *Information Technology and Changes in Organizational Work*. Chapman & Hall, 1995, p.325 – 343
- Monteiro E., Hepsø V.,(1998), Diffusion of infrastructure: mobilisation and improvisation In Information systems: current issues and future challenges , Proc. IFIP WG 8.2 & 8.6, T. Larsen L. Levine (eds.), IFIP 1998, pp. 255 – 274
- O’Callaghan R., (1998), *Technology Diffusion and Organizational Transformation: An Integrative Framework*, in “Information Systems Innovation and Diffusion”, Larsen T. J. and McGuire E. eds., Idea Group Publishing
- Robertson M., Swan J., Newell S., (1995), *Interorganizational Networks and the diffusion process: the case of the networks not working*, in Kautz K. and Heje J.P. (eds.), “Diffusion and Adoption of Information Technology”, IFIP, Chapman & Hall
- Rogers E.M., (1995), *Diffusion of Innovations*, 4th edition, Free Press
- Swanson E. B., (2001), *Telling an Innovation Story*, in “Diffusing Software Product and Process Innovations”, Ardis M. A. and Marcolin B. L. eds., Kluwer Academic Publishing
- Walsham G., (1993), *Interpreting Information Systems*, Cambridge University Press
- Walsham G., (1995), *Interpretive case studies in IS research: nature and method*, European Journal of Information Systems (1995) 4, 74-81

Appendix 2

Jacucci, E. (2004), “Temporal Disclosedness of Innovations: Understanding Innovation Trajectories in Information Infrastructures”, In: Fitzgerald, B., Wynn, E. (eds.), *IT Innovation for Adaptability and Competitiveness*, Springer.



TEMPORAL DISCLOSEDNESS OF INNOVATIONS

Understanding Innovation Trajectories in Information Infrastructures

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Abstract: The paper addresses the research question of how to analyze and evaluate innovations in complex information infrastructures. Recent studies of innovation processes involving standard-based networking technologies have called for new theoretical insights than the ones provided by traditional studies on Diffusion Of Innovations. Understanding this type of innovations becomes particularly difficult in the context of complex information infrastructures. Based on the empirical material from a case study of an IS innovation in a Norwegian hospital, the paper provides insights on temporal aspects of innovations. The paper makes two key contributions to the ongoing discussion. It introduces the concept of *temporal disclosedness*, which describes the tendency of innovations to disclose along the past, present, and future trajectory of the infrastructure, breaking traditional analytical and temporal boundaries. Secondly, with the help of this concept, it shows how some of the current theoretical approaches may be adequate to study the *disclosedness* of innovations, but their use is currently limited and hence should be extended.

Key words: Innovation, Time, Information Infrastructure

1. INTRODUCTION

This paper is concerned with the conceptualization of innovation in information systems (IS) (Kwon & Zmud 1987; Cooper & Zmud 1990; Baskerville & Pries-Heje 1997; McMaster *et al.* 1997). Innovation here refers to the process of implementation of a new idea in an organizational setting (Van de Ven 1986). In particular, the paper addresses the question of how innovations implemented in complex infrastructures of interconnected

IS should be analyzed and evaluated (Hanseth *et al.* 1996; Damsgaard & Lyytinen 1997). Recent discussions have raised the need to find new theoretical approaches to understand the complexity of such innovation processes (McMaster *et al.* 1997; Lyytinen & Damsgaard 2001). Examples of the complexity can be found in the difficulty in evaluating the success or failure of an infrastructural innovation; for instance, the difficulty to temporally and spatially isolate it from the surrounding context. When implemented, the type of innovations at case become largely dependent from the existing context, are often subject to frequent re-planning, and in some cases never seem to end. As a response, this paper aims to contribute to the ongoing discussion by focusing the attention on the study of temporal aspects of innovations. It investigates how innovations relate to the context before, during, and after its complete or incomplete implementation. The paper also discusses how approaches to the study of innovations have thus far come short in addressing in particular the influence of innovations on the future trajectory of the surrounding infrastructure.

Analyzing a case study on an innovation implemented in a large Norwegian hospital, the paper illustrates how understanding these temporal aspects is paramount to the study of the innovation. More specifically, the case deals with the implementation process of an Electronic Patient Record (EPR) system in a Norwegian hospital. The case shows how, in order to understand the dynamics of the innovation, the analysis must include the study of the context (the surrounding infrastructure) in the time before and during the implementation. Additionally, the analysis must investigate the influence of the implemented innovation on the generation of future innovations.

Based on the empirical evidence of the case, and by introducing the concept of *temporal disclosedness*, the paper aims to illustrate how innovations in complex information infrastructures tend to break analytical, temporal and spatial boundaries, and *disclose* along the entire trajectory of the infrastructure. Hence, the paper suggests that evaluations of innovations in complex information infrastructures take into consideration this particular property by extending their analysis beyond apparent temporal and spatial boundaries. The analysis of the case presented in the paper provides a practical example.

The paper is structured as follows. First, a reasoned review of recent literature on the study of innovations in IS is provided. Secondly, the methodology of the study conducted is illustrated. Thirdly, the case description will provide the empirical evidence for the subsequent discussion. Finally, conclusions are drawn summarizing the main message of the paper.

2. THEORETICAL FRAMEWORK

This paper aims to contribute to the ongoing discussion on how to conceptualize innovation in the context of Information Systems (IS) implementation (Kwon & Zmud 1987; Cooper & Zmud 1990; Baskerville & Pries-Heje 1997; McMaster *et al.* 1997). In particular, similarly to the work by Lyytinen & Damsgaard (2001) it is concerned with innovations involving complex standard-based networked technologies in large organizations. Additionally, it adopts the perspective of technology as suggested by Hanseth *et al.* (1996) whereby technology is not seen as isolated from its social-technical context. Accordingly, IS innovation can not be considered as the implementation of isolated pieces of technology: it is rather a process of continuous negotiation and re-appropriation of the existing installed base (Hanseth *et al.* 1996; Monteiro & Hepsø 1998).

The paper will try to focus the attention of the current discussion on aspects of temporality in innovations by addressing the following research question: how does the innovation relate to the past, present, and future of its lifecycle and to the surrounding infrastructure in which it is implemented?

To address this question, we will first identify two main streams of theoretical works in the field. Then we will briefly discuss their temporal conceptualization of the innovation. Finally, we will provide the background and motivation to elaborate the theoretical contribution in the discussion section.

2.1 A review of research in IS innovation

Adapting a framework proposed by Wolfe (1994) in her study of organizational innovations, the field of IS innovation may be categorized in the two research streams of *stage-model* and *process-model* innovation process theories. Accordingly, while more traditional Diffusion Of Innovations (DOI) studies seem to address the question of “What is the pattern of diffusion of an innovation through a population of potential adopter organizations?”, process theory approaches (stage-model and process-model) tend to address the question of “What are the processes organizations go through in implementing innovations?”. In turn, each of the two research streams reinterprets this question by either focusing on the identification of implementation stages (stage-model research) or by analyzing the chain of events resulting in the innovation implementation (process-model research) (*ibid.*).

The review will first provide an overview of selected works in the stage-model research stream. Following this, the process-model stream will be presented. It is worth noting how this research in the IS field, although not

purely DOI research according to Wolfe (1994), has traditionally been heavily influenced by the theoretical frameworks of DOI research (Rogers 1995). Examples of such studies are Cooper & Zmud (1990), Fichman & Kemerer (1999), and Gallivan (2001). In each of these interesting works the researchers seem, on the one side, embrace the DOI framework, and yet on the other side struggle with its clear limitations when applied in the context of complex IS. As a result, in one case the model consistently describes the adoption and infusion processes only if the innovation has a low complexity (Cooper & Zmud 1990). In another case, the struggle resulted in the need to refine the too generic stage model by Rogers (1995) into a more sophisticated one involving *primary* and *secondary* adoption (or *voluntary* and *mandatory*) (Gallivan 2001). In a third case, the researchers strived to go beyond the appearance (or *illusion*) of diffusion of an IS innovation, by measuring the often elusive and invisible gap between *acquisition* of an innovation and its factual *deployment* (Fichman & Kremer 1999).

Despite the clear attempt to overcome theoretical shortages of the DOI framework, these kinds of studies tend to remain within that framework. Yet, they differ from more classical DOI studies in their focus on the post-adoption phase of the innovation. In particular they tend, in line with DOI theories, to model the innovation in distinct (though possibly overlapping) stages.

A second set of studies on IS innovation is the *process-model* innovation process theory research stream (Wolfe 1994). These studies often recognize the limitation of the DOI framework and adopt alternative frameworks with the clear intention to dive into the messiness of the innovation process without the urge to model it in distinct stages (Lyytinen & Damsgaard 2001; McMaster *et al.* 1997; Attewell 1992).

For instance, Swanson & Ramiller (1997) introduce the notion of *organizing vision* in IS innovation providing an institutional view of how a “[...] collective, cognitive view of new technologies enables success in information systems innovation [...]” (ibid.). Other works indirectly contribute to the conceptualization of IS innovation as a mutual adaptation of technology and organization (Leonard-Barton 1988) or as sense-making of IT adaptation (Weick 1995; Henfridsson 1999).

Other researchers have focused on the role of organizational learning (Attewell 1992), or of *formative contexts* (Ciborra & Lanzara 1994). In these studies *innovation* is defined as the learning process of the organization in a particular context and in this sense independent of the technology. Ciborra also interprets the appropriation of a Groupware application in an organization as a process of *taking care* of the innovation (Ciborra 1996). This latter conception pushes the study of IS innovation in the philosophy of existentialism (Heidegger 1962).

A more recent stream of research developed the concept of “interactive innovation” (Rothwell 1994; Newell *et al.* 2000; Newell *et al.* 1998). This concept contributes to the conceptualization of innovations as the emergent process of knowledge exchange among inter- and intra- organizational networks. From this perspective, innovations are seen as the “[...] interaction of structural characteristics of organizations and the actions of individuals” (Newell *et al.* 1998).

Finally, other studies on IS innovation have adopted the conceptual framework of Actor Network Theory (ANT) (Latour 1987; McMaster *et al.* 1997; Monteiro & Hepsø 1998). For instance, Aanestad & Hanseth (2000) conceptualize the implementation of an open network technology as the cultivation of a “hybrid collectif” of humans and non-humans, technologies and non-technologies.

These studies share the interest of understanding the process of innovation as it unfolds, and not as the completion of a stage process. Accordingly, drifts, deviations, and complexities are not feared, rather are acknowledged and included in the analysis and theorization.

Specifically, the contributions by Lyytinen & Damsgaard (2001), and Monteiro & Hepsø (1998) regarding the diffusion of complex infrastructural innovations are particularly relevant for the case discussed in this paper. These two works open the discussion of IS innovation to address aspects of complexity: innovations are considered embedded in their organizational context where the existing socio-technical network has a great influence on the unfolding of their process. In this context, phenomena such as path-dependence (Arthur 1994; David 1985), lock-in (Arthur 1989), network effects (Antonelli 1992), and drift (Ciborra 2000) due to the existing *installed base*, tend to influence the trajectory of the innovation (Dosi 1982; Hanseth *et al.* 1996). In this sense, aspects of complexity are inherent to the infrastructural nature of IS innovation.

As the case study presented further in the paper will suggest, this is an area of discussion which needs to be expanded and which requires deeper understanding of the innovation phenomena.

2.2 On the current temporal conceptualization of innovation

The aim of this section is to unfold how the two broad research streams, stage-model and process-model, deal with the temporal aspects of innovation. Specifically, we mean to unveil the discourse about temporality in the two streams focusing on the three temporal analytical categories of *past*, *present*, and *future*.

The *past* category refers to the past heritage of the context where the innovation is implemented. The first research stream tends to overlook or underestimate the role of the past in the conceptualization of innovations when analyzing complex IS. The past, or the initial situation where the innovation needs to be adopted, is conceptualized as a stage which needs to be *unfrozen*, changed, and *refrozen* to implement the innovation (Kwon & Zmud 1987; Lewin 1952). It is therefore taken for granted that there is a beginning or an initiation of the innovation, which is a particular point in time where the innovation starts with a clear cut from previous events.

On the other hand, the second research stream often adopts theoretical frameworks which explicitly take into consideration the influence of the past in the implementation effort of the innovation. For example, studies on organizational learning using concepts such as double-loop learning (Argyris & Schön 1996) or formative contexts (Ciborra & Lanzara 1994), underline the relevance of existing cognitive structures and knowledge in the process of innovation. Other studies in this stream adopt ANT to take into account the role of the past showing how strength of inscriptions, black boxing, and irreversibility contribute to the shaping and establishment of socio-technical networks (Latour 1987; McMaster *et al.* 1997; Monteiro & Hepsø 1998).

As for the relation of the innovation with the *present*, the question remains as to the extent to which the implementation is regarded as realization of a “[...] ‘black box’ of readily available technological possibilities [...]” or as an emergent and open process or trajectory (Dosi 1982). According to the first research stream, the innovation unfolds in stages which have a logical order. Independent from the sophistication in quantity, quality, or temporal arrangement of the stages, the assumption of the stage-model is the possibility of reaching a *closure* of the innovation where predicted benefits are achieved.

In the second research stream the implementation process is often seen as emergent (Leonard-Barton 1988), context-dependent (Ciborra & Lanzara 1994), continuously negotiated (Monteiro & Hepsø 1998), or interactive (Robertson *et al.* 1996). Thus the range of possibilities of the innovation is continuously re-invented, re-negotiated, re-contextualized and re-appropriated undermining the closure of the implementation according to predicted benefits, and opening for potentially new ones.

Finally, the relation of the innovation with the *future* concerns the effects of the innovation on the future development of the surrounding context. In our particular case, it regards the role of the innovation in influencing the future trajectory of the infrastructure. Studies based on DOI limit their temporal scope to their unit of analysis: the particular innovation process. Hence no account of evaluation of the innovation on the future development of the context in which it is implemented is provided. Studies in the second

research stream also seem to come short in addressing this temporal dimension. That is, the analysis and evaluation of the innovation is also in this case focused on the “event” of the implementation rather than on the influence of such implementation on future innovations.

On this point, the information infrastructure (II) perspective as proposed by Hanseth (*et al.* 1996) provides useful insights. By conceptualizing the complex system of interrelated IS in an organization as an II, the critical role of the installed base in the development of the existing socio-technical network is put forward. This conceptualization acknowledges the role of the past (e.g. of path dependence) in the current shaping of the II. This implicitly points at the importance of considering the innovation process itself as a process contributing to the shaping of the new installed base influencing future innovation. It is consequently relevant to consider the present innovation in the light of future possible developments of the II.

In the case and discussion sections of this paper, we will illustrate how the temporal dimension of the future is crucial to the understanding and evaluation of the innovation discussed. We will then elaborate in more detail a temporal conceptualization of the innovation in II by introducing the concept of *temporal disclosedness*.

3. METHODOLOGY

The research reported in this paper is grounded in the interpretive approach to case study in IS (Klein and Myers, 1999; Walsham 1993, 1995). The research was guided by the following general question: “What are the complexities involved in the implementation of a standard-based technology in the setting of a hospital information infrastructure?”. The fieldwork has been conducted over a period of over two years, from October 2001 to the present. Ethnographically inspired methods were employed for data collection, including 32 interviews with doctors, nurses, secretaries and IT managers, 8 instances of observations of daily work and users training sessions, documents analysis, and participation in several discussion meetings. The interviews were recorded on MiniDisc®, the most relevant (about 30%) have been transcribed and circulated among the research group. The others have been re-listened and summarized. The research group consisted of two Ph.D. students (including the author) a lecturer and a professor. After coding and discussions, the data has been analyzed by organizing it in process narratives (Langley 1999). A second round of analysis was used for theorization (e.g. production of this paper). The head of research of the IT department of the hospital joined regularly these meetings to update the research group on the project, and to suggest interesting area for further research.

Concerning the use of theories, the process of theorizing from the collected process data was inspired by the study of temporality in the existential philosophy of Heidegger (1962). In doing so we acknowledge the risk of appropriating a concept or perspective in a different theoretical milieu than the one in which it was conceived. We do in fact recognize that, if inspired by Heidegger, the study of temporality should not be detached from a study of the *state-of-mind* (*Befindlichkeit* in German) (Heidegger 1962: p.389; Ciborra 2002). Nevertheless, we find that our appropriation of the concept is adequate as we see the current paper as a step towards the breaking-down of misleading metaphysical categories.

4. CASE DESCRIPTION

The case illustrates the nature and the context of an IS innovation implemented in a major Norwegian hospital (referred to as NorHospital). Specifically the innovation regards the implementation of a hospital wide clinical information system called Electronic Patient Record (EPR). The EPR represents a networking technology which aims to standardize and centralize the structuring, storing, and use of patient related clinical information in the entire hospital.

In order to provide the necessary historical and contextual perspective, the case describes three analytical stages of the development of the Information Infrastructure (II) in NorHospital; the second stage being the one when the EPR was conceived and implemented. The aim is to provide an account of the three different stages as three different technological paradigms (Dosi 1982).

We will now provide some contextual information regarding the hospital and the role of its IT department.

NorHospital is a large University hospital. It is the second largest hospital in Norway, with approximately 600 beds, 4000 employees and an annual budget of 2.5 billion NOK (around 360 million US Dollars). In 2002 more than 193'000 patients were treated.

The role and function of the IT department in NorHospital have considerably shifted from purely technical support in early 90s, to encompass "high-risk" clinical information systems development. At the beginning of 1990s the IT departments' staff was approximately 20 persons on a budget of approximately 10-15 MNOK. Currently over 80 people are running projects on a budget around 80 MNOK. Moreover, for the next four years (2003-2006), the IT department has set up a budget of 267 MNOK alone for development and implementation of clinical information systems. There are currently requests to raise the budget to as much as 500 MNOK. The budget for similar projects before 1995 was 0 MNOK. Moreover, in the

last decade the scope of intervention of the IT department has changed from being a “technical problems solving” department to act as a service department, oriented towards the needs of their “customer”: the different hospitals departments. Finally, after a health sector reorganization in Norway, the department started to address new “customers” outside the hospital. Indeed, during the last year, the department has been active in positioning itself as a regional actor in providing services related to clinical information systems.

4.1 LAN: From Mainframe to PC

We will now describe the first of the three analytical stages of the development of the infrastructure: the transition from a Mainframe to a LAN and PC infrastructure.

In early 1990s the information infrastructure at the hospital was primarily based on a few mainframe systems used for administrative purposes. Examples of applications were a Patient Administrative System, Human Resource management systems and a financial system. Accordingly, competencies in the IT department were limited to technical knowledge, and the type of service provided was rather routinized. At this time there was no involvement of the IT department in any activity related to clinical information.

Around mid 1990s the IT department installed a Local Area Network (LAN) and started to diffuse the first Personal Computers (PC). As a consequence, some clinical departments started to develop local systems. The systems were usually developed by doctors who were also amateur programmers and were usually serving local needs of organizing and storing data. Most of these systems have survived until today and represent an important and efficient part of several clinical departments’ practices. They were often used as local Electronic Patient Record (EPR) systems, sometimes with statistical functionality for research purposes. The systems were developed entirely inside the departments without any support from the IT department, apart from providing the basic infrastructure. Also in this transition of the infrastructure from mainframe-terminal to LAN-PC the role of the IT department was merely one of technical support and maintenance.

4.2 EPR: Centralization and Tight Integration

In this section we will describe the second stage of the development of the infrastructure: the flourishing of clinical information systems and the implementation of the centralized EPR.

It is not until 1995 that the IT department faced the need to embrace new challenges in the uncharted area of clinical information systems. During that year a considerable amount of new projects were started, alongside the traditional technical support and maintenance activity. The new projects included the development of four new laboratory systems, a Radiology Information System (RIS), and a picture archive system for x-rays (PACS). Moreover, in the same year an EPR project was started with the aim of developing a hospital-wide centralized clinical information system. The aim of the project (which was done in cooperation with four other regional hospitals) was to develop a centralized version of an EPR substituting the locally developed EPR and integrating it with the other clinical systems. The project was supposed to last three years with the vendor delivering the final version of the EPR by the end of 1999 and the IT department implementing the EPR to reach 3500 potential users. As of now, all users have been reached, but the final version has not yet been delivered, while the version currently implemented is covering only about 30-40% of the requested functionality. Moreover, local EPR are still being used, and integration with clinical systems is partial or non-existent.

Reasons for the delay and the limited implementation may be found in the complexity of the design of a standardized and centralized EPR; in the complexity of the integration process with local clinical systems (complexity which involves political and power issues besides purely technical ones); and in an overall vendor-dependent strategy of reaching for perfection.

At the time the EPR project was started the IT department consisted of 19 people including two developers. None of these people had any formal background in clinical practice and thus were not ready to take on such risky projects. However, the IT department began to systematically acquire competencies and resources in order to manage the new type of projects. For the development of any new clinical information system, a project manager from the clinical department was appointed, and some end-users were involved part-time in the project.

With the EPR and other clinical systems, the IT department started to deal with projects with an increasing complexity. Some of them were rather straightforward, others required far more time and resources than planned (e.g. the development of PACS and of the EPR). All of them required innovative ways of working. One key element was interdisciplinarity and co-responsibility. As a consequence, an increasing number of people working in clinical departments moved to the IT department covering key positions in development projects. The scope of the IT department was expanding from supporting administrative systems to also developing and implementing clinical systems. At the same time, the core competence was shifting from

purely technical knowledge to an interdisciplinary approach to the design, implementation and adaptation of clinical information systems.

With the EPR project the range of action and influence of the IT department definitely reached the width of the entire hospital organization and the depth of the complex clinical work-practices.

4.3 CSAM: Layering and Loose Integration

The development and implementation of the hospital wide EPR proved more difficult and complex than predicted. Despite the considerable change in staff, competence, and resources, the IT department of NorHospital seemed incapable of meeting some of the challenges that the vision of the EPR had inscribed in its conception. In particular, the EPR was seen as the central system meant to substitute all local systems. Furthermore, it was supposed to integrate all the information in one standardized format, while until then the information was handled, stored and structured according local standards. Finally the vision of the EPR was to provide a single solution to a variety of often contradicting requirements. For example, the EPR had to fulfill users' needs, while satisfying divergence of opinions in the different professions of the users (e.g. doctors and nurses), and disciplines (in almost each medical discipline there is an international standardization committee concerned with the structuring of their clinical information). Additionally it had to comply with national laws and regulations regarding information security, patient privacy, and the definition of the legal documentation of the patient treatment.

The idea of implementing the “one” standardized and centralized clinical system was slowly being substituted by the idea that the implementation of the EPR was the “Art of the impossible!” (in Norwegian: *Det umuliges kunst!*; cited from a presentation by a manager at the IT department). The understanding of the information infrastructure of the hospital as a puzzle of systems was leaving the stage to a more “systemic” view; that is a view of a complex lattice of interconnected systems, practices, power relations, and acquired knowledge.

At this point, the leadership at the IT department sentenced the idea of the holistic ERP to *death*, instead replacing it with a new vision focusing on *services*. The new vision was labeled Clinical Systems All Merged (CSAM) and may briefly be summarized as follows:

- Focus on information services instead of information containers (such as the EPR)
- CSAM is a process: focus on delivery of tangible benefits (e.g. better coordination between two departments) rather than of particular products (e.g. the EPR)

- Stepwise bottom-up approach leveraging existing resources rather than top-down long term planning
- Bottom-up approach responding to factual emergent needs of services
- Technological solution based on portal technology: layering and loose integration
- Increased control over direction of development, e.g. by
- Increased independency from vendors: vendors provider of tool-box technology instead of complete solution (as with EPR)

Along with a Norwegian proverb, the motto which facilitated the transition was: “The best is enemy of the good!” (in Norwegian: *Det beste er det godes fiende!*; citation from interview with a manager of CSAM). In this motto the EPR vision was seen as the ideal (i.e. the best) solution which proved impossible to reach. The CSAM philosophy, on the contrary, aimed at providing a good enough solution, although probably not the best, but achievable in a reasonably short time and with available resources.

5. DISCUSSION

We will now proceed with the analysis of the case with the aim to highlight how the implementation of the EPR related to the past, present, and future of the trajectory of the information infrastructure. We will first provide an interpretation of the three stages as three technological paradigms (Dosi 1982). Then we will discuss the extent to which the reviewed theories on innovation can provide insights in the case, highlighting their structural limitations or their limited use. Finally we will introduce the concept of *temporal disclosedness* to underline the particular temporal characteristic of innovations in the context of information infrastructure, and will accordingly suggest the direction of research in similar cases.

5.1 Three paradigms and their relation

The following table summarizes the three analytical stages of the management of the Information Infrastructure at NorHospital (Table 1).

Table 1. Three paradigms in the management of the Information Infrastructure

Dimensions	LAN	EPR	CSAM
General Strategy (IT dept.)	No big strategy	Long term focus: achieve complete integration and standardization	Short term focus: achieve benefits on focused and emergent needs using available resources
Competence (IT dept.)	Technical	Technical + Clinical	Technical + Clinical
Business Model (IT dept.)	Maintenance and Support	Delivery of solution (product focus)	Provision of information services (process focus)
Management Style (IT dept.)	Routine management	Traditional project management: hierarchies, planning, heavy documentation	“Creative” management: emergent, informal, dynamic
Role of Users	Almost none	Ideally participation of the whole user base	User base involvement secondary: heavy use of acquired knowledge from EPR implementation
Main Role of Vendor	Provider of infrastructural components (cables, computers etc...)	Provider of Complete Solution (high dependency on vendor)	Provider of infrastructural components (portal technology, database systems etc...) (lower dependency on vendor)

Each of the stages represents a different paradigm of strategy, management, and technology which shapes the trajectory of the infrastructure (Dosi 1982). In order to comprehend the dynamic of this trajectory, it is important to identify the influence of each paradigm on the next. Many of the elements are external to the context of the hospital (e.g. advances in networking technologies, the diffusion of the internet as technology and as a technological paradigm, the development of user interface technologies, laws and regulations, health reforms etc...), yet still there are several internal elements which have a great influence in the future trajectory of the infrastructure.

First, the radical change from the LAN to the EPR paradigm was mostly influenced by external factors. Yet, one determinant internal aspect of the LAN paradigm was the great potential of the establishment of a Local Area Network. This implementation was accomplished by the IT department still within the vision of it being a technical support and maintenance provider,

thus without any idea of enabling the flourishing of local (and later interconnected) clinical systems.

Thus, the EPR paradigm exploited possibilities provided by the LAN paradigm. At the same time, the diffusion of PCs inside the hospital generated the flourishing of a myriad of local EPR and other clinical systems, which at the end hugely enriched the installed base of the information infrastructure, heavily influencing the course of the EPR implementation. In this very step, it is clear how on the one hand the EPR paradigm built on the previous one, yet on the other hand, the same infrastructure which allowed the EPR dream to be formalized, hampered the course of its implementation.

So far the influence of the past (the LAN paradigm and the infrastructure which it generated) and the dynamic of the present of the implementation of the EPR (the way it drifted away from plans producing delays and a long list of compromises) should be clear. We will now briefly analyze how the implementation of the EPR, and the paradigm in which it was conceived, heavily influenced the generation of the new paradigm for CSAM.

Similarly to the EPR, the CSAM vision was the by-product of an external shift of the technological paradigm. At that time the IT industry was strongly focused on the integration of existing systems. Accordingly, often the proposed technical solutions were a portal architecture, where the existing infrastructure of systems is loosely integrated with a layering strategy. Yet, the CSAM vision is not solely shaped by this new technical hype but it is largely the evolution of the EPR paradigm. In fact, each of the dimensions in the CSAM paradigm is the outcome of the experience accumulated with the EPR implementation. Indeed, the EPR had been the first attempt by the IT department to provide clinical systems with a hospital-wide scope. The people behind the CSAM vision were the same people who had been struggling for eight years in a particular management and technological paradigm (EPR) which they then thought was inappropriate. Most importantly, the new paradigm was not simply a change in a new direction with a fresh start. It is the opposite: it is the evolution in a new direction with the inertia and enrichment of the huge amount of knowledge and competence acquired in the previous paradigm. Examples of the paradigmatic shift enabled by this learning process are the change from a long-term to a shorter term strategy; or the evolution from a product to a process focus. Even clearer is the capitalization of knowledge about users and work practices from the EPR implementation, used to reorganize the role of users in the CSAM process (see Table 1).

From this perspective, the EPR innovation was both the (partial) realization of an infrastructural technology, and a huge learning process. The learning process resulted in the tangible confidence the IT department now

has in addressing services for clinical information systems. It is also tangible in the installed base of (partly) standardized and centralized routines running on the EPR. This installed base represents a very important launching pad for CSAM like the LAN technology was for the EPR. Finally, but not least important, the implementation of the EPR created over the years a strong network of trust between the clinical departments and the IT department. Also in this case, the “installed base” of trust relationships represents an important starting point for the accomplishment of the CSAM vision.

5.2 Limits of current studies

We will now briefly discuss the literature reviewed in the theory section, and evaluate the usefulness of the proposed theoretical frameworks. Subsequently, we will point out how current theorizations tend to overlook the influence of an innovation on future innovations. We will conclude this exercise by pointing at some of the mentioned frameworks which could be used to open the analysis of innovation in the direction we are suggesting.

If we try to apply theories pertinent to the first research stream to the case, it will immediately become clear that almost each assumption and hypothesis made in those theories is hardly met. Not to say that such theories are not relevant: on the contrary. The mentioned theories simply are not adequate to the study of the innovation case presented in this paper. For instance, the model proposed by Cooper & Zmud (1990) would be flawed by the excessive complexity of the technology (here intended as socio-technical network). The study of assimilation gaps by Fichman & Kemerer (1999) would seem pointless as the deviation of *deployment* from the envisioned *acquisition* of the innovation would seem as a natural property of the trajectory of the infrastructure. Finally, any such theory based on a stage model would systematically fall short in describing the complexity of the innovation process. For one, in the model no account is given to the role of the installed base in shaping the innovation (if not for the negative connotations of something that needs to be changed). Nor does it take into consideration the fact that the innovation may remain open. According to each of these models the cycle of the innovation has to come to a final stage. This is certainly not the case of the innovation presented in this paper. While only about 40% of the EPR is implemented and operational, the remaining 60% is still under design, development, and testing.

If we turn to the second research-stream on IS innovation processes, we find at least two approaches which may be useful in the study of our case: studies on organizational learning (Attewell 1992; Ciborra & Lanzara 1994; Argyris & Schön 1996; Ciborra 1996) and studies adopting the theoretical framework of ANT (Latour 1987; McMaster *et al.* 1997; Monteiro & Hepsø

1998; Aanestad & Hanseth 2000). As illustrated previously in the paper, the change of paradigms may be interpreted as a learning process. As the mentioned theories on learning suggest, innovation as learning does not happen only as plain learning, or linear learning. In order to learn and innovate, people need to change their cognitive framework, formative context, or, finally, perform double-loop learning. While showing that the heritage of the past (in terms of e.g. formative context) influences the present nature of the innovation, such approaches tend to limit the study by identifying the innovation with the change to a different specific formative context (or set of values, or cognitive frame). For instance, the EPR paradigm entailed a new way of thinking, a new way of cooperating between departments, and a new way of looking at the technology. Nevertheless, the new formative context of the “organizing vision” (Swanson & Ramiller 1997) of the EPR was not the only one generated by the lengthy implementation process. The new way of thinking in CSAM (which we want to identify as yet another formative context) is also an instance of the EPR innovation.

Similarly, studies using ANT are effective at describing the influence from existing network and the emergence from present implementation as complex and dynamic processes of enrolment, inscription and translation. They tend however to end the analysis at the point when the network is stabilized. In the context of an infrastructure, socio-technical networks (such as “hybrid collectifs”) hardly stabilize and are hardly isolated. As a consequence, their emergent and interconnected nature continuously influences the surrounding context making it extremely difficult to draw the boundaries between one innovation and the next. We sustain that the cited literature comes short in highlighting this aspect.

In conclusion, we submit that theories from the first research stream have a structural limitation which does not allow them to be used outside the given spatial and temporal boundaries. Whereas regarding the second research stream, theories on learning and studies using ANT seem to have the adequate methodological and analytical framework to investigate beyond those boundaries, but their application seems to be intentionally limited.

An exception to the proposed theories is the concept of *path creation* (Garud & Karnøe 2001). Path creation is a concept developed exactly to address the importance of being aware that present innovations will have a path dependent influence on the future trajectory. While this intuition is extremely relevant, its application to the study of innovation in IS seems to be lacking and should thus be developed.

5.3 Temporal disclosedness of innovations

In this paragraph, in light of the collected and analyzed empirical evidence, we will introduce the concept of *temporal disclosedness* of innovations in information infrastructures (Heidegger 1962). The aim of introducing this concept is to highlight a peculiar characteristic of innovations occurring in complex infrastructures of interconnected IS: as illustrated in the case, once implemented, it becomes extremely difficult to draw temporal and spatial boundaries around the innovation.

If implementation of the innovation usually means the realization of predetermined possibilities in time, *temporal disclosedness* of the innovation means that the implementation is dealing with possibilities beyond the traditional time and space occupied by the implementation process; i.e. before the implementation starts, as the implementation unfolds, and beyond the completion (or incompletion) of the implementation.

With regard to the past and the present, the concept of *temporal disclosure* is near to other concepts highlighted in the theoretical section (from path dependency and installed base, to improvisation, interaction, and emergence). The concept proposed here is particularly relevant in that it also extends the perspective on the future evolution trajectory of the infrastructure.

5.3.1 Disclosure of the past

Temporal disclosure of the past refers to how phenomena such as path dependency, lock-in, and formative contexts of the existing installed base provide pre-existing possibilities and inertia with which the innovation has to deal. Disclosure means that the innovation is already-there in the possibilities allowed or precluded by the installed base which wait to be disclosed.

5.3.2 Disclosure of the present

Temporal disclosure of the present refers to how the complexity of the infrastructure affects the implementation as it unfolds: it drifts, it becomes emergent, interactive, renegotiated, and reinvented. Thus, compared to a view on implementation as *awaiting* of the realization of predetermined possibilities, implementation becomes also *anticipation* of new possibilities through improvisation, tinkering, and bricolage (Heidegger 1962; Ciborra 1999).

5.3.3 Disclosure of the future

As the influence of the EPR paradigm in the conception of CSAM shows, the innovation becomes part of the installed base shaping and triggering new innovations. Temporal disclosure of the future means that the new possibilities are not only regarding the implementation of the current innovation, rather they may affect the conception of new and future innovations.

5.3.4 Temporal disclosedness of innovations

Temporal disclosedness of innovations in information infrastructures means that the lifecycle of an infrastructural innovation is not closed in time boundaries defining its possibilities; it is rather *disclosed* along the entire past and future trajectory

Based on this characteristic, we propose that the analysis of future influence of the innovation on the trajectory of the infrastructure is not a matter of choice, rather a methodological imperative. This implies that the evaluation of an innovation in an infrastructure should also consider the influence of the innovation at case on the implementation of later innovations. For instance, the evaluation of the EPR should include an analysis of the influence of the EPR on the generation and implementation of CSAM. We also suggest that theories from the process-model research stream may provide adequate analytical and conceptual tools (particularly theories on learning and ANT). Yet, limiting the analysis to the particular apparent lifecycle of an innovation may be useful but it risks giving the wrong impression that innovations in such complex settings can be analytically isolated in time and space. In our case, evaluating the EPR innovation considering or not considering its influence on CSAM would bring different results. At first it could appear as a failure. At second analysis it is possible to observe the tangible (and unpredicted) benefits brought to the CSAM innovation.

More provokingly, when studying innovations in information infrastructure, one should not be fooled by the apparent suitability of spatial and temporal categories of the innovation. To understand the particular innovation, one is forced to understand also the surrounding context in which it is embedded and analyze it in an historical perspective including past and future.

6. CONCLUDING REMARKS

In this paper, we have addressed the question of how to conceptualize temporal aspects of IS innovations occurring in complex infrastructures of interconnected information systems. Using the framework of Information Infrastructure (Hanseth *et al.* 1996), we have adopted a view on information technology in organizations which acknowledges the complex dynamics of its trajectory. We have then reviewed current literature on the study of innovation processes in the field of IS, highlighting different perspectives and shortcomings in the analysis of temporal aspects of innovations. In particular, we have illustrated how there is a general lack of study on the influence of the implemented innovation on the future trajectory of the infrastructure. With the help of a case study based on an IS innovation implemented in a hospital, we have shown how it is paramount to study such influence. In order to sustain this argument and based on the evidence of the case, we have introduced the concept of *temporal disclosedness* of the innovation. This concept is useful to understand the limits of current conceptualizations of innovation processes in complex infrastructures. The limits, which we suggest should be overcome, refer to the tendency of keeping a temporally closed view on the innovation. This view, we sustain, veils the nature of the innovation phenomenon, which, on the contrary, tends to become temporally disclosed along the entire trajectory of the infrastructure.

7. REFERENCES

- Aanestad M., Hanseth O.. (2000), "Implementing open network technologies in complex work practices. A case from telemedicine". In *Proceedings from IFIP WG 8.2 International Conference. The Social and Organizational Perspective on Research and Practice in Information Technology*, June 10-12, 2000, Aalborg, Denmark
- Antonelli, C., (1992), "The economic theory of information networks". In *The Economics of Information Networks*, ed. C. Antonelli, North-Holland, 1992.
- Argyris C., Schön D.A., (1996), *Organizational Learning II*, Addison-Wesley, Reading, Mass., 1996.
- Arthur, W.B., (1989), "Competing technologies, increasing returns, and lock in by historical events", *Economic Journal* 99: 116-131, 1989.
- Arthur W.B., (1994), *Increasing Returns and Path Dependency in the Economy*, The University of Michigan Press.
- Attewell P., (1992), "Technological Diffusion and Organizational Learning: The Case of Business Computing", *Organization Science*, Vol. 3, Issue 1 (Feb., 1992), pp. 1-19.
- Baskerville R., Pries-Heje J., (1997), "IT diffusion and innovation models: the conceptual domains", in *Facilitating Technology Transfer through Partnership: learning from practice and research*, Proc. IFIP TC8 WG8.6 Conference, Tom McMaster Enid Mumford E.Burton Swanson Brian Warboys and David Wastell (eds.), Kluwer Academic Publisher.

- Ciborra C.U., Lanzara G.F., (1994), "Formative Contexts and Information Technology: Understanding the Dynamics of Innovation in Organizations", *Accounting Management and Information Technology*, Vol. 4, No. 2, pp. 61-86, 1994.
- Ciborra C.U., (1996), "What does Groupware Mean for the Organizations Hosting it?", in *Groupware and TeamWork: Invisible Aid or Technical Hindrance?*, Claudio U. Ciborra ed., John Wiley & Sons, pp. 1-19.
- Ciborra, C., (1999), "Notes on Improvisation and Time in Organizations", *Accounting, Management and Information Technologies* 9 (1999).
- Ciborra, C., Braa, K., Cordella, A., Dahlbom, B., Failla, A., Hanseth, O., Hepsø, V., Ljungberg, J., Monteiro, E., Simon, K., (2000), *From Control to Drift. The Dynamics of Corporate Information Infrastructures*, Oxford University Press, 2000.
- Ciborra C. U., (2002), *The Labyrinths of Information – Challenging the Wisdom of Systems*, Oxford University Press
- Cooper R. B., Zmud R.W., (1990), "Information Technology Implementation Research: A Technological Diffusion Approach", *Management Science*, Vol. 36, No. 2 (Feb. 1990), pp.123-39.
- Damsgaard J., Lyytinen K., (1997), "Hong Kong's EDI bandwagon: derailed or on the right track?", in *Facilitating Technology Transfer through Partnership: learning from practice and research*, Proc. IFIP TC8 WG8.6 Conference, Tom McMaster Enid Mumford E.Burton Swanson Brian Warboys and David Wastell (eds.), Kluwer Academic Publisher.
- David P., (1985), "Clio and the economics of QWERTY", *American Economic Review*, Vol. 75 (1985), Issue 2 (May), pp. 332-37.
- Dosi G., (1982), "Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change", *Research Policy*, Vol. 11 (1982), pp. 147-62.
- Fichman R.G., Kemerer C.F., (1999), "The Illusory Diffusion of Innovation: An Examination of Assimilation Gaps", *Information Systems Research*, Vol. 10, No. 3, September 1999, pp. 255-75.
- Gallivan M.J., (2001), "Organizational Adoption and Assimilation of Complex Technological Innovations: Development and Application of a New Framework", *The DATA BASE for Advances in Information Systems*, Summer 2001, Vol. 32, No. 3, pp. 51-85.
- Garud R., Karnøe P., (2001), *Path Dependence and Creation*, Lawrence Erlbaum Associates Publishers
- Hanseth O., Monteiro E., Hatling M., (1996), "Developing information infrastructure: The tension between standardization and flexibility". *Science, Technology and Human Values*. Vol. 21 No. 4, Fall 1996, 407-426.
- Heidegger M., (1962), *Being and Time*, Blackwell Publisher Ltd.
- Henfridsson O., (1999), *IT-adaptation as sensemaking: inventing new meanings for technology in organizations*, Ph.D. Thesis, Department of Informatics, Umeå University, Sweden.
- Klein, H.K., and Myers, M.D., (1999), "A set of principles for conducting and evaluating interpretive field studies in information systems", *MIS Quarterly*, vol.23, no.1, 1999, pp.67-93.
- Kwon T.H., Zmud R.W., (1987), "Unifying the fragmented models of information systems implementation", in *Critical Issues in Information Systems Research*, R.J. Boland and R.A. Hirschheim eds., John Wiley & Sons, pp.227-51.
- Langley A., (1999), "Strategies for theorizing from process data", *Academy of Management Review*, 1999, Vol. 24, No. 4, 691-710.
- Latour B., (1987), *Science in Action*, Harvard.

- Leonard-Barton D., (1988), "Implementation as mutual adaptation of technology and organization", *Research Policy*, Vol. 17 (1988), pp. 251-67.
- Lewin K., (1952), "Groups Decision and Social Change", in *Readings in Social Psychology*, Newcombe and Hartley (Eds.), Henry Holt, New York, pp. 459-73.
- Lyytinen K., Damsgaard J., (2001), "What's wrong with the Diffusion Of Innovation Theory?", in *Diffusing Software Product and Process Innovations*, Proc. IFIP TC8 WG8.6 Conference, Ardis M.A., Marcolin B.L. (eds.), Kluwer Academic Publisher.
- McMaster T., Vidgen R.T., Wastell D.G., (1997), "Technology Transfer – diffusion or translation?", in *Facilitating Technology Transfer through Partnership: learning from practice and research*, Proc. IFIP TC8 WG8.6 Conference, Tom McMaster Enid Mumford E.Burton Swanson Brian Warboys and David Wastell (eds.), Kluwer Academic Publisher.
- Monteiro E., Hepsø V., (1998), "Diffusion of infrastructure: mobilisation and improvisation", In *Information systems: current issues and future challenges*, Proc. IFIP WG 8.2 & 8.6, T. Larsen L. Levine (eds.), IFIP 1998, pp. 255 - 274.
- Newell, S., Swan, J.A., Robertson M., (1998). "A cross-national comparison of the adoption of BPR: An interactive perspective". *31st International Conference on Systems Sciences*, IEEE Computer Society Press.
- Newell, S., Swan, J.A., Galliers R.D.. (2000). "A knowledge-focused perspective on the diffusion and adoption of complex information technologies: The BPR example." *Information Systems Journal* 10: pp.239-259.
- Robertson, M., Swan, J., Newell S. (1996). "The role of networks in the diffusion of technological innovation." *Journal of Management Studies* 33(3): pp.333-359.
- Rogers E.M., (1995), *Diffusion of Innovations*, 4th Edition, Free Press.
- Rothwell, R. (1994) Towards the fifth generation innovation process. *International Marketing Review*, 11, 7-31.
- Swanson E.B., Ramiller N.C., (1997), "The Organizing Vision in Information Systems Innovation", *Organization Science*, Vol. 8, Issue 5 (Sep.-Oct., 1997), pp. 458-74.
- Van de Ven A.H., (1986), "Central Problems in the Management of Innovation", *Management Science*, Vol. 32, No. 5, Organization Design (May, 1986), pp. 590-607.
- Walsham, G., (1993), *Interpreting Information Systems in Organizations*, Wiley, 1993.
- Walsham, G., (1995), "Interpretive case study in IS research: nature and method", *European Journal of Information Systems*, Vol.4, 1995, pp.74-81.
- Weick K.E., (1995), *Sensemaking in Organizations*, Thousand Oaks: Sage.
- Wolfe R A., (1994), "Organizational Innovation: Review, Critique and Suggested Research Directions", *Journal of Management Studies*, 31:3, May 1994, pp. 405-31.



Appendix 3

Jacucci, E., Grisot, M., Hanseth, O. (2004), "Fight Risk With Risk: Reflexivity of Risk and Globalization in IS", In: Reponen, T., Saarinen, T. (eds.), *Proceedings of the 12th European Conference on Information Systems*, Turku, Finland, June 2004.



FIGHT RISK WITH RISK: REFLEXIVITY OF RISK AND GLOBALIZATION IN IS

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Abstract

In this paper, we address the following research question: "How can we understand the nature of risk in IS projects in the context of globalization?" Based on a case study conducted over a period of two years in a Norwegian hospital on the development and implementation of a Electronic Patient Record (EPR), the paper contributes to the current discussion on the conceptualization of risk in IS projects. Drawing upon the concept of reflexive modernization (Beck 1999) the paper makes two key contributions: firstly, it shows the limits of current risk management approaches in understanding the nature of new risks in IS generated by globalization processes; secondly, it suggest a possible theoretical framework for analyzing such nature. The research question is addressed by providing a historical and contingent analysis of the risk management dynamics emerging from the case.

Keywords: Risk, Globalization, Information Systems, Electronic Patient Record, Reflexive Modernization.

1 INTRODUCTION

As the process of globalization of our society intensifies, local IS projects face new opportunities of expansion in new geographical dimensions. The engagement in these new dimensions considerably changes the nature and scope of risks involved in the development of IS applications. In this new scenario, risk management approaches need to be reshaped and readapted to meet the new challenges.

Traditional risk management studies have provided useful analytical and management tools to address the challenge of an IS project and possibly of its change (see Lyytinen *et al.* (1998) for an extensive overview). Yet they may come short in describing how and why local projects (and their risks) may escalate from a local to a global scope. It is the aim of this paper to address this theoretical gap and provide empirical evidence of the need of extending traditional studies.

Based on a case study conducted at a major Norwegian hospital (referred to as Norhospita) regarding the development of an Electronic Patient Record system (EPR) the paper analyses the dynamics of escalation of the project from a local to a global scope. Adopting the concept of *reflexive modernization* as theorized by Beck (Beck 1999; Beck *et al.* 1994), the paper then discusses the nature of the process of globalization of the risks of the EPR project.

We are not engaging in the debate on globalization as such; rather we focus on the concept of risk and its recent theorization. Our aim is to contribute to the IS field by looking at how the nature of risk has changed in the context of globalization. We believe IS research needs to question traditional risk management approaches. Specifically the paper addresses the following research question: *How should we understand the nature of risk in IS projects in the context of globalization?*

The paper is structured as follows: first, we look at the main limits of the traditional approach to risk management and introduce an alternative perspective. Secondly, we describe the methodology adopted in the research. Thirdly, we introduce the case and provide the empirical evidence. Then, we engage in the analysis and discussion of the collected data, providing possible insights in to the relation between risk and globalization in IS. Finally we will conclude the paper by summarizing the main points.

2 THEORETICAL FRAMEWORK

Overall in the IS literature, we can identify two main theoretical approaches dealing with the concept of risk and its management. The aim of this section is to introduce such approaches, and discuss their characteristics. The first can be considered a more traditional approach to interpreting and managing risk, and it has been accurately summarized by Lyytinen *et al.* (1998). The second approach is more recent, and adopts a perspective on risk inspired by the sociological contribution of Beck (1999) and Giddens (1990) to the debate on globalization.

By means of the analysis of the main limits of the traditional approach, we suggest that ideas developed by Beck and Giddens give new insights into the conceptualization of risk and its interpretation in relation to IS development projects. Specifically, we will focus on reflexive modernization and the reflexive nature of risk.

2.1 The Traditional Risk Management Literature and its limitations

Risk management approaches have traditionally focused their attention on identifying specific sources of risk and developing appropriate management techniques to control it (Alter & Ginzberg 1978; Davis 1982; McFarlan 1982; Boehm 1991; Lyytinen *et al.* 1998). In this literature risk is defined and analyzed within the particular context of the project, organization, and artifact to be developed. Accordingly, various management techniques and heuristics are developed in order to manage, control, or reduce risk (see Lyytinen *et al.* 1998 for a comprehensive overview). While striving to provide rich analyses and detailed prescriptions on how to deal with risk involved in IS development, these approaches seem to come short in providing a larger perspective on the source of the risks we are dealing with and why it is increasingly difficult to manage them.

In risk management approaches the nature of risk is considered as being connected to peculiarities of particular projects or organizational contexts. Consequently, traditional approaches tend to provide analytical tools and solutions which apply and are limited to a micro level dimension of risk management. Acknowledging their value in providing rich and detailed cases, we believe it is critical for IS development projects to further dig into the complexities of the risk phenomena. Our motivation is twofold: first, as the case study will empirically illustrate, in large IS development projects, managers are not in control of the sources of risk, which are also not predictable; second, the very nature of risk and its propagation mode has changed with the intensification of global dynamics in terms of integration, interconnectivity and interdependency, and this has in turn heavily challenged traditional risk management. Instances of such change are well illustrated by the work of Hanseth *et al.* on the development of an ERP solution (Hanseth *et al.* 2001), and by the work of Rolland on the side-effects of globalization in the development and use of a survey management system (Rolland, 2003).

2.2 An alternative approach: Reflexivity of Risk in our Modern Society

In this paragraph, we suggest an alternative theoretical framework to understand risk dynamics. In particular, we suggest that local risk management is intermingled with macro realities of our modern society. With such aim, we will first introduce the concept of Risk Society and Reflexive Modernization as theorized by Beck (1999).

“Risk society” is the metaphor Beck uses to indicate the direction that the industrial society is taking. Precisely, he argues, contemporary western societies are living in a transitional period, in which industrial society is becoming a “risk society”, marked by a shifting of old relationships, rise of new uncertainties, individualism, and basic changes in major social institutions. Risk is not an invention of modernity, but in modernity it assumes a new nature: it no longer has a personal dimension, but its nature and magnitude has changed and tends to escape institutional monitoring for quantification, prevention and protection.

In particular, Beck argues, our society is characterized by a process of *reflexive modernization* (Beck 1999; Beck *et al.* 1994). According to Beck, reflexive modernization means that modernity feeds back to itself, exacerbating and possibly undermining its own foundations. More clearly, as our modern society deploys its weapons of control, rationalization and integration, the society itself becomes increasingly interconnected and interdependent. In this scenario, actions taken in a local setting may have effects that propagate in an unexpected way. Thus, unintended consequences and side-effects challenge the initial aims of increased control and rationalization. From this perspective, risk does not originate within a specific confined setting, but is the very result of the modern ongoing process of rationalization and control undermined by reflexivity.

The process of globalization just intensifies these dynamics, by increasing the number of interdependencies and relations. As Giddens puts it, globalization is “[...] the intensification of worldwide social relations which link distant localities in such a way that local happenings are shaped by events occurring many miles away and vice versa[...]” (Giddens 1990: 64). Hence, local events (like the IS project presented in this paper) when put in contact with processes of globalization (like the one pursued by the multinational vendor’s marketing strategy) suddenly become linked and interdependent with a variety of new actors around the globe, drastically reshaping the nature and distribution of risk involved in the project.

2.3 Risk and Reflexivity in IS

Beck is a sociologist, and technology is not explicitly considered in his work. However, it is evident that technological development plays a crucial role in the process of transformation of society. In fact, this theoretical framework to understand “modern” society has been interestingly applied to the analysis of studies of IT implementation and use in different organizations and work situations. In particular, specific aspects of the reflexive modernization theory have been applied to the analysis of how IT supports and enables the very process of modernization, and which consequences this creates in organizational realities. The use of this framework is quite a recent topic in IS literature. Scott (2000) builds on risk society and reflexive modernization to look at how IT and new related forms of organizational rationalization are transforming the standard spatial and temporal traditional assumptions about work and work life. As to our interests, she does not analyze issues of risk and reflexivity related to the management of the IT implementation process, but focuses the analysis on the very use of the technology.

In the IS literature, few studies deal explicitly with issues of risk, reflexivity and side effects. Such concern is an explicit aim of a theoretical chapter by Hanseth and Braa (2000). The authors report issues from the reflexive modernization theory, and explore the role that IT may play. They suggest that the role of IT can be explained by the way it supports and enables, for instance, time and space distanciation, intensifying one of the dynamics of modernity. Specifically, they frame the understanding of technological development as development of control technologies which enable organizations to be distributed globally, and at the same time enable control of global logistics. Such large technologies or infrastructures emerge as interconnected systems, thus increasing the risks of transferring side effects faster and wider. This framework is applied in a later paper to the analysis of SAP implementation in a Norwegian company (Hanseth, Ciborra, Braa, 2001). Here it is discussed how events, deviations and breakdowns in the implementation process are apparitions embedded in the dynamics of modernity and globalization with its side effects. Dynamics of reflexivity and the

propagation of side effects is also the topic of a study on the implementation of a new infrastructure in a global maritime classification company (Rolland, 2003). Rolland focuses on the role of disembedding mechanisms and new definitions of trust, to explore how information infrastructures are not just configured to adjust to local practices, but initiate a process of reinvention that takes place in situated practices of use.

In using the reflexive modernization theory, we are interested in unfolding the dynamics shaping the socio-technical process of the implementation of the EPR. Aspects of such complex processes will be addressed at different levels of granularity.

3 METHODOLOGY

The research reported in this paper is grounded in the interpretive approach to case studies (Klein and Myers, 1999; Walsham, 1993, 1995). For data collection, we employed ethnographically inspired methods conducting 32 interviews, 8 instances of observations of daily work and user training sessions, documents analysis, and participation in several discussions and meetings. The head of research of the IT department of the hospital has regularly joined these meeting to provide updates regarding the implementation project, and to suggest interesting areas for further research.

Our fieldwork is part of a long term research cooperation between our Department of Informatics at the University of Oslo and the IT department of the hospital. Between 1996 and 1999, the implementation of the EPR has been the topic for a project in an Advanced Systems Development course. Each year around 5 groups of 5-7 Master students studied and reported on some aspects of the design and implementation process in the hospital.

The process of writing this paper from the perspective of complexity and risk has helped us to look both at micro and macro level phenomena, and at the intertwining of the two. Beck's theory on reflexive modernization has guided us to the understanding of the mechanisms of appropriation and reproduction of risks. The reflexive modernization theory has directed our attention to the central role of side effects, and their mechanisms of production, in creating a situation perceived as risky and out of control.

4 CASE DESCRIPTION

In the following sections, we will introduce the case study of the development of an Electronic Patient Record (EPR) system at Norhospital. The EPR is a clinical system used for storing clinical information related to the treatment of the patient. It may be specific to a particular clinical department (e.g. cardiology) or, as in our case, regard the clinical information of all clinical departments in the hospital.

We will first provide some background information about the hospital and the EPR project. We will then describe the process of globalization of the EPR project. Finally we will conduct a preliminary analysis of the globalization process along several analytical dimensions.

4.1 Background

Today Norhospital is the second largest hospital in Norway, with approximately 600 beds, 4000 employees and an annual budget of 2.5 billion NOK (around 360 million US Dollars). In 2002 more than 193'000 patients were treated. The IT department of Norhospital currently has a staff of over 80 people and an annual budget of ca. 80 MNOK, while just ten years ago only 7 people were on the staff. The role of the department has considerably changed from providing technical support and maintenance for mainframes and networks, to developing hospital-wide clinical information systems.

At the time the EPR project started (1996), the information infrastructure of the hospital consisted mainly of a centralized paper-based patient record, numerous local clinical systems including local EPR solutions, central administrative systems (e.g. PAS: patient administrative system), and a LAN with PCs for office automation. Besides local EPR implementations in particular clinical departments, no hospital wide EPR implementation was ongoing in Norway. One exception was the Medina project: a bottom-up development project of an EPR solution partly funded by the Norwegian Research Fund (see Ellingsen & Monteiro 2002, for details). In 1996, Norhospital and other four regional hospitals became interested in developing a hospital wide EPR solution. In order to share costs and reduce risk of failure, they decided to join into a common project merging requirements and splitting costs; the project was called Medakis. In the particular case of Norhospital, the system had to reach 3500 potential users (mainly doctors, nurses and secretaries) substituting the centralized paper record and either integrating or replacing local clinical systems.

4.2 From Local to Global

For the development of the EPR, the Medakis consortium of hospitals needed to choose a vendor. In mid 1990s, the main provider of EPR solutions in Norway was a company we will here call MedInfo (a European high-tech diversified multinational company), which had also acquired the local project Medina (Ellingsen and Monteiro, 2002). At that point of time, it was the opinion of the IT managers at Norhospital that a large international company with the appropriate financial resources was needed for the development of such a complex product. MedInfo seemed to have the right credentials. Nevertheless, at that time, the involvement of MedInfo was limited to its local Norwegian subsidiary, and both the development and the target market were Norwegian. The timeframe of the project was set between 1996 and 1999. The vendor was supposed to implement a preliminary version of the EPR (which we will name NorEPR) in 1996 with the aim to substitute it with a final version at the end of the project. The target of both the vendor and the hospital was to obtain a paperless hospital with automated support for workflow and statistics.

A first critical step in the evolution of the project occurred when the IT managers of Norhospital discovered, while attending a presentation at a conference on IT and Healthcare in the UK, that MedInfo UK was also engaged in a project of EPR development. Asking MedInfo Norway for more clarification, they discovered that within MedInfo there was more than one EPR development project: at least five of them were ongoing in Sweden, UK, Germany, India, and Norway. The IT managers realized that Norway was representing the smallest market, and had the risk of being overrun by another internal project driven by a more profitable market.

As a consequence, the Medakis consortium together with MedInfo Norway agreed to take the first step and internationalize the project first to a Scandinavian dimension, and later to a European one. Accordingly, requirements from other EPR projects inside MedInfo had to be merged, and a new architecture had to be designed. Furthermore, since the original deadline for the final delivery (1999) was approaching, Medakis agreed with MedInfo to extend it in favor of the new internationalized EPR solution (which we will call IntEPR).

A second major step in the project occurred when MedInfo acquired a large "IT & Healthcare" organization in the US, and consequently changed the scope, resources, and balance of its Medical division. As a result, the division's headquarters were moved from Europe to the US, and running projects gained the opportunity and resources to reach a global scope. In this scenario, Medakis supported MedInfo in widening development and marketing range of IntEPR. As a consequence, the new IntEPR architecture was dropped in favor of a new one (GlobEPR), and Medakis obtained the basic requirements already defined for the Norwegian customer to be partly inscribed in the new architecture.

4.3 On Development, Requirements, and Control

The historical evolution of the project from the local to the global context has three interesting dimensions: the organization of the software development, the scope and complexity of the requirements, and the influence of Norhospital on the trajectory of the project.

As to the first dimension, previous to Medakis the development of local EPR solutions was carried out by amateur doctors-programmers in single clinical departments. With Medakis and NorEPR, the development was carried out in Norway by the Norwegian subsidiary of MedInfo. IntEPR internationalized the development as other MedInfo Scandinavian sites were involved. Finally, the development of GlobEPR became truly global, with development sites in the US, Norway, Sweden, Germany, and India. Thus, the number of sites grew with the process of internationalization, making coordination and cooperation dynamics increasingly difficult and complex.

As to the second dimension, in the development of local EPR solutions, the definition of requirements was done for each single clinical department. Accordingly, requirements were confined and easily controllable. The creation of Medakis made requirements the result of negotiations and agreements among several Norwegian hospitals. With IntEPR, and even more with GlobEPR, Norwegian requirements were marginalized, as the new product had to satisfy a larger customer base. In particular with GlobEPR, Norhospital initiated a struggle with MedInfo to make sure that Norwegian requirements were not marginalized or even abandoned in favor of the ones of the more profitable US customer base.

As to the third dimension, in the progressive project internationalization, the control of Norhospital over the trajectory of development decreased drastically. The senior managers at the IT department were aware of this side-effect of “going global”, nevertheless they assumed they would get greater benefits that would compensate for the loss of control.

The main points related to the three dimensions are summarized in the following table:

Table 1 Development, requirements, and control on the project

	Departmental EPR	NorEPR	IntEPR	GlobEPR
Organization of SW development	Amateur, confined in the clinical department	Norwegian: development by Norwegian subsidiary of MedInfo	European: involving subsidiaries in Norway, Sweden, and Germany	Global: development sites in US, Norway, Sweden, Germany, and India
Customer and requirements base	Single clinical department	5 regional hospitals (requirements for the whole hospital)	First Scandinavia, then European customer	Potentially customers all over the world
Control of Norhospital over the project	Norhospital is initially not interested in controlling local developments	20%: Norhospital is one of five customers	Still consistent: the design of IntEPR has the Norwegian Requirements inscribed in its architecture	Marginal: Norway is seen as a marginal market; larger emphasis is given to US customers (the largest potential customer base)

5 DISCUSSION

The aim of this section is to analyze and discuss the empirical material, emphasizing the dynamics of risk generation; once more, we would like to remind that we do not aim to engage in a discussion on risk management techniques, rather we will focus on how risk management decisions generate new

risks. Our discussion unfolds in three analytical steps: (1) we analyze the mechanism of risk management, and identify a pattern in the decision making process of the project; (2) we identify the logic behind the pattern, and describe it as a process of risk *escalation* in terms of range and scope; (3) finally, we interpret escalation as the risk management process generating new risks.

We will underline how analysis and understanding of risks involved in complex IS projects should not be limited to the confined spatial and temporal boundaries of a particular stage in the project management. Rather, the mechanism of new risk generation by means of risk management decisions should also be considered. This latter aspect, we will submit, is increasingly relevant as complexity and globalization of IS projects intensifies.

Finally, we will provide a theoretical interpretation of the observed risk dynamics by using the framework of *reflexive modernization* as proposed by Beck (*et al.* 1994).

5.1 The Recurring Pattern of Risk Management Decisions

In this section, we will highlight a recurring pattern of how decisions to increase size, scope, customer base, and budget of the project were made. The starting point of the project was the decision of a single hospital to develop a hospital-wide EPR. In this context, the EPR was clearly a technology aimed at *rationalizing* the production and consumption of information in the organization, by *integrating* sources and use practices of information. By rationalizing and integrating through the EPR, the hospital (specifically the IT department and the management) could gain *control* over the information in the organization. In this sense, the implementation of an EPR could help avoid the risk of a too fragmented and uncoordinated, thus potentially inefficient and ineffective, information system.

The decision to develop a hospital-wide EPR, in turn, raised questions of feasibility and sustainability. The five hospitals in Medakis estimated that the task was too complex and risky to be achieved independently. On the other hand, alongside complexity, the IT managers of the five hospitals considered that the design of an EPR could be standardized; that is, the requirements could be merged and aligned and the EPR easily adapted to local contexts of each hospital. This latter reasoning was triggered by the belief that *economies of scale* could be achieved through standardization. To assure the feasibility and sustainability of the development and to achieve the needed economies of scale, Medakis intentionally looked for a vendor with abundant resources and an international background. At this stage, the decision to address the risk of fragmentation and inefficiencies in the information system inside the hospital produced the need to evaluate another risk management decision. Accordingly, pushed by the same principles of rationalization, integration, and control through standardization, the EPR project gained a national scope.

The decision to involve an international partner opened up the horizon of NorEPR. The Medakis consortium immediately realized that NorEPR was just a tiny project in the international arena. It was soon assessed that Norway was representing a too small market and risked being crushed by larger projects. In this scenario, there were two alternatives: (1) either passively becoming sooner or later part of an international project with little or no decision-making power; (2) or take the first step by anticipating this likely scenario, and by actively inscribing the needed requirements in the new architecture. Interestingly, the joint decision of Medakis and MedInfo to internationalize the project followed the same logic of *rationalization*, *integration*, and *control*. From the point of view of Norhospital as part of Medakis, the new project (IntEPR) was a mean to *rationalize* the international distributed development of similar products. This was achieved by *integrating* requirements from the various countries. By doing so, Norhospital could gain *control* over the future trajectory of EPR developments in MedInfo by inscribing its requirements in the design. In other terms, the influence that Norhospital or the whole of Medakis had on the new project decreased, as the new product had to satisfy a larger customer base. Yet, in this new integrated scenario, Norway could have an international influence which was lacking before.

The next step, from IntEPR to GlobEPR, basically followed the same pattern. With MedInfo expanding in the global market through acquisitions, the horizon of IntEPR widened once again. Norhospital saw the growth and globalization of the medical division inside MedInfo as a positive sign, despite the decrease of influence on the project. Even more resources in fact could be allocated to the EPR project, in a way reassuring the Norwegian customers that the complexity of the development could be overcome. At the same time, MedInfo aimed for a global customer base, on the one side potentially increasing economies of scale, on the other side increasing the complexity of management and coordination of development processes and requirements handling.

Throughout the trajectory of the project, the actors involved in the decision-making process seemed to have followed a recurring pattern. At each stage of the project, the decision to go to the next stage by increasing its scope and range seems to follow the same quest for increased rationalization, integration, and control. At the first stage, these principles apply to the information generated and used in the hospital. At the second stage (creation of Medakis), the principles are applied to the gathering of requirements, the organization of the development process, and the control over costs. The same pattern applied with the internationalization of NorEPR to IntEPR, and subsequently to GlobEPR.

Certainly, many other factors have influenced the decision analyzed in this case. Moreover, the pattern we have identified is also a rather obvious rationale behind most IT projects; in this respect it is nothing new. What we aim to underline is that under certain conditions the quest for rationalization and greater control can produce opposite effects: increased complexity and loss of control. It is therefore relevant to investigate further in this dynamic in order to understand how the perception and redistribution of risk is affected.

5.2 The Logic of Escalation

So far, we have described the trajectory of the project along particular dimensions (requirements, development, and control). Moreover, we have highlighted a recurring pattern in each step of the trajectory of how decisions were met. We can now observe how iterative attempts to address the “problem” of developing an EPR brought about an unplanned creation of a larger “problem” which contained the initial one. More specifically, the initial quest for rationalization and integration through the EPR created a problem of a certain complexity. In order to address this problem, the five Norwegian hospitals teamed together and transformed a local problem to a national problem. If, on the one hand, more resource were guaranteed for the initial problem (one hospital), the increased complexity of the new problem (standardization of five hospitals in NorEPR) required the search for more resources. MedInfo provided the new resources, but also reshaped the problem once again. Being an international player, the contextualization of NorEPR in the international arena redefined the original problem by increasing the scope of the development and marketing at European level. The same logic then applied for the transition from IntEPR to GlobEPR.

If we put the trajectory of the project in perspective, we see how the recurring decisions followed a logic of *escalation*. Consequently, the escalation of the problem setting generated an escalation of the risks involved as well, as the number of actors involved and size and complexity of the project grew exponentially.

We can identify two sources of this logic of escalation: (1) a mechanism of re-appropriation of the complexity of the problem; (2) the role of MedInfo as a global amplifier of the setting of the project. Regarding the first source, iteratively a more complex situation is created at each decision making step in the process. The increased complexity then triggers the need of the redefinition of the project at a new level.

Regarding the second source, the escalation from a Norwegian to a global level could not be possible if the chosen vendor was not as global as MedInfo. Being a multinational with globalized networks of innovation, production, and marketing, MedInfo simply *enabled* the *amplification* of the project on a global scale with its existing infrastructure.

Finally, we can observe how the two sources drive escalation in different ways. At each iteration, the increased complexity of the development *constrains* the project to search for greater resources; while the global infrastructure of MedInfo *enables* the escalation to happen. In this sense, the escalation is pushed by the increasing complexity of the project, and pulled by the opportunity of standardization and economies of scale. Alongside with the project, its risks were also enhanced with the complexity, and amplified on a global scale. Thus, the risk management of the project at one level, required the creation and involvement of new risks at a next level, with greater scope.

5.3 On Globalization, Reflexivity and Risk

The case presented in this paper is an example of how local IS projects can be reinterpreted in a global context. As we have discussed, by being marginally connected to a global network, a local project like NorEPR is reshaped and deeply redefined: the locality of Norhospital becomes one of the elements of a wide global network. Moreover, interests and requirements are disembedded and reembedded in the global environment (Giddens 1990). In this global scenario, the IT department of Norhospital saw its interests less and less represented, and the risk of having delivered an unsatisfactory product increased. Paradoxically, the decisions taken by the IT department in the project have actively contributed to the creation of such risky situation. This reflexive mechanism has lead to a scenario that, from the perspective of Norhospital, is out of control.

The concept of reflexivity provides a theoretical interpretation to the micro-dynamics of the escalation process. Applied to our case, it explains how the production of greater complexity and less control, has its source in the attempt to rationalize and control a less complex problem. Moreover, the reflexive mechanism in our case regards a process of *modernization*, as, in fact, the aim behind the development of the EPR is rationalization and control. In terms of risk, the reflexive logic of risk management in the EPR project is paradoxically the following: in order to fight risk involved in the project, a more complex project involving greater risk is created. While it is true that for each new iteration of the project, risks are distributed in a different way, it is also true that the overall risk involved in the project is greater, as greater numbers of actors can be affected to a greater extent. Moreover, those actors have less and less control over the project.

The concept of *reflexive modernization*, applied to the analysis of risk, provides a framework to understand how new risks can be generated in the process of globalization of the EPR project. The new risks are related to possible side-effects and unintended consequences which can occur in a so tightly integrated global network.

6 CONCLUSIONS

In this paper, we have investigated the relation between generation of risk in IS projects and the process of globalization. Based on a case of globalization of an IS development project, we analyze and discuss how new risks are generated and distributed at each step of the globalization process. In particular, we have highlighted how decisions which increased the size and scope of the project were guided by the same pattern of principles: rationalization, integration, and control. Furthermore, we have shown how the project moved along a trajectory of escalation. The escalation, we submit, was due to the need to address an increased complexity of the original problem, and due to the opportunity of globalization, enabled by actors in the project, such as the vendor. Finally, we observed how the nature and distribution of risk changed at each iteration of the escalation process. The case and the analysis put an emphasis on the need to extend current studies on risk in IS project to include an understanding of the role of globalization. Indeed, traditional studies tend to focus the analysis of risk to confined temporal and spatial boundaries. We have shown that, in order to understand the escalation of risk in the case at study, a new framework is needed, which can relate to processes of globalization. With this purpose, we have proposed and applied the concept of reflexive modernization (Beck, 1999).

We claim that this concept provides new insights to the study of risk dynamics in IS development in contexts of globalization.

References

- Alter, M., and Ginzberg, M. (1978). Managing Uncertainty in MIS Implementation. Sloan Management Review, Fall (1978), pp. 23-31.
- Beck, U., Giddens, A., Lash, S. (1994). Reflexive Modernization. Politics, Tradition and Aesthetics in the Modern Social Order, Polity Press, 1994.
- Beck, U. (1999). World Risk Society, Polity Press, 1999.
- Boehm, B. W. (1991). Software Risk Management: Principles and Practices. IEEE Software, January (1991), pp. 32-41.
- Davis, G. B. (1982). Strategies for Information Requirements Determination. IBM Systems Journal, 21, 1 (1982), pp. 4-30.
- Ellingsen, G., Monteiro, E. (2002). Big is Beautiful: electronic patient records in large Norwegian hospitals 1980s – 2001. Scandinavian Journal of Information Systems. (*accepted for publication*).
- Giddens, A. (1990). The Consequences of Modernity, Polity Press.
- Hanseth, O., Braa, K. (2000). Globalization and 'Risk Society'. Chapter in From Control to Drift: the dynamics of corporate information infrastructures, C. U. Ciborra and Associates editors, Oxford University Press.
- Hanseth, O., Ciborra, C., Braa, K. (2001). The Control Devolution: EPR and the Side-effects of Globalization. The Data Base for Advances in Information Systems, special issues on EPR systems, Fall 2001, Vol. 32, No. 4, pp. 34-46.
- Klein, H.K., and Myers, M.D. (1999). A set of principles for conducting and evaluating interpretive field studies in information systems, MIS Quarterly, vol.23, no.1, 1999, pp.67-93.
- Lyytinen, K., Mathiassen, L., Ropponen, J. (1998). Attention Shaping and Software Risk – A Categorical Analysis of Four Classical Risk Management Approaches. Information Systems Research, Vol. 9, No. 3, September 1998, pp. 233-55.
- McFarlan, W. (1982). Portfolio Approach to Information Systems. Journal of Systems Management, January (1982), pp. 12-19.
- Rolland, K. (2003). Re-inventing Information Infrastructure in Situated Practices of Use, PhD Thesis, University of Oslo.
- Scott, V.S., (2000), "IT-enabled credit risk modernization: a revolution under the cloak of normality", *Accounting Management and Information Technologies*, 10, 221-255.
- Walsham, G. (1993). Interpreting Information Systems in Organizations, Wiley, 1993.
- Walsham, G. (1995). Interpretive case study in IS research: nature and method, European Journal of Information Systems, Vol.4, 1995, pp.74-81

Appendix 4

Jacucci, E., Shaw, V., Braa, J. (2006), “Standardization of Health Information Systems in South Africa: the Challenge of Local Sustainability”, Accepted for publication in *The Journal of Information Technology for Development*.² (forthcoming)

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STANDARDIZATION OF HEALTH INFORMATION SYSTEMS IN SOUTH AFRICA: THE CHALLENGE OF LOCAL SUSTAINABILITY

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Abstract

The implementation and development of routine health information systems, despite being important for planning and resource allocation, continue to provide a number of challenges for managers – the more so in developing countries where resources are scarce and human resource and technical skills limited. This paper contributes to the discussion on the implementation of sustainable information systems in developing countries by conceptualizing the interdependence between the local adaptation and appropriation of global standards, and the value that this adds to the global standard through improved quality of data. These processes mutually reinforce one another in the creation of sustainable information systems. The paper draws upon a case study of a rural hospital in South Africa where we document a successful change process where the organization, through innovative management and leadership, actively and successfully appropriated the national standard. The case study is used to highlight three main messages, namely that standards should be able to be locally appropriated (i.e. not so rigid that they cannot be adapted to local circumstances), that the creation of networks helps to support the local adaptation of standards, and that the layering of information systems (where different information systems feed one another) is important to encourage the use of information and helps to improve data quality.

Keywords: standardization, district health information system, sustainability

1. INTRODUCTION

The implementation of routine health information systems in developing countries is widely seen as critical for improving the quality of health services (Lippeveld *et al.* 2000). By providing the management of the health sector with timely and accurate data, for instance, resources can be allocated more effectively and epidemics can be monitored and appropriately addressed. In order to address the health system of an entire country it becomes imperative to standardize the processes of data production and collection at the various levels of the health sector. By standardizing the dataset to be collected, all sorts of statistical analyses between facilities, districts, and provinces become possible. While standardization is necessary to harmonize and integrate the information, the actual implementation of a standard at the local level often demands flexibility and adaptation (Hanseth *et al.* 1996; Rolland & Monteiro 2002; Timmermans & Berg 1997).

Especially when considering implementation of Information Systems (IS) in developing countries, issues of diversity and context dependency of the implementation sites become extremely relevant (Avgerou 2002; Avgerou & Walsham 2000).

In South Africa the Health Information System Programme (HISP) addressed this challenge by means of a particular standardization and implementation strategy: the creation of a hierarchy of standards to allow flexibility, and particular attention to build “local capacity” (Braa & Hedberg 2002; Shaw 2002). Accordingly, a core set of essential health data is defined and used at all levels (from the facility to the national level) and additional data elements are added at each level to satisfy local management needs. The set of essential data and its hierarchy constitutes what we can call the ‘standard’.

Once the standard is implemented, data quality in the entire system must be guaranteed to ensure its sustainability. Possibly, the best strategy is to make sure that the data is used at the level of collection. In order to obtain proper local use, the intervention should also build local capacity in terms of human resources, competencies, and infrastructural support. Hence, it can be argued that the sustainability of the “global” standard-based health IS is highly dependent on achieving a “local” sustainability of a local system which collects and reports the data.

While larger hospitals tend to receive more attention due to the greater complexity of the intervention, smaller hospitals risk receiving less attention and being marginalized in the process. In fact, rural and smaller hospitals are statistically less significant, usually have less infrastructural support, are less attractive for skilled workers, and it can be argued, but we will demonstrate the opposite, information systems are not so important after all to run them. This paper tries to look deeper into the challenge of “local” sustainability in the particular case of small rural hospitals.

More in general, the following issues have been identified as main sources of problems in achieving the sustainability of IS in Developing Countries (Sandford *et al.* 1994; Heeks & Baark 1998; Littlejohns *et al.* 2003; Braa *et al.* 2004):

- Limited time of donors' financial support
- Inadequate focus on local expertise
- Too narrow interventions (often a sustainable Health Information Systems requires a parallel reform of the health sector)
- Technical bias of projects (inadequate focus on Human Resource development)
- Pilot projects orientation

The paper contributes to the ongoing discussion on implementation of sustainable health information systems in developing countries by better conceptualizing the role of local implementation in the quest for global sustainability. By introducing the concept of *local sustainability*, we intend to stress a necessary condition in order to achieve the sustainability of the whole information system. The paper will show how this concept addresses some of the above mentioned recognized challenges of sustainability.

By drawing on a success case of a small rural hospital, the paper shows how *local sustainability* is not simply an equilibrium state to be reached. On the contrary, sustainability at the local level, we will show, means proactively appropriating what is imposed by the *global* standard in order to follow *local* vision and entrepreneurship.

The remainder of the paper is structured as follows. We will first position our contribution in the ongoing discussion on sustainability of information systems in developing countries. Then we will provide an account of the methodology for data collection, their analysis, and the process of theorization. Subsequently we will describe the case study. A discussion of the main findings will follow, where we will build the theoretical concept of *local sustainability* from the empirical evidence. Finally, conclusions will be drawn.

2. LITERATURE REVIEW

The overall aim of the paper is to contribute to the discussion on sustainability of information systems in developing countries by developing a theoretical concept. In the following section we will provide an account of the ongoing theoretical discussion in order to better position our contribution.

2.1 Sustainability of IS in Developing Countries

Sustainable development was first defined as “[...] development that meets the needs of the present without compromising the ability of future generations to meet their own needs [...]” (Brundtland 1987). This definition has been reinterpreted in the domain of Information Systems to address challenges in the design and in the implementation of sustainable IT solutions (Reynolds & Stinson 1993; Korpela *et al.* 1998;

Oyomo 1996; Misund & Høiberg 2003). Within the IS field, other contributions addressed the challenge of overcoming the socio-techno divide (Roode *et al.* 2004), and discussed the role of donors (Kimaro & Nhampossa 2004).

We will here focus on a particular aspect in establishing a sustainable national standard-based health information system. Specifically, we will try to analyze the *local* (hospital) dimension of creating a sustainable global (national) standardized system.

2.2 Sustainability and Standardization

If the implementation of the IS is not local but reaches a national dimension, standardization of the data, the tools for data collection, and the organization around them become key aspects. Especially in developing countries, IS implementation tends to be very sensitive to local context (Avgerou & Walsham 2000; Walsham *et al.* 1988). This implies that if the endeavor is one of developing the same idea (the standard) in many different contexts, the challenge of sustainability tends to split on two levels: a global level where the standard should be accepted by processes of institutionalization, support, networking, funding; and a local level where the standard needs to be implemented in a way that becomes well integrated in the local context. This creates a tension between the local and global scale development of the information system (Braa & Hedberg 2002). In terms of scalability of standards, the attempt to standardize across local contexts is mediated by the need for local flexibility of the standardized solution (Hanseth *et al.* 1996; Rolland & Monteiro 2002). This is even more true in the case of standards for health care, where the local conditions and work practices tend to reinterpret, if possible, any universal solution as a localized solution, thus creating “local universalities” (Timmermanns & Berg 1997).

In the context of the case study, the standardization of data, data collection tools, and organization support, was a necessary step to reduce the fragmentation of systems and channels of information nation wide. The aim was to reach a degree of coordination at national and provincial levels so to improve efficiency of health management. It follows that the “[...] local-scale development relies on development at the global scale [...]”, since “[...] local health units are part of, and dependent on, the larger health system and will therefore need to interact with the higher level health system by way of standards for data collection [...]” (Braa & Hedberg 2002).

The problem then, of balancing the local and global, has been addressed by suggesting that sustainability should be built “[...] through ongoing and continuous *translations*, around both the vertical (local appropriation) and horizontal (diffusion) axes [...]” (Braa *et al.* 2004). The concrete strategy suggested is to create an inherently flexible standard in the form of a hierarchy of standards. A core standard, an essential data set, is decided at national level and applied everywhere. At each lower level of the hierarchy

(province, district, facility) the data set can be expanded to include other indicators, which will be collected in the level below.

These strategies, which so far proved to be adequate, tend to address the tension between standardization and flexibility and find a balance between the global and the local.

3. METHODOLOGY

For the research presented in the paper we adopted an interpretive approach to case study (Walsham 1995; Klein & Myers 1999). The interpretive approach has proven to be a suitable methodology to study IS as social systems where the aim is to investigate in the intricacies of social and technical aspects of IS development (Walsham 1993). Moreover, case study research constitutes an adequate empirical enquiry that helps investigating a contemporary phenomenon within its real-life context, where boundaries between the phenomenon and the context are not clearly evident, and in which multiple sources of evidence are used (Yin 1989). Sources of data used during this research include: interviews, direct and participant observation, physical artifacts (PC and software programs, such as the District Health Information Software and the Budget Spreadsheet, and the Excel Ward register described in the case section), and documentation.

Initially, a considerable amount of data was collected during the visit to eight hospitals in Eastern Cape in the time span of two years (2003-2004): four district-rural, one district-urban, and three tertiary-urban. The hospitals approached were all experiencing evident problems in collecting and reporting health data. The majority of the hospitals visited were situated in rural areas in the Transkei region in the Eastern Cape Province. The data have been collected during a total of 22 days of on-site fieldwork which included interviews with hospital staff and observations of meetings and work performed by the HISP team. Hospital staff interviewed included the hospital superintendent, matrons, nurses, the information officer, data entry clerks and in some cases doctors.

Preliminary analysis of data from the hospitals indicated that the data was of poor quality and not suitable for use by managers to inform their decision making. This raised the question: how to build local capacity, and adopt a context sensitive implementation strategy of a national standard, that would ensure a sustainable HIS? It became clear at that point that visiting a hospital which was submitting high quality data could provide insights and ideas on how to intervene in more problematic hospitals. New Hope was selected from among a group of several hospitals in Eastern Cape with a “functioning” information system. Its rurality and small size make it a suitable case study example. The initial idea was that it could be compared to a similarly small hospital in a more rural area in the Transkei.

The first author spent two full days at the hospital conducting interviews with the hospital manager, the matron, the information officer and with nurses in the wards. During the same two days he participated to

the budget review meeting conducted by the budget review committee of the network of Provincially Aided Hospitals (see case chapter). Notes were taken during the observation and a whole session of interview was recorded on mini disk (MD) and transcribed afterwards.

Additional source of data specific to the case of New Hope Hospital was provided by the first author who previously played a role in the establishment of the network of Provincially Aided Hospitals and (at the time of the research) acted as manager of the HISP program in South Africa.

A diary, updated on a daily basis, served as a first step in the data collection and analysis and was used, together with the interview transcript, to build the empirical section presented in the paper.

As for the use of theory, the data presented in the paper was collected with the aim of understand what sustainability meant for the hospital in the case study. Hence, if not a theoretical framework, at least the discourse on sustainability (as presented in the theory section) served as initial guide to the fieldwork design and data collection.

Finally, the aim of this interpretive work (and type of contribution) is to generalize from the case by developing the theoretical concept of *local sustainability* in order to contribute to the discourse on sustainability of IS in developing countries (Walsham 1995).

4. CASE DESCRIPTION

In this section we will present the case study. First we will provide some background information on the nation-wide Health Information System standardization program in South Africa. The information system analyzed in the case is a part of the South African standardization program. Then we will describe how the information system works at New Hope¹ hospital and how it has been changed after the first implementation in 1999 as part of the standardization program. Finally we will make a preliminary analysis of contingent factors which contributed to the creation of a locally sustainable information system.

4.1 The quest for a national standard for routine health data in South Africa

As part of the Reconstruction and Development Program (ANC 1994b) in South Africa an effort was launched for the restructuring of the health sector in all provinces. This effort included the creation of a unified Health Information System (HIS) (ANC 1994a). The HISP (Health Information Systems Programme) initiative addressed the challenge in the Western Cape Province by defining an Essential Data Set (EDS) of indicators and by developing a District Health Information Software (DHIS) to support data collection, aggregation and analysis at the district level. Eventually, the HISP initiative scaled up to

¹ The real name of the hospital has been disguised.

national level and the standardization process was carried out in the other provinces in a coordinated manner (Braa & Hedberg 2002; Braa *et al.* 2004).

In the Eastern Cape Province the implementation of the DHIS and the EDS standard was launched in 1999. As part of the implementation, hospitals were provided with new forms and registers for data collection, computers, and the DHIS software. In addition, training sessions were organized for the hospital staff (Shaw 2002).

An assessment of many hospitals in Easter Cape in 1999 indicated that:

“Data is collected ‘at all levels in hospitals, but most of it is never used’.

Indicators are submitted to the district offices, but give a ‘very bland picture of administrative activities, and no feeling of what goes on inside hospitals’.

‘Registers are non-standardized, and tend to be anarchic, and hand written’, and often on an assortment of different types of paper and books.

‘Analysis of data is minimal at all levels’.” (Shaw 2002)

4.2 Implementation at New Hope rural hospital

In the following sections we will provide an account of how a small rural hospital in the Eastern Cape Province managed to appropriate the standardized HIS in a successful and proactive way.

4.2.1 Background

The New Hope Hospital is a small hospital of 25 beds in the northern area of the Eastern Cape. The town of New Hope was founded in mid 1800 and is reachable with a tar road.

The hospital is staffed with two sessional doctors (amounting to a full-time equivalent doctor) and 40 staff (of which 20 are nurses) as well as a hospital manager, an admin officer, one information officer, and a clerk. The registers, the DHIS and a computer were installed during the DHIS rollout in Eastern Cape in 1999. The intervention put in place an information workflow complete of registers, forms, a computer and the DHIS application (see figure 1 for a simplified overview).

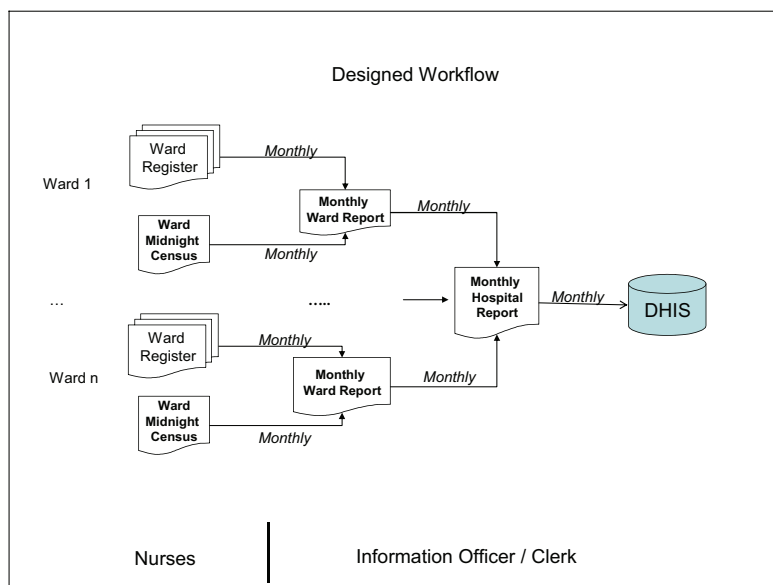


Figure 1 The workflow of information initially implemented by HISP in 1999.

The Ward Registers are books where the nurses should enter the data about the patients that are admitted and discharged. There is one long line to fill for each patient and often the fields (like the type of diagnosis or type of separation) simply require a tick (hence the name “tick register”). The Midnight Census is a form compiled by a nurse during the night shift indicating the number of patients present in the hospital during the night. A ward report is then compiled on a monthly basis. The data from the monthly ward reports is then aggregated at the hospital level and then usually entered in the dedicated software: the District Health Information Software.

The hospital is one of a group of hospitals, called the Provincially Aided Hospitals (hereafter called the PAH network). They have been functioning as semi-autonomous hospitals in the Eastern Cape and other provinces for over 10 years. A service level agreement (SLA) between the Eastern Cape Province and the hospitals defines their size (the number of beds) and the amount of financial aid. As part of the SLA, the hospitals are required to raise 10% of their budget through the provision of services to private patients, and the balance (which is 90% of their total budget) is funded through the province.

In order to run and sustain the PAH network a budget review committee periodically assesses the budget and the routine health data, and provides recommendations to the managers of the hospital. To maintain the budgetary information, the hospitals are provided with an Microsoft Excel application developed by the budget review committee with the aid of the provincial office – the Budget Spreadsheet.

4.2.2 The Information System of the Hospital

Creativity and Teamwork

The situation we found in New Hope was surprising. The registers and the mid-night census form provided during the DHIS roll out were not in use. The staff in the hospital decided that these were too time consuming (especially for the nurses). Hence, the manager, the clerks, the admin officer, the sisters, and the matron discussed what information they needed to collect and how, and designed new forms according to their needs. They developed an own solution which is now working (Figure 2), which both provides data for the DHIS (which is mandatory) and data for themselves in a manner more appropriate to their situation.

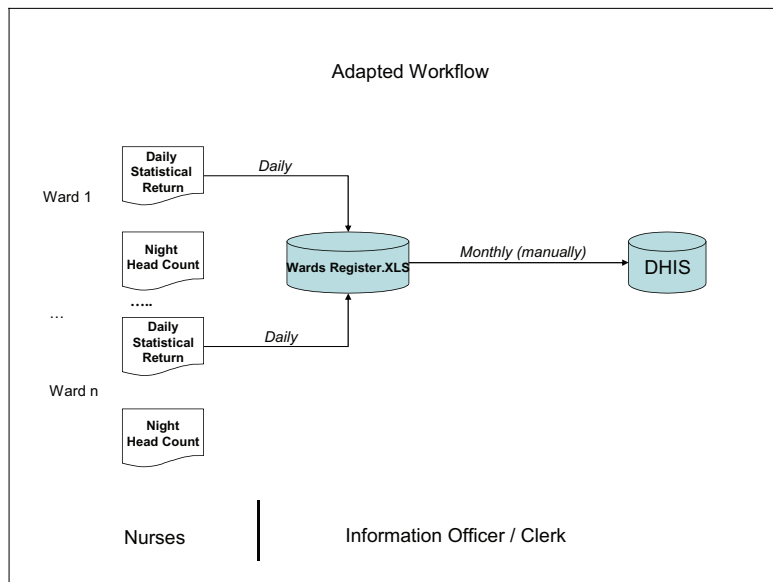


Figure 2 The redesigned information workflow: most of the registers are gone.

Interestingly and in contrast with basically all the other hospitals visited, they did not use an admission/discharge register, nor a midnight census. They substituted them with two forms compiled daily. One is the Daily Statistical Return, the other is the Night Head count. The Daily Statistical Return lists all admissions/discharges of the day and is filled in by the sisters as the patient arrives or is discharged. At the end of the day the admin clerk does the round of the wards and collects these forms and writes each single entry in the Ward Register Spreadsheet (a replication of the ward register in MicroSoft Excel). The nurses now have to enter very simple data compared to the ward register. They also do not need to calculate and compile the monthly reports. Overall the nurses perceived that their administrative work was considerably eased.

The Night Head count is used by the sisters for local use to know every day who is in the beds in the wards. At the end of the month the information officer easily counts and calculates the aggregated data from the Ward Register Spreadsheet and enters them in the DHIS monthly report to be handed to the district information officer. At the same time she updates several graphs depicting various monthly statistics, which we found hanging in the manager's office. Examples of those statistics are: in-patients admissions, turnover of patients, bed occupancy, theater activity (source of large costs), and number of private (paying) patients.

The observed re-appropriation of the implemented standardized workflow was possible primarily thanks to the availability and teamwork of skilled and competent people. The roles of both the hospital manager and of the information officer were key to the change process: the manager had the vision of an improved local IS and the information officer had the necessary competencies and computer skills to implement it.

The main results of the redesign are:

- Nurses have less and simpler data to enter and no monthly report to compile: they perceived that their administrative work was considerably eased
- There is one form less: the midnight census is indeed redundant as the same information can be calculated from the Ward Register Spreadsheet
- There are less steps in the workflow which require manual calculations and data entry, hence there is less possibility of creation and propagation of mistakes
- As the Ward Registers are now replicated in the Ward Register Spreadsheet, immediate/daily analysis of data is possible
- A drawback, however, is that the clerk or the information officer are now required to be more skillful and have now a greater responsibility.

From what we have observed, the redesigned system still had considerable space for improvement since not all the computing capabilities of Microsoft Excel were exploited.

The manager stressed that all this was possible only through a good cooperation and teamwork:

"We try our best and we really work as a team. You can't do anything if you don't have the support of others. Then you can close down the Hospital."

What was surprising for us was that no external intervention, aid, or pressure played a role in the vision and execution of the redesign. It was all possible with the given tools (by the DHIS rollout) and the local human resources.

Use of Information

As mentioned, graphs were regularly (monthly basis) produced from the DHIS. When we asked the manger what she would do with all that information and the graphs, she replied that she used it mainly for two things: to manage the hospital and to do financial negotiations with the district health administration.

Looking at the graphs on the wall we also asked a more direct question:

Researcher: *What do you see from these graphs?*

Manager: [Looking at the in-patient admission statistics] *The in-patient admission is a lot. It shouldn't be so many admissions at the same time. So I must go and look that doctors don't just seek patients to admit them to set the stats high. Turnover tells me how quick the patients move out; also the average days per patient that they don't stay too long. That they don't stay longer than 5-6 days. Our bed occupancy is confronted also with the daily costing from kitchen and cleaning.*

[In the bed occupancy graph] 100% will be 25 beds. But we are using more.

R: *And the peak in the theater activity the end of last year?*

M: *There was a problem with cesarean sections. We had a lot of problem births. This other graph is to see how our private patients go because we need to make up our 10% [10% of the hospital budget must be privately funded by 'private' patients].*

If we look at the complete picture of the Information System in place in New Hope Hospital (Figure 3) we see that there are several end-users of the information at local (ward) level, hospital, and district (or higher). We also see that the three computerized components (the DHIS, the Ward Register Spreadsheet, and the Budget Spreadsheet) all play the central role of preparing and aggregating the data for the end users.

In general we can observe that all the information is collected and used for a reason. There is no fall-out of information (information collected but not reported or used) and the information channels are also sometimes integrated (e.g. the budget review information builds upon an indicator calculated with the DHIS).

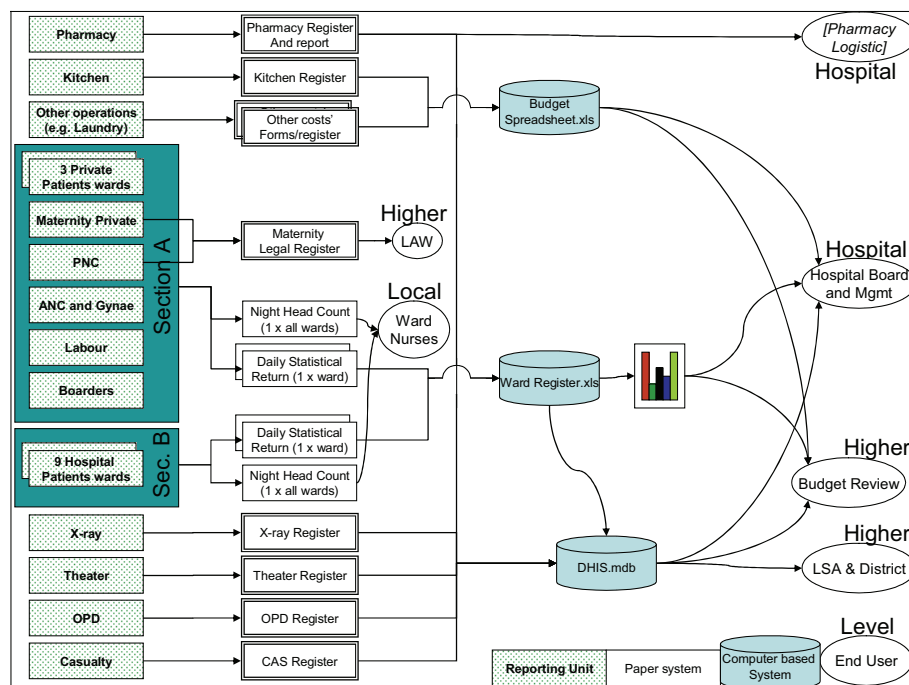


Figure 3 The overall view of the information system at New Hope Hospital.

Layering of information systems

A last element we would like to highlight is the relationship between the described hospital information systems and the budgetary system used in the PAH network. During the budget review session of this hospital, which we attended, the most relevant indicator that was used to evaluate the overall management performance was the cost-per-patient-day indicator. This indicator is created by dividing the total costs of the hospital by the number of in-patient days. The number of in-patient days is taken from the statistics created from the hospital information system (particularly from the mid-night census data) and entered in the DHIS. This indicator should be between 350-400 ZAR per in-patient day.

It is worth noting that poor quality of the in-patient-days indicator reflects an underreporting of the number of in-patient-days. Hence, the more accurate the number of in-patient days, the lower the cost per patient day, the better the indicated performance, the better the outcome of the budget review.

The layering of one information system over another creates dependencies and forms of incentives for keeping the quality of data accurate.

4.2.4 Analysis of contingent factors

In this section we will do a preliminary analysis of some themes which emerged from the fieldwork that resulted to be relevant for the positive outcome of the local redesign and change process.

We don't have evidence that the training during the roll out implementation of the DHIS was of a better or worse quality than for other hospitals of the same size. Nevertheless, it was clear to us that the manager and the admin officer had sufficient competence to fill any possible gap. The information officer of the hospital implemented the idea of replicating the Ward Register in Excel, so to have continuous and accurate statistics. This shows a probably above-average level computer literacy compared to her colleagues in other rural hospitals in Eastern Cape. The hospital organization acted as a team, sharing knowledge and creativity. This is evidently the main source of knowledge, rather than the simple sum of the individual skills.

Moreover, teamwork also meant participation so that the nurses had their requirements of having less administrative workload fulfilled. Being part of the final solution, made them motivated to sustain it. This kind of teamwork and leadership evidently kept the motivation of the staff high.

The Provincially Aided Hospitals (PAH's) are not financially advantaged compared to provincial hospitals (who get 100% subsidy, and are not autonomous). In reality the cost per patient day in the PAH's is less than that in the provincial hospitals. However, it appears that there is a caring ethos that has been created around being an employee of a PAH, that translates not only to care of patients but also to care of the environment. It therefore appears as if these hospitals are financially advantaged, but in reality their ethos translates to taking a greater interest in keeping the environment around them neat and tidy. Still, the hospital had to constantly negotiate with the district office to have their workload recognized financially.

Finally, as mentioned, New Hope managed to become part of a wider network of Provincially Aided Hospitals. As illustrated, the network sustains itself by means of mutual assessment and mentoring. In addition, the network can act as one actor for bigger arguments with the province. In a way, the network helps the hospital to exit its rurality and risk of isolation.

5. DISCUSSION

In this section we will further analyze the data to understand the factors which positively contributed to the reinvention and sustainability of the system. In the light of such factors we will then generalize one step further in order to better conceptualize what *local sustainability* means and why it is relevant to achieve the overall sustainability of the *global* system.

5.1 What can be learned from New Hope

5.1.1 Creating space to allow local innovation to ensure local relevance

Building local infrastructural and human resources (HR) capacity is certainly a key aspect for a sustainable information system (Shaw 2002). In New Hope Hospital this capacity manifested itself by the manager displaying her rigorousness, willingness to improve the situation, and determination to achieve the improvement. These skills were nourished by the PAH network which met frequently (four times per year) and encouraged local innovation to improve care provided to patients. Her awareness of the importance of a participatory approach in the design of the new solution was probably the most important factor for the success of the change process. In this sense her authority was used to lead the change, rather than simply as a mean for control of bureaucratic activities. Certainly, without the skills of the information officer the changes would have probably not been so radical.

The main characteristic we would like to highlight, and which we suggest constitutes the core of the success, is the willingness to improve together with the ability to reflect and question the status quo. In this hospital, the status quo created by the DHIS implementation was simply the starting point for a local reinterpretation of what that implementation meant. The people in the hospital managed to make a distinction which is not always understood: the distinction between the means and the goal of the implemented standardization. The actual standard (the Essential Data Set, or EDS) is an abstract construct and constitutes the specific goal of the standardization process. The tools and the workflow design which is provided are elements around the standard, but are not the goal. They are the suggested means to achieve the specific goal of filling in the data sets with appropriate data.

These tools (registers, forms, and workflow) are provided as a “start-up” kit, where the information system is lacking or is too fragmented. But the hospitals are not really bound to them. In principle they can arrange their own information system as they like, as long as good quality data is passed above (e.g. through an EDS). New Hope Hospital did not fall in the easy trap of simply following the orders of the province in a bureaucratic way. Instead, with a bit of entrepreneurial spirit, they reorganized the system to meet the goals of the province and their own as well. What we can hence observe is that the EDS and the DHIS acted as enabling (i.e. not as constraining) factors through their reflexive appropriation by the hospital.

Local adaptation of the standard is particular important in obtaining buy-in to the system, which is important to ensure long-term sustainability. Because they have “made it their own” they have an interest in seeing it work and continue to “invest” in the systems and processes to keep it working. In other hospitals, where there is less innovation, the system and tools are seen as “coming from province” and the product is “for province”. In this case there is little interest whether the product (the data in the EDS) is either good or bad, because it has little local relevance.

5.1.2 Networking against marginalization

Rural hospitals always run the risk of being marginalized. Poor communication and transport, often together with poor socio-economic conditions, make hospitals in rural areas less attractive for skilled employees. In the worst case a vicious circle of de-motivation and lack of teamwork between professions in the organization risks setting the hospital in a dangerous downward spiral. While this phenomenon has been observed in one particular hospital in the Transkei (see endnote 1), it is certainly not the case of New Hope. Yet, the risk is concrete, and, when addressing the implementation in other small and rural hospitals, it should be taken into account seriously.

A possible counter-strategy to fight the risk of marginalization (whether real or potential) is becoming part of an active network of similar hospitals. By becoming part of the Provincially Aided Hospitals, New Hope Hospital escaped this risk gaining advantage at least on two fronts: (1) the hospitals in the network mutually support and learn from each other, by frequently monitoring and improving each other's management performance; (2) the network acts as an institutional amplifier of New Hope Hospital's voice and needs.

5.1.3 Layering of information systems

A last aspect we would like to emphasize is the relation between the Financial Budget information system and the information system for health data.

As mentioned in the case section, the cost-per-in-patient-day indicator constitutes a clear example of new possibilities opened by a working health information system: the better the health information system, the more accurate the in-patient-day indicator, the more accurate the evaluation of the management performance (cost-per- in-patient-day).

Thus the layering of health and budget information systems creates a double incentive:

- in order to have the budget review working, the health information system of the hospital must also be working
- the more accurate the in-patient-day indicator, the lower the cost-per-in-patient-day indicator (usually bad quality of the indicator reflects in an underreporting of in-patient days), the better the performance indicator and the outcome of the budget review.

5.2 What does Local Sustainability mean

In this section we will try to summarize our findings and generalize them by explaining the meaning and the role of the concept of "local sustainability".

In the theory section, we argued that the (global) sustainability of a standard-based system is dependent on its use, which in turn is dependent on the quality of the information which is reported. Apparently, the best strategy is to make sure that the data is used locally (at the point where it is collected). This requires flexibility of the standard (to enable local adaptation and appropriation) and the establishment of local capacity (or unleashing the local potential) to maintain it.

What we intend to stress is the perspective of the local site (in our case a small rural hospital). What is clear from the case is that local use, local capacity building, and local appropriation of the standard are part of the same effort of locally achieving a sustainable information system.

But *local sustainability* is more than sum of these parts: it implies a shift of responsibility from whatever hierarchical level above to the very people managing the data locally. *Local sustainability* is reached not simply when the data is collected and used properly, but when the local organization at the bottom of the hierarchy is also capable to proactively reinvent the standard by independent reflection on its own work.

In this sense, sustainability is not the reaching of a state of equilibrium; it is rather created, reinvented, and continuously negotiated. All this implies a proactive engagement by the *local* in re-appropriating (in its own terms and following its own vision with entrepreneurship) what is imposed on it by the *global*.

Finally, we can analyze how these findings address the more general set of common problems of building a sustainable system. Referring to the issues listed in the introduction which contribute to lack of sustainable systems in developing countries, we argue that by creating the conditions for local sustainability:

- The implementation on the local level becomes less dependent on the limited time of donors' financial support
- An increased focus on local expertise is facilitated
- Does not prevent too narrow interventions. However, a precondition for local sustainability is a dialectic relationship with a more general or global effort
- A more holistic (not purely technical) approach is forced which focuses on leveraging local innovative resources

6. CONCLUSIONS

In this paper we have addressed the challenge of creating a sustainable standard-based nation-wide Health Information System. More specifically we have analyzed how the quest for sustainability splits on a global and a local level. In both levels sustainability needs to be created and managed, and each level is dependent on the other level. Hence, on the local level the main challenge faced by hospitals is to create a locally

sustainable information system using what is provided by the global standardization process as a starting point.

With the help of a case study, we have demonstrated how *local sustainability* is not simply a state to be reached. It is rather a continuous change process where the local organization reflects upon and proactively reinterprets its own way of working.

Finally, we have emphasized how creating the condition for *local sustainability* is particularly important for small rural hospitals in order to reduce the risk of being further marginalized. The case suggests that cultivating a sense of entrepreneurship, networking with other similar hospital, and interlinking information systems within the hospital may be possible strategies to create *local sustainability*.

[Endnotes]

(1) In a previous fieldwork we visited several rural hospitals in the Transkei region. In one of them (the smallest) it appeared to us that building a working Information System was the least of the problem. The organization was under stress; the employees were demoralized and there was very little team work between the various professions.

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7. REFERENCES

- ANC (1994a). *A National Health Plan for South Africa*, African National Congress, Johannesburg, South Africa.
- ANC (1994b) *The Reconstruction and Development Programme*, African National Congress, Johannesburg, South Africa.
- Avgerou C. (2002). *Information Systems and Global Diversity*, Oxford University Press, Oxford, UK.

- Avgerou C., Walsham G. (2000). *Information Technology in Context: Studies from the perspective of developing countries*, Ashgate Publishing.
- Braa J., Hedberg C. (2002). "The Struggle for District-Based Health Information Systems in South Africa", *The Information Society*, Vol. 18:113-127.
- Braa J., Monteiro E., Sahay S. (2004). "Networks of Action: Sustainable Health Information Systems Across Developing Countries", *MIS Quarterly*, Vol. 28, No. 3, 337-362, September 2004.
- Brundtland G. H. (ed.) (1987). *Our Common Future: The World Commission on Environment and Development*, Oxford University Press, Oxford, UK.
- Hanseth O., Monteiro E., Hatling M. (1996). "Developing information infrastructure: The tension between standardization and flexibility", *Science, Technology and Human Values*. Vol. 21 No. 4, Fall 1996, 407-426.
- Heeks R., Baark E. (1999). "Evaluation of Donor Funded Technology Projects in China", Working Paper, Institute for Development Policy and Management (IDPM), University of Manchester.
- Kimaro H. C., Nhampossa J. L. (2004). "The challenges of sustainability of health information systems in developing countries: comparative studies of Mozambique and Tanzania", Timo Leino, Timo Saarinen and Stefan Klein (Eds.), *Proceedings of the 12th European Conference on Information Systems*, Turku, Finland.
- Klein, H.K., and Myers, M.D. (1999). "A set of principles for conducting and evaluating interpretive field studies in information systems", *MIS Quarterly*, vol.23, no.1, pp.67-93.
- Korpela M., Soriyan H. A., Olufokunbi K. C., Mursu A. (1998). "Blueprint for an African Systems Development Methodology: An Action Research Project in the Health Sector", in C. Avgerou (ed.), *Implementation and evaluation of information systems in Developing Countries I*, pp. 173-285, International Federation for Information Processing, Vienna.
- Lippeveld T., Sauerborn R., Bodart C. (2000). *Design and Implementation of Health Information Systems*, World Health Organization, Geneva, Switzerland.
- Littlejohns P., Wyatt J.C., Garvican L. (2003). "Evaluating Computerized Health Information Systems: Hard Lessons Still to Be Learnt", *British Medical Journal*, (26), April 2003, pp. 860-863.
- Misund G., Høiberg J. (2003). "Sustainable Information Technology for Global Sustainability", *Digital Earth – Information Resources for Global Sustainability Symposium*, Brno, Czech Republic. Available from: http://www.ai.hiof.no/~gunnarmi/omd/dig_earth_03/ [Accessed August 2004].
- Oyomno G. Z. (1996). "Sustainability of governmental use of microcomputer-based information technology in Kenya", *Global IT & Socio-economic Development*, Mayuri Odedra-Straub (Ed.), Ivy League Publishing, USA.
- Reynolds J., Stinson W. (1993). *Sustainability Analysis, Primary Health Care Advancement Program*, Aga Kahn Foundation, Bangkok, Thailand.
- Rolland K. H., Monteiro E. (2002). "Balancing the Local and the Global in Infrastructural Information Systems", *The Information Society*, Vol. 18:87-100.

- Roode D., Speight H., Pollock M., Webber R. (2004). "It's not the Digital Divide-It's the Socio-Techno Divide", Timo Leino, Timo Saarinen and Stefan Klein (Eds.), *Proceedings of the 12th European Conference on Information Systems*, Turku, Finland.
- Sanford P., Kanga G.J., Ahmed A.M. (1994). "The Management of Health Services in Tanzania a Plea for Health Sector Reform", *The International Journal of Health Planning and Management*, (9:4), 1994, pp. 295-308.
- Shaw V. (2002). "The Development of an Information Systems for District Hospitals", *Proceedings of the 7th IFIP 9.4 Working Conference*, Krishna S. and Madon S. (eds.), Bangalore, India.
- Timmermans S., Berg M. (1997). "Standardization in action: Achieving universalism and localization in medical protocols", *Social Studies of Science*, Vol. 27:273-305.
- Walsham, G. (1993). *Interpreting Information Systems in Organizations*, Wiley, 1993.
- Walsham G. (1995). "Interpretive case studies in IS research: nature and method", *European Journal of Information Systems*, (1995), Vol. 4, pp.74-81.
- Walsham, G., Symons, V., Waema, T. (1988). "Information Systems as Social Systems: Implications for Developing Countries", *Information Technology for Development*, Vol. 3, No. 3.
- Yin, R.K. (1989). *Case Study Research – Design and Methods*, Newbury Park, California, Sage Publications.



Appendix 5

Jacucci, E. (2005), “Duality of Control in Large-Scale IS: the Case of the Health Information System in South Africa”, In: Schreyögg, G., Sydow, J., Quack, S., Rudolph H. (eds.), *Proceedings of the 21st EGOS Colloquium*, Berlin, Germany, July 2005.



Duality of Control in Large-Scale IS:

The case of the Health Information System in South Africa

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Abstract

The paper addresses the issue of balancing the tension between centralization and decentralization of control in large-scale, standard-based Information Systems (IS) in Developing Countries (DC). Understanding the dynamics of control structures is relevant for improving the chances of success in development and implementation of Health IS in DC. By drawing from a case on the implementation of the Health IS in South Africa, the paper makes two contributions. First, it empirically identifies the two logics of control which create the tension in the system. Secondly, it proposes a model providing an interpretation of how the two logics work by contradicting, interfering, and supporting each other. Through the concept of “duality of control”, the study presented in the paper provides an interpretation of the dynamics of control structures and their relation with centralization and decentralization forces.

1. Introduction

This paper addresses the issue of balancing centralization and decentralization of large-scale, standard-based Information Systems (IS) in Developing Countries (DC). By large-scale IS we mean IS with large geographical and organizational span, such as national Health Information Systems (HIS). With standard-based IS we refer to such large-scale systems where the horizontal and vertical communication is based on common protocols supporting information gathering, aggregation, and reporting.

HIS in DC are seen to have a major role in facilitating decentralization of responsibility in order to strengthen health management at local level and build local capacity (Braa 1996; WHO 2000). By gaining local empowerment and negotiation power, the peripheries can thus become the backbone of a sustainable national HIS (Heeks 1999; Braa *et. al* 2004). However, the aim of local empowerment must be balanced with the need of maintaining some degree of central coordination and control. This generates a tension which needs to be balanced and managed.

In practice, decentralization and centralization of the HIS can refer to the system architecture and the development methodologies, as well as the distribution of decisional power. In fact, the two are related, as greater local flexibility of the development reflects in greater local empowerment to adapt and use the information to better serve local needs. We will hence not propose a clear distinction between the development approach and the designed distribution of decisional power to be supported.

On the front of development, the issue of finding the right approach in IS projects in DC has proven to be difficult (Walsham 1992). On the one hand, excessive centralization of design and development risks making the system too rigid and unadaptive at the local level. On the other hand, excessive decentralization risks generating fragmentation and lack of coordination. Moreover, the development approach is often influenced by fears of institutional actors of loss of central power and attitudes favoring autocracy.

However, studies show that centralization and decentralization of power and control in the information system are not purely development choices but also possible effects of IS implementation (George & King 1991). Hence, the issue of finding the right balance should take into consideration both the intentions of the developers and the inherent dynamics of large IS. This dynamics may generate tensions between centralization and decentralization of power and control (George & King 1991; Zuboff 1988; Elmes *et al.* 2004). A focus on control and control structures can be an appropriate perspective to study the tension (King 1983).

The aim of the paper is to be specific about the mechanism by which control structures are generated and managed in large scale IS. Our empirical research was guided by the following research questions:

Q1: What are the control structures which reflect this tension in large-scale IS?

Q2: What is their relation and how can it be exploited to achieve a successful implementation?

The paper bases the discussion on a case study conducted on the development and implementation of the national health information system in South Africa. By analyzing the principles and development approach, and the use at the provincial, district, and facility level, the paper aims at unveiling the underlying tension between the need of centralized control and standardization, and the need of decentralized control and adaptation of the system.

Based on the analysis of the case the paper makes two contributions. First, it empirically identifies the two logics of control which create the tension in the system (exogenous and endogenous control). Secondly, it proposes a model providing and interpretation of how the two logics work in the system by contradicting, interfering, and supporting each other, ultimately creating a virtuous circle of sustainability. We

interpret this phenomenon as constituting a duality (as opposed to dualism) of control structures in the system.

The paper is structured as follows. First a literature review on IS decentralization and control is provided. Secondly the methodology of the research is presented. Subsequently the case is described. An analysis and discussion section follows, where the main contribution of the paper is synthesized.

2. Review of literature

In this section we will provide a review of relevant literature with the aim to first position our contribution in the ongoing discussion on IS centralization-decentralization in DC, secondly to frame the analysis within the perspective of control structures.

2.1 IS Centralization-Decentralization in DC

According to Walsham (1992), one of the reasons why system may fail in DC can be traced to an inappropriate top-down development and implementation approach. That is that decisions, standards, and policies are decided up in the hierarchy and then imposed downwards to the peripheries of the system. He suggests that an alternative approach could be a bottom-up one, where voice is given to the people operating down in the hierarchy by means of participation to the design and development of the system. This shift, however, implies a redistribution of power and control which creates a tension. Often, this shift is resisted due to fears of loss of central power and existing cultural attitudes favoring autocracy (*ibid.*).

For the sake of analysis, Walsham proposes a “polar categorization” of decentralized large-scale IS. On one extreme (type A) are systems which provide information for higher level of control. These systems should be designed at the center, with a top-down approach and the implementation should focus on training lower level staff on data collection. On the other extreme (type B) are systems whose primary purpose is providing information for lower level support. The design should happen by local-center interaction and the implementation should address data collection training but also continuous learning and system modification at the peripheries (*ibid.*).

However, reality, as usual, lies in-between:

“It is important to note that the systems described above [type A and B] are ‘ideal types’, in the sense that any real system will be much more *complex* than is represented here, and will normally contain elements of both Type A and Type B systems.” (*ibid.*) [italic added]

In fact, one of his conclusions is that “[...] Type B systems do not necessarily decentralize power to local levels [...]” and empowering staff at local level may “[...] result in closer central surveillance and overall control of local activities.” Alas, following Walsham’s reasoning, the question remains open: whether and how to decentralize control and power. Moreover, a control decentralization approach

(Type B) may trigger closer centralized control, and vice-versa. We thus propose to reframe to centralization-decentralization problem in terms of processes and tensions by which control structure are changed.

2.2 Double Nature of Control in Large-Scale IS¹

In this section we will review a particular body of literature which focuses on the relation between information and communication technologies and control. In particular, this literature underlines the dual nature of control which is enabled by communication technologies.

In organizations, information technologies are seen as amplifiers of communication flows and structures. The synergy of those with systematic management spawned a new range of possibilities of amplifying control structures as well (Yates 1989). Consequently, control could be better exercised downwards, upwards and in an indirect form; downwards in the forms of abstract rules and procedures coming from above; upwards through the data submitted from below, with a by-product of lateral flow of coordination; and indirect control through the development and diffusion of re-personalized communication tool running on the same infrastructure (Yates 1989).

Thus information technology does not only substitute and rationalize existing process through their automation. Its bidirectional nature and flexibility (Yates 1989) allows the flows of information to travel in multiple directions, thus providing a new service to the organization: to *informate* it (Zuboff 1988). This new role of a technology used in organizations implies that potentially new power is given to its peripheries. Automation is the quintessential form of centralized and hierarchical control. A technology that not only automates but informs, is a technology which provides both the possibility to exercise control (and power) and the tools to question the very same control (and power) structure.

Mulgan (1991) underlines how communication systems (IT in our case) are in fact control infrastructures, as "[...] any channel of communication can also serve as a channel of control." But, as already Zuboff noted, IT is not merely an automation technology used to strengthen one type of control. In communication systems,

"[c]ontrol has a *double nature*. [...] One is the notion of control as exogenous, imposed, abstracted, and rationalized. The second is the notion of control as endogenous, as communicative and shared. [...] The tension between the two ideas of control forms a dramatic fault line at the heart of all information technologies which simultaneously offer massive enhancements of both types of control." (*ibid.* p.4) (*italic added*)

In order to conduct the analysis of the case, we will mainly draw from Mulgan's conceptualization of the double nature of control and will frame it within the debate

¹ There are recent studies that investigate drift, side-effects, and out of control dynamics which can constitute a possible theorization of the duality of control related to large-scale IS (Ciborra *et al.* 2000). However interesting, the study of these phenomena is not the main focus of this paper and is thus not included in the review.

around centralization and decentralization of IS development and use. Our aim will be to further develop this thesis proposing the concept of *duality of control* to describe the model of virtuous interdependencies of control structures found in the case. In order to do so, the case will try to let the two logics of control (endogenous and exogenous) emerge from the data.

3. Methodology

For the research presented in the paper we adopted an interpretive approach to case study (Walsham 1994). Initially, a considerable amount of data was collected during the visit to over 10 hospitals in Eastern Cape in the time span of two years (2003-2004). The majority of the hospitals visited were situated in rural areas in the Transkei region in the Eastern Cape Province. Data was collected mostly through participant observation and semi-structured interviews. Interviewee included nurses, doctors, information officers, data entry clerks, hospital managers and CEOs, managers at the provincial level as well as facilitators, managers, and developers of the HISP project in South Africa.

A preliminary analysis of the data collected focused our attention on the existing tension between the local and the central levels of the system. As part of a broader study of this tension, this paper explores the case from the perspective of control structures. A previously published paper explores the same tension from the perspective of standardization and sustainability (Jacucci *et. al* 2005).

As for the use of theory, the paper draws from the social studies of communications systems in organizations to provide an interpretive lense for the case. However, the theoretical contribution of the paper goes beyond the mere application of concept in the context of the case study. The paper proposes the concept of “duality”, as opposed to “double nature” or “dualism”, to better conceptualize the observed dynamics of control structures in large IS.

4. Case Description

In this section we will present the case discussed in this paper. The case section is organized in four paragraphs. Each paragraph provides an insight into the logics of the Information System from a particular level. The first paragraph illustrates the historical background and motivation behind the system implemented and presents a bird’s-eye view on the rationale behind the system. The second paragraph provides an account of the logics at the provincial level. The third paragraph presents an insight at the district level, while the fourth paragraph reports of a successful implementation at the facility level in a rural hospital.

4.1 The rationale behind HISP

In order to better understand the nature of the architecture of the Information System at case, we will here provide some contextual and historical information. A bird’s-eye view on the main architectural principles of the system will follow.

As part of the Reconstruction and Development Program (ANC 1994b) in South Africa an effort was launched for the restructuring of the health sector in all provinces. This effort included the creation of a unified Health Information System (HIS) (ANC 1994a). The apartheid legacy left a situation of fragmentation and poor coordination of information gathering and flows. These processes were fragmented regionally and divided in separate top-driven health programs. As a result the existing HIS was inflexible, uncoordinated, and was not properly supporting local management. These problems can be considered to be common to other developing countries as common is the view that a unified (i.e. standardized and integrated) HIS to support health managers can improve the quality and effectiveness of health services (WHO 2000). This improved HIS should at the same time become a standardized infrastructure used to collect and report data up and down the health administration hierarchy, as well as a flexible information system to allow for decentralization of responsibilities and empowerment of management at the district level (WHO 2000; Braa & Hedberg 2002).

In South Africa a major role in the implementation of a new HIS was played by a particular program: the HISP (Health Information Systems Programme). The HISP initiative first addressed this challenge in Western Cape in 1996 by defining an Essential Data Set (EDS) of indicators and by developing a District Health Information Software (DHIS) to support data collection, aggregation and analysis at the district level. Eventually, in 2000, the HISP initiative scaled up to national level and the standardization process was carried out in the other provinces in a coordinated manner (Braa & Hedberg 2002; Braa *et al.* 2004).

The development and implementation work done by HISP in South Africa builds on a strong vision which underlines a clear agenda envisaged for the role of the HIS in the community:

“To support the development of an excellent and sustainable health information system that enables all health care workers to use their own information to improve the coverage and quality of health services within our communities.” (HISP 2005 (from website))

This vision is supported by the following list of principles:

- *Empowerment, democratization & transformation*
- *Develop an Information Culture at local level*
- *Action-led District Health Information System*
- *Integration of health & management information systems*
- *Computer software supporting processes, not driving them*
- *Primary focus on district teams, supervisors & facility managers*
- *Shift power from IT managers to Health managers/workers*
- *Appropriate training programmes*
- *Educational programmes (Certificate, Diploma, M.Phil, Ph.D) key elements in developing professional skills and career paths*
(HISP 2005) [emphases added]

During the implementation, HISP tried to inscribe the above mentioned vision and principles into the actual HIS: that is its artifacts, its people, and their relations.

The vision of both the WHO and the Reconstruction and Development Program required the implementation of a system which could at the same time integrate through standardization and empower through decentralization. This implied allowing upper management to operate with better information on the peripheries while concurrently allowing lower or district management to adapt the system to their own needs. The solution was to implement a flexible system (including its technical implementation in the form of the District Health Information Software or DHIS) that would allow creating "hierarchies of local universalities" (Braa & Hedberg 2002). The whole system is based on the definition of an essential or minimal set of data (EDS or Essential Data Set). This dataset should satisfy the information need of each hierarchical level in the health service administration. In South Africa these management levels comprise the national, the provincial, the district, the facility and the ward level inside the facility.

It is clear that each of these levels needs to address different duties and management responsibilities, which require different data and indicators. For example the national level will only be interested in aggregated indicators based on a few general data-elements like number of in-patient days and number of new TBC cases. At the facility level, on the other side, the management may be also interested in the trend of cesarean sections in their particular maternity ward. Accordingly, in order to accommodate these varied and changing needs, the HISP structured the EDS in a pyramid shape (see Figure 2). At the top there is the national (or international) level and a core set of elements. Each level below may add new data elements to the set as long as they also include the ones defined on the level above.

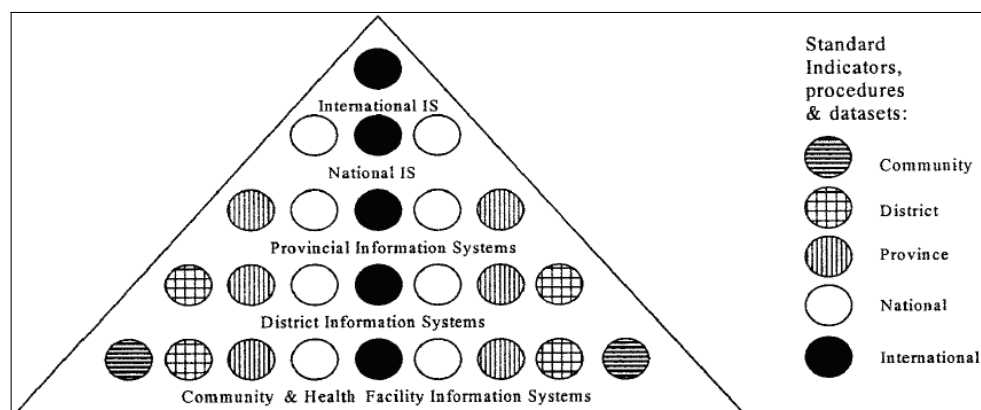


Figure 2 "Hierarchy of standards where each level has freedom to define its own standard as long as they align with the standards at the level above." (Figure and caption adapted from Braa & Hedberg 2002)

The practical implementation of this concept is allowed by the DHIS (District Health Information Software) which can run on single PCs and can be adapted locally to satisfy particular requirements in line with the above described pyramid principle.

4.2 The role of the Provincial Department of Health

In this section we will report about the perspective on the HIS at the provincial level. In April 2003 we interviewed the head of the IT function of the Department of Health of the Province of Eastern Cape and his assistant. What we will try to highlight here is the role of the department in the overall process of data collection and reporting, as well as information use and system adaptation.

The IT function receives the data from the districts of the Province. In the districts the data is exported from the DHIS and reported up to the provincial level. Here the data is entered in the local DHIS installation on a PC, fed back to the health program managers in the department, further aggregated, exported from the DHIS and reported to the national level.

The head of the IT function cleared this process:

Manager 1: *"We use DHIS software to capture, analyze and report on the data. It is used throughout the line, national offices, provincial and district office. We are now busy with the process of decentralizing to our district hospitals. [...] We want to make sure that we decentralize the software down to the facility level. Which will then allow the facilities to manipulate the data with greater ease. [...] The system works in so that at any level only needed data to the next level is exported. [...] In other words they [the hospitals] are not under our direct supervision. We support them but they are not our subordinates. The relation between us and them is a line function."*

In particular, at the provincial level new data specific to the health programs which run in the Province were added. Such health programs include for example "Maternal and Child Health Program", HIV and AIDS, or TBC programs. Previously there were "hundreds" of paper forms to be filled for the programs. In the current situation the data collection process had been integrated into one single form to be filled in for all the programs. This data set is now part of the EDS for the Province of Eastern Cape. Which specific data elements are needed is decided by the program manager in conjunction with the IT function.

The managers described the previous situation as follows:

Manager 2: *"A lot of these things were very top driven. Nationals would tell you "This is what you have to collect!". We never had the opportunity in those systems to say "Ok but this is what we would like to add to it". The systems were always very closed and inflexible. Were written from someone at national to contain those elements. If you wanted some change you had to fight nationals. If you wanted to do something simple like add on a new facility (new facilities open all the time) you had to get a new version of the program. Everything was completely inflexible to our needs or the needs of the LSA (Local Service Areas)."*

Researcher: *"If we take the analogy of the pyramid then it was like that there was only the central part of it dictated from the top (i.e. no wings)."*

M2: *"Yes, if we needed more data we had to create yet another system."*

[...]

R: *"Then I understand that the way the new IS was designed is to push decentralization and integration of programs. Is this correct?"*

M1: *"Absolutely!"*

Hence, the new system allowed greater flexibility from above. Likewise, the role of the province towards the levels below changed. The province had to allow for and facilitate the exploitation of the potential flexibility of the system also at the levels below:

MI: "As a first round we collaborated with districts. And we tried to understand what would be the minimum data set for the province and the districts. In this first round the districts have added some new elements but we did not allow them to have much more additional data elements in the EDS. We had even less than 104 but we included also what most of the districts would have liked."

This effort later implied also the involvement of hospitals in understanding the data they were collecting, reflecting on them and using them for management. While it is not direct responsibility of the department of health to intervene in the single hospitals to improve data collection and use, there was a clear awareness that this was a key issue to functioning of the system:

R: "Who is responsible to make sure that data is collected in the proper way and of the right quality?"

MI: "When we come to the facility level, the responsibility of the data collected in that facility is of the supervisor of the facility. That is the one which must ensure that the data is submitted and of the right quality. The supervisor is the one that must check the form."

However, the quality of the data collection depends on the discipline the organization in the facility has in properly collecting them. This discipline depends on the existence of an authority structure together with the acceptance of the responsibility for the process. For the whole to work, an understanding of the relevance of the data collection process and of local use of the collected data by the management of the facility is essential, as the following quote explains:

MI: "People need to know who is supposed to do what, from the lowest level. Clearly a data collection clerk cannot impose to a nurse to collect the data. It is for the medical superintendent to tell to the sister: "You will submit your data, now!". You see, so the clerk is in the background and the rank is no more an issue. But if the medical superintendent does not look up to the process and does not understand that: "How can I manage my hospital without this data!" Then you are losing the battle as well, because he is not going to do anything about it."

4.3 The Information Officers at District and Facility Levels

In this section we go one level down again and provide an insight into the role and responsibility of the information officer at the district level. We will first comment on the existing job descriptions documents. Then we will provide a brief account of a visit done by one information officer to a rural hospital.

As part of the outcome of the implementation, the HISP produced recommendations of data flow policies and job descriptions of information officers at district and hospital facility level. The aim of these documents is to start formalizing and standardizing across the hospitals and provinces in South Africa, how and when the data should be collected and reported and who at each level has the responsibility of

what. For instance, in the data flow policy document for each level basically two tasks are specified: (1) the collection, aggregation, validation and reporting of data upwards; (2) and interpretation, reporting and feedback of the same data to both the management at that level and at the level below. Even for the facility level these two tasks are clearly underlined:

"[...] The facility supervisor is responsible to check the data sheets for completeness and correctness. Once this is done the facility supervisor must sign the form and submit it to the District [...] coordinator by the eighth (8) working day following the end of the reporting month. He/She is also responsible to ensure that all facilities under his/her control submit these forms in a correct and timely fashion. [...]" [emphasis original]

*"[...] The primary use of the data collected through this system is at the facility level. **It is therefore the duty and responsibility of the person in charge of the facility to ensure that the data is validated, analyzed and interpreted for action at the facility.** [...]" [emphasis original]*

The data flow policy document produced by the NHISSA (National Health Information System South Africa) committee of the Department of Health explains further the responsibilities of each level. Again, at the facility level the information officer should both submit and retain a copy of the collated information, and analyze and present the data to the staff. At the district level the data coming from the facilities should be aggregated and exported upwards to the health district level, and pivot reports should be produced and fed back to facilities and supervisors. And so on up to the national level.

Keeping the above guidelines in mind, we will now report about a visit performed by a district information officer to a rural hospital facility. The aim of the visit was to supervise the data flow and basically make sure that data was submitted to the district in time and in good shape. We want here to highlight the challenge that the information officer has in trying to follow the tasks described in the data flow policies and in the job description documents. As a result, in this occasion the officer just focused on one of the two main tasks that the facility has to fulfill: the collection, validation and reporting of data upwards to the district. Here we will report excerpt from the observation. This example is by no means representative of the current situation in the whole of South Africa. It is here used as a case to stimulate the discussion on the relation between the policies and their implementation.

In this episode the district information officer is meeting with the matron in charge of a small rural hospital in order to improve the quality and timeliness of their reports. The visited hospital was experiencing serious problems of understaffing, the workers (including doctors) were de-motivated and frustrated. The geographical isolation of the hospital and its infrastructural problems made things even more complicated. Apparently, a working local hospital information system was the least important thing. Nevertheless, the inspecting information officer decided to focus solely on the delays and outstanding reports from this hospital:

Matron: *"[...] you are not going to have problems anymore, this is our first month."*

Officer: “Now we have decided that since we are going to have an expenditure review, we must have coming in those three data elements from September 2002 up to March 2003. We need the in-patients for each ward and then later we collect them into one for all the wards. It is needed in the provincial office.”

M: “Yeah, that’s why I say I am going to assist that.”

O: “We need total in-patient days, total OPD head count and total admissions. I would also like to set timeframes help to speed up and to see whether you catch up with the work needed.”

[...]

O: “Because you know, the information is different for each level. The provincial office is not interested in knowing how many in-patients for female or male ward. It is interested only in the hospital as a whole and in the district level. That why now they require only the in-patients for the whole hospital and total OPD etc... because they need the overall picture for the hospital.”

4.4 A success case in a rural facility

In this section of the case we will provide an example of a successful case of adoption and implementation of the HIS at the facility level in a rural hospital in the Eastern Cape. (More details of this part of the case can be found in Jacucci *et al.* 2005)

The reason why this hospital is considered a success case is that data is reported regularly and timely to the district level. Since the data flow policy (and the whole philosophy of the HISP implementation) frequently states that both good upwards data reporting and local data use must be present, the consequent research question was to investigate if and how data was also used locally.

The collected empirical evidence shows that in this small 35 beds rural hospital besides the two requested uses of data (reporting and local use) there were two additional practices:

1. Data was used to negotiate funding from the Province
2. Routine data was merged with financial data to produce health service performance indicators, creating a virtuous dependency between the financial IS and the hospital IS for routine clinical data

Regarding the latter practice, the performance indicator (cost-per-patient-day) is created by dividing the total costs of the hospital by the number of in-patient days. The number of in-patient days is taken from the statistics created from the hospital information system and entered in the DHIS. This indicator should be between 350-400 ZAR/in-patient-day. It is worth noting that usually bad quality of the IS in the hospital reflects in underreporting the number of in-patient-days. Hence, the more accurate the number of in-patient days, the lower the cost per patient day, the better the indicated performance, the better the outcome of the budget review, the more incentives to have a working IS.

Additionally, the visited hospital was part of a network of rural hospitals. The activities in the network were concentrated on quarterly mutual financial and management review based on the data provided by the financial and routine data

ISs. Through these assessments, knowledge and experiences were shared, compensating the scarce local human resources with a larger pool of ideas and best practices. Additionally, the network amplified the representational power of each hospital in negotiations with the province.

What we find relevant to observe here is that the introduction of the HIS created the basis for empowering this hospital in three directions: (1) providing the tools for a better internal management; (2) gaining contractual power towards the province by backing negotiations with hard data; (3) reducing the risk of marginalization by enabling the creation of a group of smaller hospitals regularly meeting, reviewing, and improving each others' performance on the base of the collected data. Consequently (although linked with point 2) the group's contractual power as a whole increased.

This case shows that not only the two main tasks demanded by the data flow policy were implemented, but also new potentialities enabled by the implementation of the HIS were discovered and proactively enacted.

5. Analysis and Discussion

In this section we will analyze the data presented in the case section and formulate our contribution. The first step will be to analyse the data in terms of logics of control. Subsequently, we will discuss how the considered system relates to the Type A and Type B categories proposed by Walsham (1992). Thirdly, from this analysis we will abstract the underlying virtuous mechanism which enables conflicting logics of control to contradict and support each other.

5.1 Emerging Logics

We will here highlight for each level of the case (general, provincial, district, and facility) the control logics behind documents, interviews, and observed meetings. Analytically we look at control as the result of the interference of two different logics, exogenous and endogenous, which find their way through the design, development, and implementation of the communication system (Mulgan 1991).

In the WHO reports and in the Reconstruction and Development Program of the ANC, it is emphasised a need to create a system that can be *both* standardized and integrated, *and* decentralized to support local management (WHO 2000; ANC 1994a). This latter aspect of decentralization is particularly evident in the declaration of principles and vision of the HISP (HISP 2005), where emphasis is given to words like "empowerment", "democratization", "local", "district" (as opposed to national), "supporting", and "shift power".

Also the idea of the Essential Data Set as the backbone of the system includes both of these requirements: the system, through the EDS, should satisfy each level of the hierarchy. To "satisfy" implies that through the same system *both* national standards are applied, *and* local modifications are allowed. This, again, points to a tension between the need of the national standard to be recognized and adopted as such,

and the power given to local management to reinterpret and change the standard to suit their local needs.

At the provincial level there is evidence of this tension in the multiple (conflicting) responsibilities given to the IT function of the Department of Health. On one hand, the IT function is responsible to aggregate and submit data from the province to the national level. This implies that managers are required to discipline the lower levels in order to obtain good quality and timely data reports. On the other hand, the IT function needs to interact with the program managers to improve their management by information (possibly by modifying their level of the EDS). Moreover, it also needs to implement the decentralization of the system to the lower levels. Hence, especially when interacting with the lower levels, two different vocabularies and set of actions are at play: the IT function at the province level exercises power and authority, *yet* it decentralizes and empowers.

In the case of the district and facility information officers, the data flow policies indicate evident conflicting logics. In this situation, as our data shows, the information officers have difficulties to act accordingly. In the observed case, the officer had the intention to comply with the logic of exogenous control: she wanted to apply rules and orders from the province and use her own authority to impose them to the facility level. However, as already noted, the precondition to a good upward reporting system is a well-working local system. Arguably, the priorities of the information officer should be inverted when intervening at the facility level. To intervene on this second aspect, the officer would probably have had to switch to a logic of empowerment (or support of endogenous control), in order to achieve her goal (satisfying exogenous control).

The case of the rural hospital successfully running a local information system and submitting timely and good quality data shows the work needed to manage the coexistence of the two logics, of local empowerment and of central control. In the description of the case we have seen how the management of the hospital managed to separate the two logics and to address them individually maximizing the potentiality of each of them. In order to comply with the rules of the dataflow policy (its formats and deadlines) good data had to be produced. A smart way to achieve that is to have people use the very data they “have” to collect. But the management of the hospital did not simply limit itself to achieving these two goals specified in the data flow policy. They added two new meanings to the system: it was also used to negotiate with the Province and to reinforce this negotiation by building a network of hospitals. These two innovations represent new forms of endogenous control which in fact create the conditions to satisfy the needs of the exogenous control (the system still served the levels above) and at the same time question it.

Hence, our analysis has identified conflicting logics at different levels in term of exogenous and endogenous control. We have concluded by discussing how in the case of the rural hospital the coexistence of the two logics has been rendered

workable. We proceed now with the analysis to see how this evidence fits into Walsham's categorization (Walsham 1992).

5.2 The System *in-between*

Referring to Walsham's categories of large-scale IS in DCs, we can argue that the system developed by HISP is "by design" *in-between*. If we take the pyramid representation as a reference, Type A system would look like a thin and tall column, while Type B system would look like a large and short one (Figure 3).

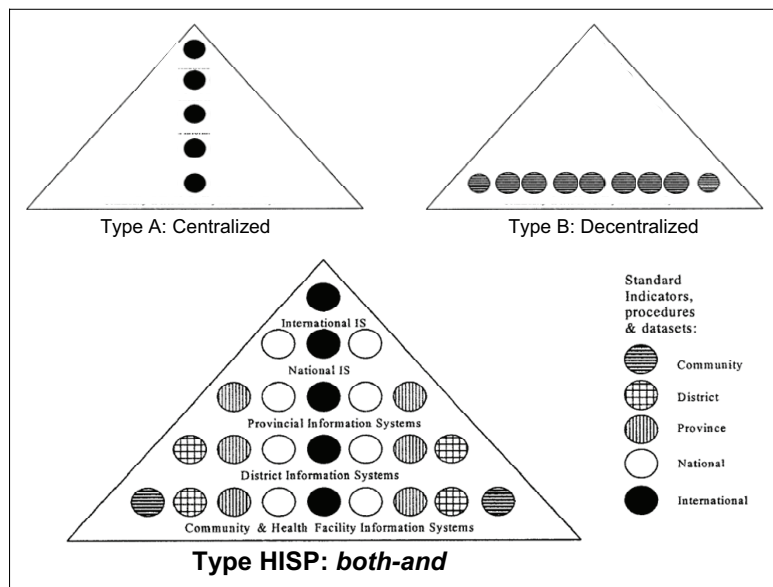


Figure 3 Positioning the HISP system between Type A and Type B systems (elaborated from Braa & Hedberg 2002).

One could be inclined to argue that HISP is a type C, that is, a third category of systems. We submit instead that it is at the same time *both* a centralized *and* a decentralized system, but not something different. It is by design a centralized communication system aiming to enable local empowerment. If Walsham (1992) claimed that real systems are much more *complex* because they contain elements of both types A and B, then our conclusion is that this system is inherently complex *by design*: it carries an intentional dual architecture of control.

5.3 Virtuosity of the Duality of Control

So far we have seen that the reform of the healthcare sector in South Africa required the development of a working Health Information Systems. This system had to achieve two goals: standardize and integrate existing systems so to harmonize the data collection nationally; and decentralize and empower lower levels of the health administration hierarchy to allow for local adaptation, change, and innovations. Following our analysis, this goal implied the design and implementation of a system

which was supposed to explicitly support both forms of exogenous and endogenous control.

The HISP addressed this challenge by inscribing this requirement into the pyramid structure of the system and into the data-flow policies at the various levels of the hierarchy. As Walsham noted, purely Type A system risk degenerating in non-sense and out-of-date data reporting, while purely Type B risk being chaotic and fragmented when put in a national context. What the design of the HISP tried to do, instead, is to have each of these two logics to work for the other. This way a virtuous circle of dependencies could be created where each logic at the same time questioned and supported the other one.

Summarizing, as we can see from Figure 4, if the aim of the system is to improve data quality (to improve management, to improve efficiency and efficacy of the health service) the preconditions to reach this aim are that good standards for data collection and processing are defined and that data is used already at the level of collection (this is a basic assumption behind the rhetoric of decentralization). On the one hand, good standards need to be defined and designed centrally, on the other, good local use of the data requires these standards to be locally adapted by empowering the peripheries. Local empowerment can take the form of networking (e.g.) with other hospitals and of implementing local innovations and modification of the standard (as shown in our case). However, for these two conditions to happen, a major role is played by the existence of centrally defined standards (dotted arrows). In this case we see that the same communication system provides the means for the exogenous control (the standards) which at the same time enable forms of endogenous control (networking through the same system and the tools to develop local innovations). In turn, the reinforced empowerment ideally participates (through negotiations) to the improvement of the centrally developed standards (other dotted arrow).

Once these conditions are granted, data of good quality is created and reported at all levels. The implication is that the “informating” (Zuboff 1988) system provides the means of reinforcing *both* central *and* peripheral control.

Duality of Control in Large-Scale IS

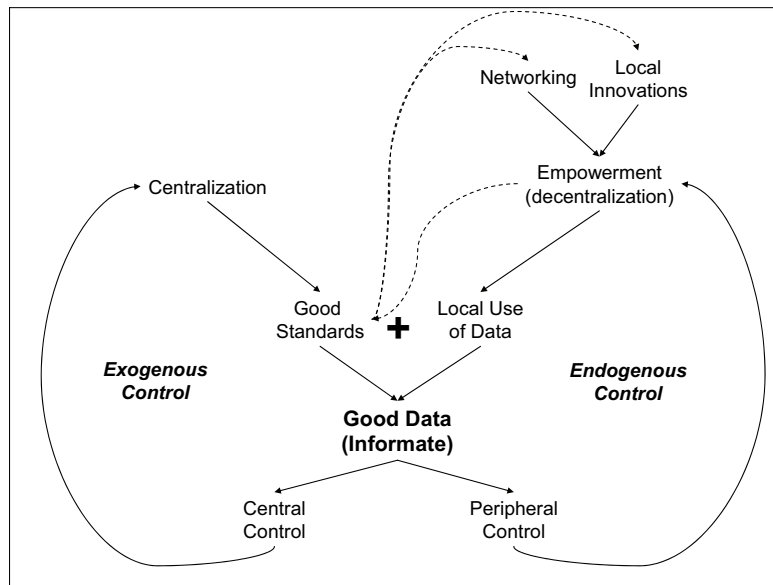


Figure 4 The virtuous circle of the interaction of the exogenous and the endogenous control logics in the design of HISP.

The “double” nature of control in large-scale IS (as coined by Mulgan 1991) can hence better be interpreted as “duality”. The concept of doubleness underlines a dualistic view of control as divide in two paired but distinct categories. The concept of duality, instead, highlights the interdependence between the two categories (Jackson 1999)²:

“A duality resembles a dualism in that it retains two essential elements but, unlike a dualism, the two elements are interdependent and no longer separate or opposed, even though they are conceptually distinct [...]”

The inherent virtuous duality of the system should by now be clear. The point, we submit, is that not only this duality needs to be understood as being part of the design, but its awareness should also become explicit in the training, documents, and education which form the socio-technical network of the system.

6. Conclusions

In this paper we explore the nature and interdependence of control structures in large-scale standard-based IS. Understanding the dynamics of control structures, we argue, is relevant for improving the chances of success in development and implementation of Health Information Systems in Developing Countries. In such setting, the ability to successfully balance the aim of empowerment and the need of central control is paramount. Through the concept of “duality of control”, the study presented in the paper provides an interpretation of the dynamics of control

² “Duality as an alternative to dualism is set out in Giddens’s writings on the ‘duality of structure’ [...]” (Jackson 1999)

structures and their relation with centralization and decentralization forces. This interpretation can be used to better inform development and management actions.

References

- ANC, (1994a), *A National Health Plan for South Africa*, African National Congress, Johannesburg, South Africa.
- ANC, (1994b), *The Reconstruction and Development Programme*, African National Congress, Johannesburg, South Africa.
- Beniger J.R., (1986), *The Control Revolution: Technological and Economic Origins of the Information Society*, Harvard University Press.
- Braa J., (1996), "Decentralization, primary health care and information technology in developing countries: Case studies from Mongolia and South Africa", *Global IT & Socio-Economic Development*, Mayuri Odedra-Straub Ed., USA.
- Braa J., Hedberg C., (2002), "The Struggle for District-Based Health Information Systems in South Africa", *The Information Society*, Vol. 18:113-127.
- Braa J., Monteiro E., Sahay S., (2004), "Networks of Action: Sustainable Health Information Systems Across Developing Countries", *MIS Quarterly*, Vol. 28, No. 3, 337-362, September 2004.
- Ciborra C., (2000), *From Control to Drift*, Oxford University Press.
- Elmes M.B., Strong D.M. Volkoss O., (2004), "Panoptic empowerment and reflective conformity in enterprise systems-enabled organizations", *Information and Organization*, Vol.15, Issue 1.
- George J.F., King J.L., (1991), "Examining the Computing and Centralization Debate", *Communications of the ACM*, July 1991, Vol.34, No. 7.
- Heeks R., (1999), "Centralized vs. Decentralized Management of Public Information Systems: A Core-Periphery Solution", Paper No. 7, *Information Systems for Public Sector Management: Working Paper Series*, Institute for Development Policy Management, Manchester, UK.
- HISP, (2005), www.hisp.org, [last accessed 050401]
- Jacucci E., Shaw V., Braa J., (2005), "Standardization of Health Information Systems in South Africa: the Challenge of Local Sustainability", *Proceedings of IFIP 9.4*, Abuja, Nigeria.
- Jackson W.A., (1999), "Dualism, duality and the complexity of economic institutions", *International Journal of Social Economics*, Vol.26, No.4, 1999.
- King J.L., (1983), "Centralized versus Decentralized Computing: Organizational Considerations and Management Options", *Computing Surveys*, Vol.15, No. 4, December 1983.
- Mulgan G.J., (1991), *Communication and Control*, Polity Press.
- Walsham G., (1992), "Decentralization of Information Systems in DC's: Power to the People?", in *Social Implications of Computers in Developing Countries*, S.C. Bhatnagar and M. Odedra (eds.), Tata McGraw Hill, India.
- Walsham G., (1994), "Interpretive case studies in IS research: nature and method", *European Journal of Information Systems*, (1995), Vol. 4, pp.74-81.
- WHO, (2000), *Design and Implementation of Health Information Systems*, World Health Organization, Geneva, Switzerland.
- Yates J., (1989), *Control through Communication: The Rise of System in American Management*, The John Hopkins University Press.

EGOS 2005, Berlin

Edoardo Jacucci

Duality of Control in Large-Scale IS

Zuboff S., (1988), *In the Age of the Smart Machine: the Future of Work and Power*, Basic Books.

Appendix 6

Hanseth, O., Jacucci, E., Grisot, M., Aanestad, M. (2006), “Reflexive Standardization: Side-Effects and Complexity in Standard-Making”, *Management Information Systems Quarterly*, King, J. L., Lyytinen, K. (guest eds.), Special Issue on Standard-Making, *forthcoming*.



REFLEXIVE STANDARDIZATION: SIDE EFFECTS AND COMPLEXITY IN STANDARD MAKING¹

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Abstract

This paper addresses the general question proposed by the call of this special issue: "What historical or contingent events and factors influence the creation of ICT standards, and in particular, their success or failure?" Based on a case study conducted over a period of three years in a Norwegian hospital on the standardization process of an electronic patient record (EPR), the paper contributes to the current discussion on the conceptualization of standard-making in the field of Information Systems. By drawing upon the concepts of logic of ordering adopted from actor-network theory and upon reflexivity and the unexpected side effects adopted from reflexive modernization, the paper makes three key contributions: (1) it demonstrates the socio-technical complexity of IS standards and standardization efforts; (2) it shows how complexity generates reflexive processes that undermine standardization aims; and (3) it suggests a theoretical interpretation of standardization complexity by using ideas from complexity theory and the theory of reflexive modernization. These research questions are addressed by offering an historical and contingent analysis of the complexity dynamics emerging from the case.

Keywords: Standards, reflexive moderation, side effects, socio-technical theory, electronic patient records

Introduction

The research presented in this paper explores the borders and limitations of modern standardization in the context of developing a pan-Norwegian standard for electronic patient record systems (EPR). An EPR is a computer-based information

¹ John King was the accepting senior editor for this paper.

system for storing and presenting patient clinical data in hospitals.² We interpret the failed effort to replace the fragmented (mostly paper-based) patient record and information system collage with one integrated electronic record system as an inherent element and outcome of the complexity of standard setting. Moreover, we show that standardization processes can be reflexive, resulting in outcomes antagonistic to the original aim. For example, standard setting in EPR eventually produced a more fragmented record and IS portfolio.

We will interpret this case and its narrative by highlighting the complexity of the standardization effort. Our theoretical tool in this interpretive act is actor–network theory (ANT) combined with the concept of *reflexivity* adopted from the theories of risk and reflexive modernization (Beck 1986, 1994, 1999; Beck, Bonss, and Lau 2003; Beck, Giddens, and Lash 1994; Giddens 1991). The mobilized concept of reflexivity reveals unexpected side effects and how such side effects can trigger new actions which will have their own side effects, and so on. Initial actions with good intentions may lead to self-destructive processes in which side effects propagate and are “reflected” back on their origin, resulting in the opposite of what was initially intended.

The paper makes three key contributions. First, it demonstrates the socio-technical complexity of IS standards and standardization efforts. Second, it provides an empirical case showing how this complexity may generate reflexive processes that undermine the initial aims of standardization. Third, the paper suggests a theoretical interpretation of this phenomenon by means of complexity theory and the theory of reflexive modernization.

The paper is structured as follows. First, we show how the development and implementation of an EPR can be seen as a standardization process and how such a standard can be considered a complex system. Second, we present our theoretical framework, conceptualizing standards as complex socio-technical systems. Third, our research design and methodology are outlined. Fourth, our case is presented, followed by analysis and discussion, including implications and conclusions.

²We have chosen to use the terms *patient record* and *medical record*, which are used by core standardization organizations such as CEN TC251, HL7, and ASTM, and indicate a wider scope of the system that may go beyond single organizations.

EPR Standardization and its Complexities

Electronic patient record systems can be used by individual doctors, as a common system in a clinical department, as a shared, common system in an entire hospital, or even among a set of interconnected hospitals. An EPR can be an off-the-shelf product, a proprietary system, or (as in our case) a system codeveloped by a group of hospitals and a vendor. An EPR system is used to specify, routinize, and make uniform the type and format of clinical information to be collected. Moreover, the ERP system is meant to support coordination and cooperation between departments, professions, medical specialities, and hospitals. A hospital-wide EPR could reduce redundancy and inconsistency of patient information, since the information is stored in a single location, accessible from any place at any time. Standardization activities aim to define the appropriate design of the EPR as an information system (e.g., with respect to fundamental architecture, access control, and data storage). In order to allow new users to quickly begin using the system or to avoid fumbling in emergency situations, standardization of user interface and data presentation is advocated. However, an EPR can be also be conceptualized as a *package* of standards. It builds on existing technical standards (e.g., with respect to operating systems, databases, and network standards). It embeds clinical procedural and performance standards as well as numerous classification schemes and terminologies (Timmermans and Berg 2003). These standards go beyond the EPR system as such.

We conceptualize the EPR standardization attempt as a process of alignment. Successful standardization entails the achievement of stabilization and closure in the definition and boundaries of the standard (Bijker 1993; David and Greenstein 1990; Law and Bijker 1992). This is not easily achieved because of the socio-technical nature of standards, as well as the number and variety of standards and their interrelations (Bowker and Star 1999; Brunsson and Jakobsson 2000; Fomin et al. 2003). In our case, a number of different actors were involved, both within the individual hospitals and inside and outside the consortium or national project.

Delineating the intricacies involved in standard development processes, de Vries (2003, p. 155) defines standardization as

the activity of establishing and recording a limited set of solutions to actual or potential matching problems directed at benefits for the party or parties involved balancing their needs and intending and expecting that these solutions will be repeatedly or

continuously used during a certain period by a substantial number of the parties for whom they are meant.

Taking this definition as a reference, we submit that the observed phenomenon reported in the case study can be seen as a process of standardization (de Vries 2003, p. 156) for the following reasons:

- (1) The activity was aimed at finding a common set of information needs to be addressed by balancing possible differences and views.
- (2) The clear aim was to create a single solution (with the possibility of some degree of adaptation) to be shared by hospitals and, internally, by clinical departments.
- (3) The intended solution was aimed at addressing a set of *matching problems*, that is, at harmonizing the problem of collecting, presenting, and sharing clinical information between departments and possibly hospitals.
- (4) The development was a clear long-term investment aiming at achieving a shared and long-lasting electronic solution to recording, storing, and sharing clinical information.

We also propose that it is appropriate to conceptualize the EPR standard as a complex system. We do so by means of Schneberger and McLean's (2003) definition of complexity as dependent on the number of different *types of components*, the number of *types of links*, and the *speed of change* of the system. As noted above, a standardized EPR system includes or builds on a large number of different standards that define very different types of objects. These individual standards embed a wide range of different work practices and are developed by many different standardization bodies that include a range of different user groups and technical expertise. Further, the standards contain a large number of different types of links and relations between these elements, and, as will be demonstrated later in this paper, many of the individual components and their relations are rapidly changing. The EPR system standard is also in line with Cillier's (1998) more detailed definition of a complex system as one made up of a number of elements interacting in a dynamic and nonlinear fashion, forming loops and recurrent patterns involving both positive and negative feedback; it is open in the sense that it is difficult to define the borders between it and other systems; it has history (i.e., its past is co-responsible for its present as well as its future); and each element is ignorant of the system as a whole, responding only to information available locally. This broad definition will

underlie our conceptualization of the systemic nature of the EPR throughout the paper.

Standards, Socio-Technical Complexity, and Reflexivity

The socio-technical complexity of IS standards has been studied from a variety of perspectives. One strand has primarily addressed the role of network externalities, in particular focusing on how these make standards increasingly difficult to change as their installed base grows (Shapiro and Varian 1999). Another strand has focused on the complexity, including local specificity and variety, of work practices and organizational structures, and embedding them into standards (Bowker and Star 1999; Forster and King 1995; Hanseth and Monteiro 1997). A third strand has addressed the increased heterogeneity of the actors involved in standardization on the one hand, and increased speed of technical change on the other, and the resulting challenges to standards setting. These perspectives favor industry consortia over traditional, formal standardization bodies as a preferred institutional framework for standards setting (Hawkins 1999; Shapiro et al. 2001; Vercoulen and van Weberg 1998).

Overall, these studies highlight the complexity of IS standards and standardization dynamics. We suggest moving one step further by looking at the interdependencies and interactions between forms of complexities which can lead to reflexive (i.e., the combination of self-reinforcing and self-destructive) processes. The theoretical framework upon which we will draw is based on actor-network theory (ANT), primarily developed and used to analyze the alignment of social networks or, in our context, making order in a complex world. This world includes human and nonhuman, or technological and nontechnological, elements. ANT has been used to study various types of order-making, including development and acceptance of scientific theories (Latour and Woolgar 1986), working technological solutions (Law 1987), and organizational structures and strategies (Law 1994). Standardization is order-making *par excellence*.

Central concepts in early ANT research are closure (Law and Bijker 1992), stabilization (Bijker 1993), and enrollment and alignment (Callon 1991). Specifically, closure indicates a state where consensus emerges around a particular technology. Closure stabilizes the technology by focusing resistance to change. It is achieved through a negotiation process and by enrolling actors/elements of various kinds into a network and translating (reinterpreting or changing) them so that the elements are aligned in a way that supports the designer's intentions.

The early ANT studies focused on the rich and complex relations between the scientific and the technological on the one hand, and the social on the other, resulting in scientific theories and technological solutions. ANT has been used in research on the negotiation of IS standards and embedding those standards in local contexts of development and use (Bowker and Star 1994, 1999; Fomin et al. 2003; Hanseth and Monteiro 1997; Star and Ruhleder 1996; Timmermans and Berg 1997).

Since its emergence in the early 1980s, ANT has evolved from the managerial approach, which focuses on how a single actor–network is aligned by a dominating central actor (Law 1999). Addressing complexity more explicitly, the focus has turned to the unfolding dynamics of independent actors aligning with different but intersected actor–networks (Latour 1988; Law 2000; Law and Mol 2002; Law and Urry 2002; Star and Griesemer 1989). This has happened as attention has moved toward more complex cases where order and universality can not be achieved in the classical way.³ These cases are described as worlds too complex to be closed and ordered according to a single mode or logic. There is only partial order, interacting in different ways, or interconnected and overlapping subworlds, ordered according to different logic.⁴ The interconnectedness of the subworlds means that while one is trying to make order in one subworld by imposing a specific logic, the same logic is causing disorder in another: each order also has its disorder (Berg and Timmermans 2000; Law 1999). Rather than alignment, stabilization, and closure, the keywords are now *multiplicities*, *inconsistencies*, *ambivalence*, and *ambiguities* (Law 2000; Law and Mol 2002). Mastering this new world is not about achieving stabilization and closure, but rather about more *ad hoc* practices: ontological choreography of an ontological patchwork (Cussins 1998). This approach has been applied to studies of train accidents (Law 2000), a broad range of high-technology medical practices (Mol and Berg 1998), and interdisciplinary research (Star and Griesemer 1989). This approach to complexity has also been applied to analyzing the challenges of achieving closure and stabilization in relation to complex IS and IS standards (Aanestad and Hanseth 2000).

³Law and Mol (2002, p. 1) define complexity as follows: “There is complexity if things relate but don’t add up, if events occur but not within the process of linear time, and if phenomena share a space but cannot be mapped in terms of a single set of three-dimensional coordinates.” This definition is very brief and rather abstract, but is in perfect harmony with Cillier’s definition presented earlier.

⁴For a more extensive discussion of the logic of EPRs, see Gregory (2000, 2004).

The evolution of ANT has brought it closer to the theory of reflexive modernization (Beck et al. 2003). Latour observed the similarities between ANT and reflexive modernization, stating that a

perfect translation of “risk” is the word “network” in the ANT sense, referring to whatever deviates from the straight path of reason and of control to trace a labyrinth, a maze of unexpected associations between heterogeneous elements, each of which acts as a mediator and no longer as a mere compliant intermediary (Latour 2003, p. 36).⁵

From the perspective of Beck and his colleagues, the recent change of focus within ANT signals a move from the first modernity to a second *reflexive* modernity,⁶ which is reflexive in the way that modern society itself is now modernized: the change is happening not *within* social structures but *to them*. This leads to a pluralization of modernities, a “*meta-change* of modern society results from a critical mass of unintended side effects...resulting from...market expansion, legal universalism and technical revolution” (Beck et al. 2003, p. 2), what we normally refer to as *globalization*. They define *side effect* more precisely as “effects that were originally intended to be more narrow in their scope than they turned out to be” (Beck et al. 2003, p. 2).

The term *reflexive* connotes, in Latour’s interpretation, that “the unintended consequences of actions reverberate throughout the whole of society in such a way that they have become intractable” (2003, p. 36). Side effects can thus be reflexive to the extent they propagate through multiple, separate networks and finally become reflected—hence the term reflexive—back onto what initially triggered them. The end result can be the opposite of what was originally

⁵The most substantial difference between the two is maybe the status they attribute to theories. Reflexive modernization is presented as a theory in the classical sense, describing the world “as it is,” while ANT has adopted the ethnomethodological position, seeing itself as one “ethnotheory” having the same status as other such theories (Latour 2003).

⁶According to Beck (1999), two processes of modernization of our society can be distinguished: the first, called “first” or “simple” modernization, is characterized by a stable system of coordinates as, for instance, the nation state, the gainful employment society—a concept of rationality that emphasizes instrumental control; the second, called “reflexive” modernization, is characterized by a fundamental societal transformation within modernity which revolutionizes its very coordinates and calls into question its own basic premises.

intended.⁷ In ANT terms, the propagation of side effects results in the disordering of networks created by an initial ordering action.

Standardization forms a key feature of modernization. Consequently, if the theories of Beck and Giddens are valid, we should find reflexive processes unfolding in standardization. And indeed, such examples are not hard to find. Standardization is prone to escalated processes of disordering (Ciborra et al. 2000; Ciborra and Osei-Joehene 2003; Hanseth et al. 2001; Rolland 2003). Hanseth and Braa (2001), in the context of corporate IT standards, denote standardization vividly as “chasing the rainbow.”

In the following case, we will narrate efforts to standardize an EPR system. This process *qua* standardization unfolded as a prototypical narrative of modernity. It can be interpreted as a control-seeking process where the actors attempt to create a universal order by enrolling heterogeneous elements, and thereafter translating and aligning them into one closed and stabilized network. We will show how the order that actors sought to create was linked to multiple worlds. The ordering effects originating from each of these worlds created disorder in others. The end effect was the undermining of the order-making and increased disorder, what we will call *reflexive standardization*, where efforts and actions taken toward standardization and stability lead to an opposite result. We standardize in order to integrate, order, and control a fragmented world, and to reduce its complexity, to forge order out of chaos. Reflexive standardization, then, shows that when we try to achieve order and closeness we get chaos, openness, and instability.

Research Approach and Setting

The following research question, suggested by the call for papers of the special issue, is addressed: What historical or contingent events and factors influence the creation of ICT standards and, in particular, their success and failure? By addressing this question, the research focuses on three aspects of standardization: (1) the socio-technical perspective on IS standards and standardization as outlined above, (2) identification and analysis reflexive standardization processes, and (3) interpretation of these processes with the theory of reflexive modernization as discussed above.

⁷ Reflexivity may be seen as a form of *path-dependence*. This concept has more recently emerged as influential within broader discussions of complexity theory. It has diffused from economics into other scientific fields, first historical sociology (Mahoney 2000), then sociology and social sciences more broadly (Urry 2003). Path-dependency in terms of self-reinforcing processes leading to lock-ins has been widely studied in relation to standards.

The socio-technical perspective provided us with a conceptual lens that was valuable in understanding and interpreting complexity associated with standardization. In particular, the concepts of the logic of ordering, order, and disorder provided a helpful sensitizing device to interpret *ordering* processes of reflexive standardization. The theory of reflexive modernization, in contrast, has guided us in discerning the mechanisms of standardization that create disorder: how the uncertainties and difficulties with the standard implementation were not due to external factors, but, in contrast, were internally and reflexively produced. By directing our attention to the critical role of side effects and their production mechanisms, we can analyze loss of control in the creation of standardization situations.

We will examine these questions in the context of a case study that focused on the development of a national standard EPR system and its initial implementation in the Rikshospitalet in Oslo, Norway. This is a specialized university research hospital with about 600 beds, 17 clinical departments, and approximately 3,500 potential users of clinical information systems. We studied both the intended and unintended consequences of this standard implementation with a particular emphasis on the possible side effects of ongoing standardization actions.

Research Design and Context

The data for this paper were collected between 2001 and 2004. Other information is derived from our previous collaborations between 1996 and 2001, where the EPR implementation was the topic for Master's student projects and three Master's theses. Since 2001, the collaboration has evolved into a structured research program to study the implementation and use of clinical information systems, in particular the EPR system. To date, the project has involved two professors, three post-doctoral and doctoral researchers, and three Master's students.

The fieldwork has been structured as a longitudinal case study in order to follow the implementation process in its various stages. To gain valid knowledge for the case analysis, the data analysis and collection were grounded in interpretive principles of case study method (Klein and Myers 1999; Walsham 1993, 1995). In line with these principles, the focus of the research has evolved over time while the authors gathered and analyzed more data, influencing the next round of data collection, while the case progressed into new stages.

As noted the case deals with developing an electronic patient record (EPR) accompanied with the design and implementa-

tion of a specific product (first called DocuLive, then IntEPR, then GlobEPR⁸) by Alpha Medical Solutions (the medical division of Alpha⁹), as well as the adoption of this standard via the implementation at our study site. The EPR was intended to be the electronic equivalent of the paper-based patient record. For decades, EPR systems have been a major topic in the field of Medical Informatics. Their design, development, and implementation entail considerable complexity and challenge (see Berg and Bowker 1997; Ellingsen 2002). In our study context, EPR systems had for some years been widely used in general practitioners' offices and in smaller hospitals. Specialized and limited systems have also existed within single clinical departments in larger hospitals. However, developing a hospital-wide centralized EPR system, which involves standardizing the local systems and practices across clinical departments, is a different task. Developing generic systems for use in hospitals across multiple countries is even more difficult.

Research Methods and Data Analysis

We gathered data from seven clinical departments (out of 17), and from the archive and IT departments by following theoretical replication. These clinical departments were chosen using the implementation stage and department size as a sampling criterion. Specifically, we sought to increase variance in these conditions and therefore gathered data from departments where the EPR system had been in use for a long time, a short time, or where it was still under implementation.

We collected data with more than 35 formal interviews with 23 different employees of the hospital including medical doctors, nurses, and secretaries in clinical departments, project leaders, heads of hospital units, and senior managers in the IT department, including the former CIO of the hospital. The interviews were semi-structured and lasted from 1 to 2 hours each. Most interviews were audio recorded, and notes were taken as well. All interviews were summarized and circulated within the research group, and key interviews were fully transcribed.

Data were also collected in 18 direct observations by participating in various discussions and meetings, as well as from document analyses. The length of these observations varied

between 2 and 8 hours. Observations included tracing a patient trajectory in or between clinical departments (and the production and use of information); use of the paper-based and electronic patient record; observation of individual and team work in relation to information artifacts and IT support; observation of nursing activities and use of information before and after implementation of the EPR (in the form of "shadowing"); attendance at project meetings; attendance at EPR courses for user groups; and attendance at preliminary meetings by the IT department and clinical departments before the actual implementation.

Regarding document analysis, we made use of primary and secondary sources. Primary sources of documents included EPR project documents and other material produced mainly by the managers of the IT department. We also analyzed policy documents and contracts from the Norwegian consortium project. We had full access to the intranet of the IT department, including relevant documentation on the department's budget and strategic plans. The main secondary source of document information is comprised of the fieldwork reports and theses written by Master's students during the period 1996 to 2001, and reports, articles, and theses written by members of the EPR research group since 2001. Finally, relevant data were gathered during numerous meetings between members of the IT department of Rikshospitalet and the research team. A weekly meeting of the EPR research group was organized to discuss fieldwork, preliminary findings, and further research activities. The head of research of the hospital's IT department joined these meetings at least once a month, providing continuous updates on the ongoing activities in the project and proposing new themes of research.

Finally, we note limitations of our fieldwork. We recognize that the fieldwork could have been extended to both the software company and to other hospitals implementing the same system. We approached the software company but could not reach an agreement regarding participation in the research. We intentionally decided to focus the fieldwork on the one hospital discussed herein. Through our contacts with other researchers throughout Norway, we were updated on the progress of concurrent implementations in the other hospitals.

Detailed Case Description

In Norway, work on the definition of a national standard for EPRs started in the late 1980s. A new organization, the Competence Center for IT in Health Care (with the Norwegian acronym KITH), was established with standardization (definition as well as adoption) as its main responsibility. KITH aimed at defining communication standards based on EDI (electronic data interchange) for routine message exchange

⁸The names of the product and the company have been disguised.

⁹Alpha is a global multinational employing about 430,000 people generating revenue of over 75 billion Euros. Alpha is engaged in diverse industries such as healthcare, manufacturing, services, transportation, and telecommunications.

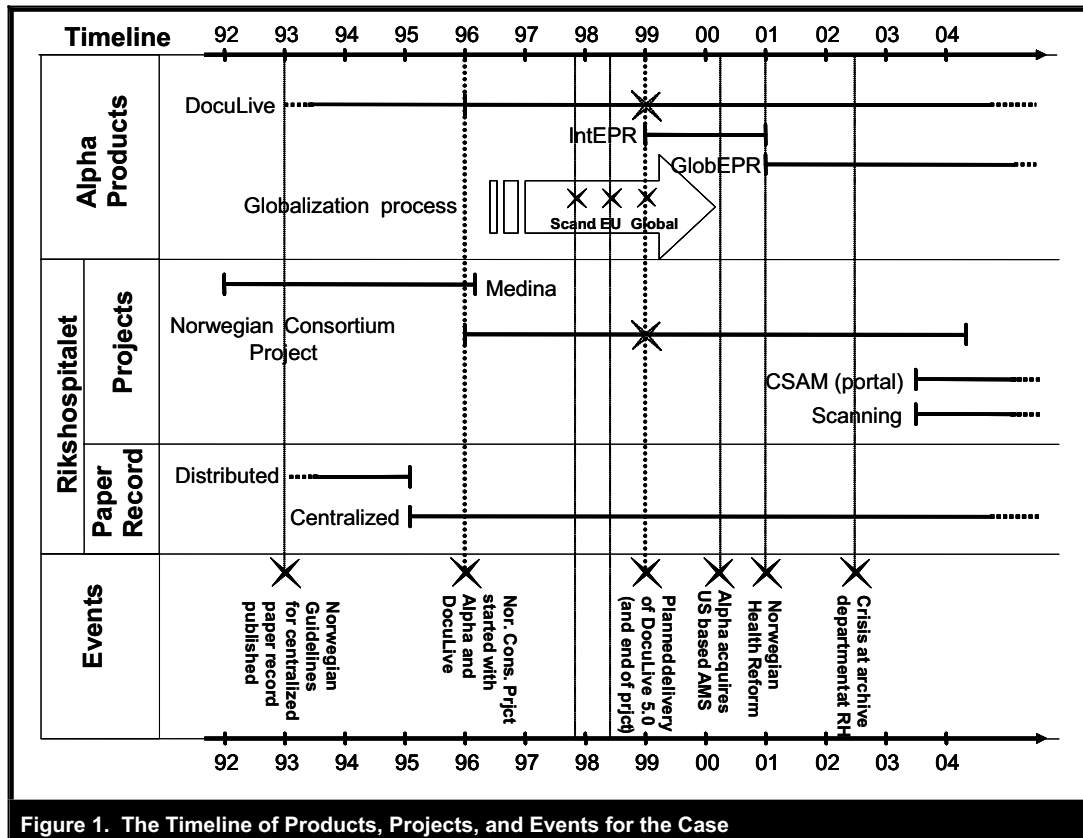


Figure 1. The Timeline of Products, Projects, and Events for the Case

(e.g., lab orders and results, prescriptions, admission, and discharge letters), closely linked with the work of CEN TC251¹⁰ to which the EU commission had delegated the responsibility for development of European IT standards for health care.

In the early 1990s, two of the five Norwegian regional university hospitals and a small Norwegian software company initiated a project aimed at developing an EPR system called MEDINA. A project manager from KITH was hired. At this time, KITH also started work on specifications for the Norwegian standard for EPR systems, conforming to the

Norwegian standard for paper records (Statens Helsetilsyn 1993) and the CEN EPR standards as closely as possible. In 1996, the project enrolled the Rikshospitalet and the other two regional university hospitals not already involved, resulting in a consortium of the five largest hospitals in Norway (see Figure 1 for a timeline). This led KITH to see this project as an important opportunity to develop a standardized Norwegian EPR system, not just a specification of some of its elements. To do so, KITH wanted to merge MEDINA with another system, DocuLive, under development for about a decade and hosted by several software companies. DocuLive had recently been acquired by Alpha Norway. After the project organizations merged, Alpha, as the largest and financially strongest company, eventually bought MEDINA from the other vendors and took over the entire product development project.

¹⁰CEN is the European branch of the International Standardization Organization (ISO).

In this new project, Alpha kept the DocuLive name and the deadline for delivery of the finalized system was set for the end of 1999.¹¹ The DocuLive project started with the intention of involving users, acknowledging current work practices, and favoring a bottom-up development strategy. As the number of involved users grew, however, large-scale participatory development became unmanageable. After a few years, only a small number of user-representatives from each hospital continued to actively participate in the development. Moreover, the need to continuously find common agreement between the hospitals turned the intended bottom-up approach into a top-down one.

Overall, the strategy of the DocuLive project can be summarized as follows:

1. The EPR should be developed to satisfy the needs of the five regional university hospitals (with the implicit plan that with the successful completion of the project, the EPR would also satisfy the needs of all other hospitals in Norway and accordingly would be adopted by them).
2. The EPR should be complete, that is, it should include all information about a patient.
3. The EPR should be realized as one shared, integrated information system for all departments.

This joint project between the five hospitals and Alpha was terminated early in 2004 without the realization of the initial goal: the implementation of a complete EPR system. The version of DocuLive currently in use has limited functionality in comparison to the project's aims. Eventual further development of the system, at the time of writing, is regulated by separate contracts between the vendor and the individual hospitals. At the regional level, four of the five regions in Norway (including the one which contains Rikshospitalet) have decided to standardize on EPR systems other than DocuLive.

The focus of our study is to analyze the role of one important factor behind the failure: complexity. We have organized the empirical material into four stories. Each story will be on one or more of the "modes of ordering" exemplified by the strategy elements mentioned above. The purpose of each is to illustrate how efforts aimed at making order interfered with

conflicting orders or order-making, ultimately producing more disorder.¹²

Alpha and the Stabilizing of the Scope of the Standard

The first story focuses on the role of Alpha in relation to shaping the project trajectory. Alpha is a large company and its international orientation challenged the stabilization of the Norwegian standard and the creation of the EPR system.

When the project started in 1996, it was expected to have the economic, political, technical, and medical capacity, both in terms of support and competence, to establish a national standard EPR system in Norway. In the end, this did not happen because the project evolved in unexpected directions. Shortly after the DocuLive project began, the IT managers of Rikshospitalet became aware that Alpha UK was also engaged in EPR development. Asking Alpha Norway for more clarification, they found that within Alpha, several EPR development projects coexisted: at least five EPR projects were underway in Sweden, the UK, Germany, India, and Norway respectively. The IT department at Rikshospitalet realized that the Norwegian project was not at the top of Alpha's priorities since Norway represented the smallest market. Within Alpha, the DocuLive project ran the risk of being overrun by other internal projects for more profitable markets. As a consequence, the project consortium, together with Alpha Norway, decided to internationalize the project, first to a Scandinavian level, and later to a European one.

As a senior IT manager commented,

Alpha decided and the hospital agreed to internationalize the product. At that time there were different competing systems within the Alpha company. We saw potential danger to our system and our development and requirements. We supported Alpha in bringing this up on the corporate level and getting DocuLive and the Norwegian product to become a main product for Alpha internationally, because that would secure further development on our system. It was a strategic decision.

The strategy of the consortium was to push the project to a larger dimension in order to secure its continuity. On the other hand, this decision weakened the hospital consortium's

¹¹ Ellingsen and Monteiro (2003b) outline the overall history of DocuLive from the early 1980s. For an analysis of aspects of complexity in the Norwegian EPR project other than the ones on which we focus in this article, see Ellingsen and Monteiro (2003a).

¹² The reader should refer to the timeline provided in Figure 1 to better follow the unfolding of the four stories.

position with respect to Alpha, since now it was not the only client with system requirements. Requirements from all other EPR projects in Alpha had to be merged and a new architecture had to be designed. Furthermore, since the original deadline for the final delivery (1999) was approaching, the project consortium agreed with Alpha to extend the time frame to include the development of the new internationalized EPR solution (called IntEPR).

At the time the IntEPR project started in 1999 (see the timeline in Figure 1), Alpha decided to acquire AMS (American Medical Systems¹³), a large U.S. software development company. As a consequence, the scope, resources, and balance of the Alpha medical division changed: the division's headquarters was moved from Europe to the United States, and the project's scope became global. In this scenario, the project consortium supported the intent of Alpha to internationalize IntEPR. However, as the project became global, the IntEPR architecture was dropped in favor of a new system called GlobEPR. The basic requirements previously defined for the Norwegian customers of DocuLive were only partly supported by the new architecture.

From this story we can see the meeting of two different worlds, each with its own mode of ordering: the one of the Norwegian project for the Norwegian hospitals, and the one of Alpha and its international scope. To Alpha, achieving economies of scale by targeting international markets is a key concern. In addition, the medical division within Alpha is large, with a traditional base within medical imaging technologies. As the imaging instruments have become digital, supplementary software systems have been built. As the EPR development activities were increasing within Alpha, it became more and more important to align and integrate the EPR strategy and product(s) with other Alpha products and strategies.

Within this world, Norway becomes marginal, as the appetite for larger markets escalates in a self-feeding process. From the Norwegian point of view, the original interest in creating a Norwegian standard had to be reinterpreted in a Scandinavian, then European, and finally global context. A side effect of the expansion of ambitions and scope was increased complexity: the larger the market at which Alpha was aiming, the more diverse the user requirements and, accordingly, the more complex the system had to be in order to satisfy them. This implied that the development costs were growing, which again implied that a larger market was required to make the whole project profitable.

The Complete EPR

In our second and third stories, we look more closely into the implementation process inside the hospital. The efforts aimed at replacing the fragmented paper-based record with a complete and smoothly integrated electronic one turned out to be more challenging than foreseen. In the end, the volume of paper records increased (second story) and the patient record became more fragmented (third story). This in turn increased the overall complexity and consequently slowed down the standardization and implementation processes.

Before 1995, the main problem at Rikshospitalet (as well as most other hospitals) was the fragmentation of the medical record system: each department had its own record archive. If a patient was admitted to several departments, several records would be created, each one containing information specific to the department. In addition, various smaller local information systems, partially overlapping with the paper records, were in use. In this picture, a long time might be needed to retrieve critical information on patients. This could lead to situations where critical decisions were made without possessing vital information contained in all the relevant medical records.

In 1996, the same year as the DocuLive project started, Rikshospitalet standardized and centralized its paper-based patient records according to the principle: one patient, one record. The new centralized paper standard followed the recently published Norwegian guidelines for paper-based patient records. This centralization process was not without problems. In particular, a major complaint was familiar: the long time needed to retrieve a patient record from the central archive. Doctors also complained that, due to the centralization, the merged patient records had become less easy to browse quickly, as a lot of the information was not relevant to their specific interests. In this situation it was widely assumed among doctors, as well as IT people at the hospital, that a standardized, complete EPR system would make information instantly available anywhere at anytime, as well as avoid duplication of information and inconsistency of data.

Basically, the aim of the DocuLive project was to replicate and replace the recently standardized and centralized paper-based patient record. However, at the time of writing (autumn 2004), a full transition from the paper to the electronic record has not yet been accomplished. The DocuLive system mainly contains textual information, while much other information is still on paper forms (lab results, radiology reports, images, and other printouts from various equipment).

A manager from Rikshospitalet's IT department helped to quantify the situation: "Currently DocuLive covers about 30

¹³The name of the company has been disguised.

to 40 percent of information contained in an average paper-based record. Basically most of the information is text.”

From an October 2002 internal report, we found an even more pessimistic estimate of DocuLive’s coverage:

[It] covers 18 of a total of 66 document groups defined in the Norwegian standard for the paper patient record. In terms of volume—with a high degree of uncertainty—that accounts on average for about 10 percent of the total volume of a paper-based record. (Translated from Norwegian by the authors.)

Although the implementation of the EPR aimed at reducing paper and eventually replacing the paper system, the paper-based record still remained an important tool. Paradoxically, the production of paper documents increased markedly after the implementation of DocuLive. First, new laws on medical documentation required detailed records from professional groups not previously obliged to maintain a record, such as nurses, physiotherapists, and social workers. Second, for legal reasons the hospital kept the paper version of the record updated. Thus, each time a clinical note was written in the EPR, a paper copy was also printed and added to the paper record. Printout efficiency was not a design principle for the current EPR, causing non-adjustable print layouts that could result in two printed pages for one electronic page form. Third, multiple printouts of preliminary documents (e.g., lab test results) were often stored in addition to final versions. The result was that the volume of paper documents increased. This growth created a crisis at the paper record archive department. The hospital had moved into new facilities designed with a reduced space for the archive as it was supposed to handle electronic records only. In 2003, the archive was full and more than 300 shelf meters of records were lying on the floors. This situation also affected the time needed to find records, often resulting in the failure to satisfy requests.

An internal report noted that

In...2002, a daily average of 790 requests for paper records were received....About half of the requests did not turn out as an actual delivery. There are several reasons for this. The most common are that the record has already been delivered in another department or has already been collected; that it is not possible to locate the record (due to wrong archiving); or that the archive never had the record for that patient (usually because it is a new patient). (Translated from Norwegian by the authors.)

To alleviate this situation, a scanning project was started in 2003, with the aim of reducing the amount of paper documents sent to the archive. However, even after the documents were scanned they had to be kept. One reason was that DocuLive’s storage solution was not yet accredited; for that, one had to wait for release and implementation of a new version of the software. Another reason was that the existing communication and coordination of work practices were based on a flow of paper documents, and DocuLive did not yet contain the functionality that would allow the paper to be removed from the daily work practices. The result is that the benefits from the scanning activities were slow to be realized.

This story may be seen as a confrontation between what we might call “the order of computers” and “the order of paper.” Computers, we can argue, are best exploited if they are allowed to work the way that fits them best: where all information is stored in a shared, consistent, and nonredundant database. However, the paper record is ordered according to different principles in order to also be an efficient tool for local work practices, and the assumption that all patient-related information could be ordered according to the “computer order” has not yet been proven. At best, the transition period from paper-based to digital information will be long. During this period the electronic and the paper-based record have to coexist and cooperate.

One Record (per Patient), One (Integrated Information) System

The third story focuses on the relation between the new EPR system and the other clinical information systems in the hospital. When the implementation of DocuLive started, a few local systems containing clinical patient information already existed. Those systems were often overlapping with DocuLive’s (planned) functionality. The original plan as revealed by project documentation was to replace these with DocuLive so as to have the EPR as one integrated information system. DocuLive should

- *create a common platform for a multitude of customized EPR modules,*
 - *[be] powerful enough to support all health-related information and legal aspects*
 - *[be] general enough to serve as a basis for a wide variety of hospital information systems*
- (Technical Overview Document 1998, translated by the authors.)

In this story, again, the project’s ambitious plan ended up producing the opposite outcome, which contributed to inten-

sifying the degree of fragmentation of the medical record. The main ordering principles for achieving the integrated record were that there should be one record for each patient, containing all patient-related information, that this record should be shared among all units within the hospital, and that all patient records should be maintained by and stored in one single integrated information system. In order to achieve this, it was planned to integrate DocuLive with a few other systems: the central Patient Administrative System (PAS) and certain information supply systems, notably laboratory systems that store and deliver laboratory test results and image archives for radiological images. The idea of entirely substituting the other local EPR-like systems was slowly abandoned. To include the functions of all these systems into the EPR would have made its development unmanageable, and users generally perceived local systems to better support their work routines and refused to give them up. For instance, as a doctor in pediatric cardiology, referring to a local system, stated,

If you have congenital heart defects, it is very likely that you have also other congenital defects. So it is a very complex logistics of patients. These two reasons, the very detailed diagnostics, and the need of keeping track of the patient, are the basis for the design of our system.

Rather than replacement, various solutions for technical integration of DocuLive with some of the local systems were considered. These intentions were realized only for a few systems, leading to a situation where users had to either perform double entries or cut and paste information between the systems. Simultaneously the number of specialized information systems were growing, based on well justified needs of the different medical specialties and departments. For example, the *in vitro* fertilization clinic needed a system that allowed them to consider a couple as a unit, as well as allow tracking of information from both semen and egg quality tests through all procedures involved, up to the birth of the child. The intensive care unit acquired a system that allowed them to harvest digital data from a vast array of medical equipment and thus eliminate the specialized paper forms previously used to document events and actions. Moreover, new digital instruments in use in many different departments include software components with medical record functionality.

Hence, the envisioned role of DocuLive changed from being the only system to being one among a large (and increasing) number of systems (see Figure 2, from "Original Vision" to "Later Vision"). As the problems and the challenges with the original integration strategy emerged, the popularity of the Internet and its technology triggered the IT department at the

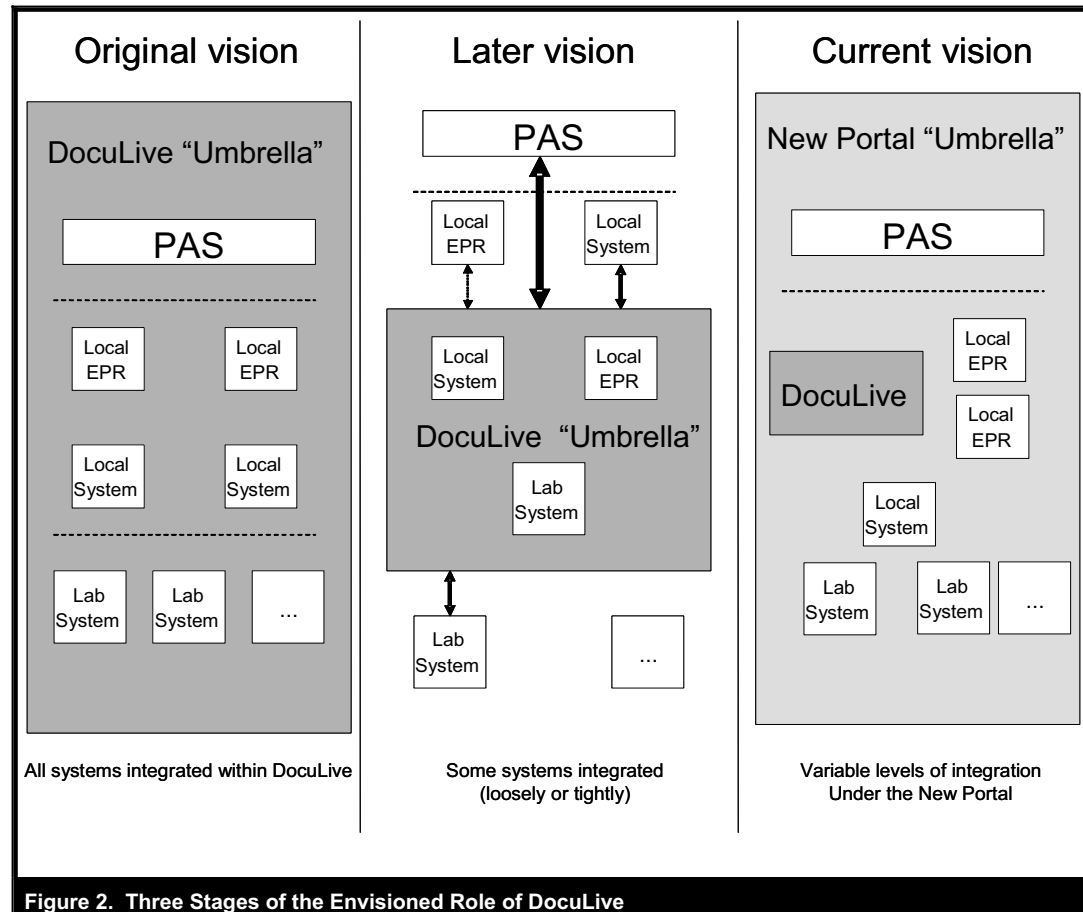
hospital to start thinking about other potential strategies. It started tinkering with portal technology, and this led to the idea of an integrated EPR system achieved by means of a more loosely coupled infrastructure where the many clinical and laboratory systems (and DocuLive itself) were brought together under the common umbrella of a portal (see Figure 2, "Current Vision"). The portal was part of a larger change in strategy which went under the acronym CSAM: Clinical Systems All Merged. Thus, while visualization and access to the systems were integrated, the systems themselves did not need to be integrated with each other.

This story shows, again, how the world of DocuLive and its order was confronted with other worlds with different orders and ongoing ordering processes. Different medical specialties focus on different types of information (in particular when dealing with specialized or tertiary hospitals like the one in this case). The ordering principle of "one patient, one record" is non-problematic for many, but may interfere with and create disorder for others. As a result, the attempt to achieve a tightly coupled integration of systems (in view of the logic of ordering of DocuLive) clashes with different logic, which reflects the actual complexity and diversity of the work practices to be standardized. From this clash—this interference of order—comes the generation of a new logic, implicit in the portal strategy CSAM.

To a certain degree, the novel portal strategy appears promising. It is a less strict and accordingly a more flexible way of standardizing and ordering. It seems more likely that this IS strategy can deliver a complete system for accessing information. To implement such a strategy is far from trivial or without risk. It entails further development work, as adapters need to be developed between the portal software and the different applications. Moreover, the laws and regulations concerning documentation of patient information are clearly based on the envisioned, all-encompassing EPR. One complete patient record is recognized to be the legal document, while the idea of keeping information in different sources as the CSAM strategy proposes is legally problematic: not all of the underlying systems are designed with adequate security of patient data in mind; therefore, they do not conform to the standards of the privacy laws, neither when it comes to access control solutions nor long-term storage of confidential data.

The Role of the Regional University Hospitals Revisited

The fourth story describes how a health sector reform in Norway interfered with the ongoing EPR standardization process. When the DocuLive project started, new procedures



and technologies were usually developed or first adopted by the five university hospitals, and subsequently by the other hospitals. The standardization of the EPR was expected to follow this pattern, but a major reform in the health sector, initiated in 2001, affected the standardization process significantly.

Before the reform, hospitals in Norway were owned by the country's 19 counties. There was a widely held view that the health system was too fragmented, did not encourage smooth collaboration, and did not maintain a rational division of labor. The reform implied that the government was taking over ownership of all hospitals by means of five regional health enterprises, which again owned the individual hos-

pitals. The reform significantly altered the dynamics in the sector. As a health enterprise, each region had to define cost-efficient and effective strategies to realize benefits of scale. A key concern was then to standardize on IT, and specifically to select one standard EPR system among the three systems in use. Inevitably, this created competition among the hospitals for each to have its own EPR system prevail over the others.

At this point, the DocuLive system progressed slowly due to continuously emerging new elements and demands originating from Alpha's activities and shifting strategies. In this situation, the IT department at Rikshospitalet attempted to market DocuLive as the standard system to be adopted by other hos-

pitals, even though its development was far from complete. Moreover, Rikshospitalet sought to become the reference center for delineating and implementing regional IT strategies. However, this strategy of promoting DocuLive soon changed, as the IT department at Rikshospitalet acknowledged its rather weak position in the regional “battle of systems” (Hughes 1983). Accordingly, they made a strategic move, promoting the portal concept rather than DocuLive. This turned out to be a more flexible and robust strategy in order to enroll the other hospitals in the region into a collaborative rather than competitive standardization effort. The strategic move to promote the portal strategy also implied that DocuLive would no longer be the standard EPR (although it would still be a product).

Analysis and Discussion

In this section we discuss the complexities that this case exhibits, and identify three research contributions. First, we show the socio-technical complexity of IS standardization by highlighting how the standardization was shaped by the different orders, multiple actors at play, and the interference between orders that created disorder. Second, by analyzing how disorders may undermine the creation of a possible stable ordering logic or solution and of a closure of the standard, we show how this complexity generates reflexive mechanisms. We call this phenomenon *reflexive standardization*. Third, we discuss how the reflexive mechanism is an instance of the complexity inherent in IS standardization, and we contrast our findings with traditional approaches to IS development and standardization.

Interference and Propagation of Side Effects

The four stories presented above provide an account of the multiplicity of perspectives, intentions, constraints, challenges, and agendas at work in the socio-technical network of the standardization process. As Law points out, orders are not “simply told, performed and embodied in agents, but rather they speak through, act and recursively organize the full range of social materials” (1994, p. 109). This perspective helps us to go beyond the intentionality of single actions and to see how ordering logics are embedded in heterogeneous social networks. Thus, their character is contingent and, in part, a matter to be determined empirically (Law 1994).

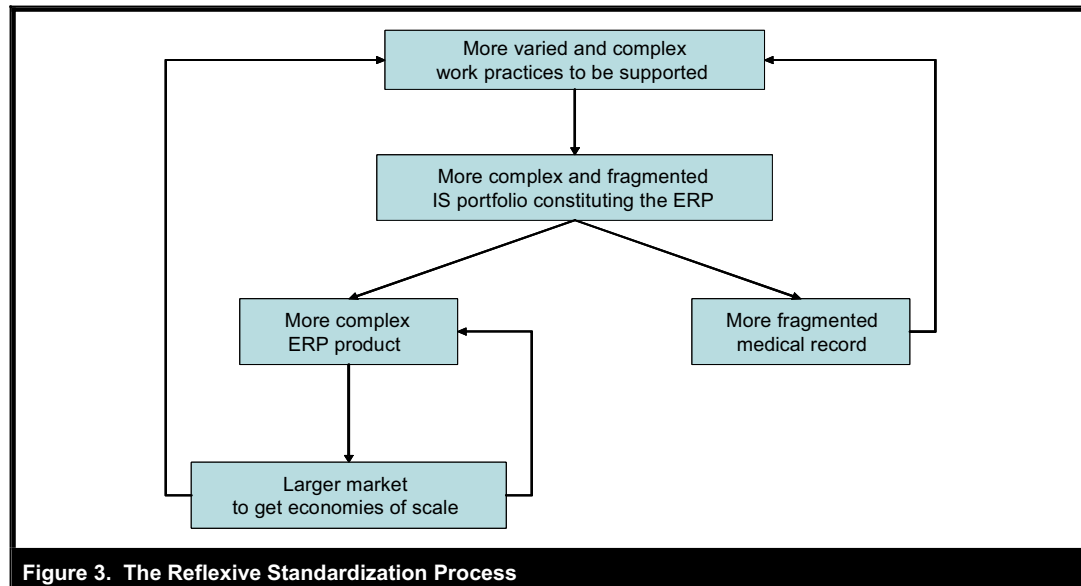
Different orders interact with and reorganize one another: they may create disorders, or reinforce existing orders. While it is true that standardization processes may eventually

stabilize—we have a large number of standards embedded in our practices—this case suggests that, under certain circumstances, interferences between orders will reflexively produce additional interferences with greater complexity, which will ultimately destabilize the initial order.

In the first story, we see how the two main actors, Alpha and the Norwegian EPR project, mutually and iteratively redefined their aims, strategy, and design of the standard as the project gradually escalated to a global level. The overall result of this dance of orders and redefinition of interests was that the Norwegian standardization project, as initially conceived, did not succeed. The second story highlights conflicts between (the order of) the electronic patient record and (the order of) the paper-based record. As a result, the strategy for creating an integrated record created, as an unintended consequence, a more fragmented one. The third story illustrates how the ordering principle of “one record (for each patient), one integrated information system” created disorders in terms of making it more difficult for workers to have easy access to the specific information they needed. The final story illustrates how a new order enforced by the government interfered with the ordering principles of the project.

The failure of DocuLive, at least as a standardization story, can be seen as a failure in attempting to control complexity. Arguably, the main mistake was to follow a traditional standardization approach—typical for (first) modernity; that is, overemphasizing criteria of universality, uniformity, and centralization of control to achieve alignment, stabilization, and closure. In line with our theoretical framework, our case data suggest that the complexity defines standardization as the emergence of multiplicities, inconsistencies, ambivalence, and ambiguities (Law 1999; Law and Mol 2002). Ironically, what happened was the opposite of the initial aim. When actors tried to stabilize the standard by enrolling more actors, it became less stable. Attempts to improve fragmented records by means of one integrated EPR made the records more fragmented. The complexity of DocuLive turned out to be one where the ordering efforts created disorder. The side effects triggered new ones, which again were reflected back on the origin. The standardization process turned out to be reflexive and self-destructive. The dynamics of reflexive processes at work are summarized in Figure 3.

The concept of reflexivity offers an interpretation of the dynamics of the case. The theory of high modernity helps to observe how the logics of the first industrial modernity find their limits (Beck et al. 1994). The intensified interconnectedness of social practices with technical artifacts and the need to align geographically dispersed actors effectively undermines the reductionist approach to control complexity. The



weakness of such an approach becomes visible when the control itself reflexively reproduced the complexity, thus creating the immanent paradox of modernity. Reflexive standardization seeks to highlight the need to develop alternative standardization approaches that better overcome the paradoxes to deal with complexity, as discussed below.

On the Validity of the Case Analysis

We have so far attributed the failure of the standardization effort to the inherent complexity of the standardization process and the ways in which the complexity was addressed. But this may not be the only possible explanation. It may be argued that the effort failed because of poor project management, insufficient user participation, incomplete requirements specifications, bad decisions, historical circumstances, following the wrong standardization approach, and so on. In our view, a standardization effort like the one described here almost never fails for one reason only. We do believe that the EPR project management followed strategies and made decisions that were well in line with “best practices” in software engineering, based on traditional standardization models. Without doubt, questionable decisions were made. Yet, we think that improved user participation or requirements specifications would not have saved the effort. In a similar

vein, sophisticated risk management methods would not have been of much help; rather they, most likely, would have added to the overall complexity and triggered new reflexive dynamics. In fact, when dealing with complex phenomena, we will always be confronted with unpredictable events and problems (Perrow 1999). We think that a different approach to complexity could have improved the chances of a successful standardization effort. Still, the people involved are not to blame. Rather, we submit, the problem is the poor understanding of complexity and standardization within the software engineering, information systems, and standardization fields.

With regard to the external validity of our case, we can ask: Is our case representative of a new class of standardization problems? We believe so, especially in the health care domain, where plans for developing electronic health records grow continuously bigger and more ambitious. For example, in his 2004 State of the Union address, George W. Bush Jr. envisioned “an EHR for all Americans within the next decade” (White House 2004). In addition to building a national health information infrastructure, establishing data interoperability and comparability for patient safety data is seen as crucial. This is expected to be facilitated through adopting standards that allow medical information to be stored and shared electronically while assuring privacy and

security. Similarly, the British “Connecting for Health” initiative proposes to establish the NHS (National Health Service) Care Record Service. For each individual patient the Patient Clinical Record will be used to deliver direct patient care, and in addition a centralized database (“The Spine”) will contain a National Summary Record in order to support urgent and emergency care (NHS 2005). For both initiatives, huge challenges can be recognized and critical voices emanating from our analysis can predict significant obstacles. However, from official documents and presentations of these projects, the general perception of standards is the value of increased control: developing and adopting standards is definitely seen as part of the solution rather than part of the problem.

We do not claim that standardization of medical information systems is impossible or undesirable. Because our case study site is a specialized hospital, it represents a paradigmatic example of the socio-technical complexity arising from the close intertwining of technical standards with local and highly professional work practices (in terms of professional disciplines and geography). To some extent our case represents a general class of problems associated with the interactions between the complexity of information infrastructures, information processing, and local work practices. Thus, the common shared complexity in these classes is the immense heterogeneity and multiplicity of actors involved and the need to coordinate and standardize their behaviors. Not surprisingly, challenges associated with complexity similar to those described here have been identified in multiple areas including enterprise resource planning (ERP) systems, corporate IT infrastructures in the oil and chemical industry (Ciborra et al. 2000; Hanseth et al. 2001), the financial sector (Ciborra and Osei-Joehene 2003), ship classification (Rolland 2003), and e-government (Ciborra 2003). All these are responses to a “quest for integration” (Dechow and Mouritsen 2005) and will unavoidably lead to increases in IS complexity. Accordingly, we believe that the reflexive processes as illustrated here will grow in number and importance.

Implications for Research and Practice

What are the implications of our findings for practice? Significant research efforts into the complexity of IS standards and their dynamics are called for before detailed concrete advice can be given. We agree with the authors of the British Computer Society report (BCS 2004) that complexity is the single most important issue for software engineering and information systems design. Research on the “duality of standards” regarding complexity (i.e., how

standards may reduce as well as increase complexity) forms an important part of this. Further research is needed on specific reflexive effects of complexity in different situations. Here, we will offer only tentative answers to this question. In doing so, like Perrow (1999), we assume that identified problems are inherent to complex systems and better structured methodologies or management tools for control will not solve them. To address such problems, we need to avoid creating complex systems.

Avoiding the kind of socio-technical complexity we have pinpointed may be possible by resisting the temptation to gain perfect order. The case study of the development of an EPR standard illustrates that traditional engineering approaches are risk prone in complex areas like designing technologies that span multiple work practices. These approaches tend to overestimate the universality of work practices, thus seeking order by simplification and abstraction and putting strong emphasis on design criteria such as consistency, completeness, and nonredundancy. These are all sound engineering principles and central to modernity. These criteria have been explicitly emphasized within the development of IT standards for health care (De Moor et al. 1993; McDonalds 1993). They all work well if we can start out by delimiting a part of the world that can be treated as closed and in isolation. But they can become a risk if and when such assumptions do not hold as identified in failures of IS-related standards in various areas (Graham, Lobet-Maris, and Charles 1996; Graham et al. 1995; Hanseth and Braa 2001; Hanseth and Monteiro 1997; Hanseth et al. 1996). In the case of IS standards-making, the closer the object of standardization is to local work practices, and the more knowledge-intensive the work practice (e.g., a specialized hospital), the less likely the traditional approach will succeed, possibly generating a reflexive self-destructive process. As Law (2000, p. 14) notes, “the search for system perfection is not only impossible but, more strongly, it may be self defeating.” We need to accept in our standard making that our complex worlds are populated with a multiplicity of orders that are inconsistent. We need to be able to live with such multiplicities and inconsistencies. We need to master the trade of what Cussins (1998) calls “ontological choreography.”

Another key element of a strategy accepting a multiplicity of orders is to identify subworlds that can be properly ordered and interfere with each other as little as possible; that is, make subworlds that are *loosely coupled* (Perrow 1999). Maintaining loose coupling between the social and the technical is perhaps the most important strategic element. What should be avoided is embedding specific working practices into the standards. To do so, one needs to be well aware of the local

specificity of work practices, and the fact that the practices are embedded into the technology.

Another way to reduce socio-technical complexity is to reduce the organizational complexity that results from the large number and heterogeneity of actors and their interdependencies. This is caused by the reach and range (Keen 1991) of the standard, which we see as a key source of its technical complexity. One strategy to reduce the scope is to split the standard into separate and independent packages, each of which has a more restricted reach and range. Rather than one universal standard in which the elements are tightly coupled, we should aim at a multiplicity of simpler standards that are loosely coupled. Such loose coupling between standards and the infrastructures based on them can be achieved by means of *gateways* (Hanseth 2001). In the domain of EPR systems, this means that one should develop separate systems for different countries, and that these systems could be further split up into individual systems for specific medical specialties or hospital departments or functions. Different medical record systems in a hospital can then be integrated either by gateways enabling the exchange of shared data between them, or by means of a portal that provides a shared interface for all of them.

Complexity is a vague term. It is hard to measure. We have learned in both the natural and social sciences that everything is indefinitely complex when we look at it carefully, if we “open the black box” (Latour 1988). Black-boxing is a strategy for reducing complexity and is closely related to modularization. It is a potentially powerful strategy, but it works well only under conditions of stability. A simple description of a complex system (in terms of an interface or an abstract specification) may be sufficient for a specific purpose. However, if the complex system is changing or the needs change, the simple description may no longer be appropriate. From this, we can derive another strategy to reduce complexity: look carefully for elements in the world—medical practices, instruments, ICT solutions—that will not change. These are the elements that may be black-boxed, ordered, and turned into standards.

The points made above can be illustrated by contrasting DocuLive with the portal strategy. The portal strategy is certainly very promising in terms of its robustness and flexibility. Its guiding principle is loose coupling between the different parts of the EPR system in contrast to the tight coupling strategy of DocuLive where all information was stored in one shared database and all functions integrated into one single software system. The portal strategy potentially makes it easy to include any kind of information and illus-

trations produced by new IS into the electronic record. For the time being, this strategy also embodies its risks. We do not know much about the long-term requirements of such a portal nor how to structure and design it. Such a portal can also be complex as more applications are integrated and its sophistication grows. It may become so complex that reflexive processes are triggered.

Conclusion

In this article, we argue that socio-technical complexity is a major issue in information system standardization. Through a case study of EPR standardization, we argue that critical dynamics related to this complexity relate to reflexivity. Reflexivity (Beck 1994) explains how, under certain circumstances, efforts aimed at reducing complexity through standardization may generate the opposite outcome. The circumstances described by the case represent a paradigmatic example of increased intertwining of technical standards with local, heterogeneous, and dispersed work practices. Through our analysis, we argue that traditional standardization approaches can not deal with such complexity appropriately. Not only will such approaches fail to deliver the intended outcome—order—they can also lead to the opposite effects of greater disorder and instability. The need of future research on IS standardization is, therefore, critical in approaches that help mitigate the increasing complexity of IS standardization.

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References

- Aanestad, M., and Hanseth, O. “Implementing Open Network Technologies in Complex Work Practices: A Case from Telemedicine,” in *Organizational and Social Perspectives on Information Technology*, R. Baskerville, J. Stage, and J. I.

- DeGross (eds.), Kluwer Academic Publishers, Boston, 2000, pp. 355-369.
- BCS. *The Challenges of Complex IT Projects*, report of a working group from The Royal Academy of Engineering and The British Computer Society, April 2004 (available online at <http://www.bcs.org/NR/rdonlyres/3B36137E-C5FE-487B-A18B-4D7281D88EF7/0/complexity.pdf>).
- Beck, U. "The Reinvention of Politics: Towards a Theory of Reflexive Modernization," in *Reflexive Modernization: Politics, Tradition and Aesthetics in the Modern Social Order*, U. Beck, A. Giddens, and S. Lash (eds.), Polity Press, Cambridge, UK, 1994, pp. 1-55.
- Beck, U. *Risikogesellschaft: Auf dem Weg in eine andere Moderne*, Suhrkamp Verlag, Frankfurt am Main, 1986.
- Beck, U. *World Risk Society*, Polity Press, Cambridge, UK, 1999.
- Beck, U., Bonss, W., and Lau, C. "The Theory of Reflexive Modernization: Problematic, Hypotheses and Research Programme," *Theory, Culture & Society* (20:2), 2003, pp. 1-33.
- Beck, U., Giddens, A., and Lash, S. *Reflexive Modernization: Politics, Tradition and Aesthetics in the Modern Social Order*, Polity Press, Cambridge, UK, 1994.
- Berg, M., and Bowker, G. "The Multiple Bodies of the Medical Record: Toward a Sociology of an Artifact," *The Sociological Quarterly* (38:3), 1997, pp. 513-537.
- Berg, M., and Timmermans, S. "Orders and Their Others: On the Construction of Universalities in Medical Work," *Configurations* (8), 2000, pp. 31-61.
- Bijker, W. E. "Do Not Despair: There is Life After Constructivism," *Science, Technology & Human Values* (18), 1993, pp. 113-138.
- Bowker, G., and Star, S. L. "Knowledge and Infrastructure in International Information Management: Problems of Classification and Coding" in *Information Acumen: The Understanding and Use of Knowledge in Modern Business*, L. Bud-Frierman (ed.), Routledge, London, 1994, pp. 187-213.
- Bowker, G., and Star, S. L. *Sorting Things Out*, MIT Press, Cambridge, MA, 1999.
- Brunsson, N., and Jacobsson, B. *A World of Standards*, Oxford University Press, Oxford, UK, 2000.
- Callon, M. "Techno-Economic Networks and Irreversibility," in *A Sociology of Monsters: Essays on Power, Technology and Domination*, J. Law (ed.) Routledge, London, 1991, pp. 132-161.
- Ciborra, C. "E-Government: Between Development and War," in *People and Computers*, T. Järvi and P. Reijonen (eds.), TUCS Publications, Turku, Finland, 2003, pp. 253-266.
- Ciborra, C., Braa, K., Cordella, A., Dahlbom, B., Failla, A., Hanseth, O., Hepsø, V., Ljungberg, J., Monteiro, E., and Simon, K. *From Control to Drift. The Dynamics of Corporate Information Infrastructures*, Oxford University Press, Oxford, UK, 2000.
- Ciborra, C., and Osei-Joehene, D. "Corporate ICT Infrastructures and Risk," in *Proceedings of the 11th European Conference on Information Systems*, C. Ciborra, R. Mercurio, M. DeMarco, M. Martinez, and A. Carignani (eds.), Naples, June 19-21, 2003.
- Cilliers, P. *Complexity and Postmodernism: Understanding Complex Systems*, Routledge, London, 1998.
- Cussins, C. "Ontological Choreography: Agency for Women Patients in an Infertility Clinic," in *Differences in Medicine: Unravelling Practices, Techniques and Bodies*, M. Berg and A. Mol (eds.), Duke University Press, Durham, NC, 1998, pp. 166-201.
- David, P., and Greenstein, S. "The Economic of Compatibility Standards: An Introduction to Recent Research," *Economics of Innovation and New Technology* (1), 1990, pp. 3-41.
- De Moor, G. J. E., McDonald, C., and van Goor, J. N. (eds.). *Progress in Standardization in Health Care Informatics*, IOS Press, Amsterdam, 1993.
- de Vries, H. J. *Standardization: A Business Approach to the Role of National Standardization Organizations*, Kluwer Academic Publishers, Boston, 2003.
- Dechow, N., and Mouritsen, J. "Enterprise Resource Planning Systems, Management Control and the Quest for Integration," *Accounting, Organizations and Society* (30:7/8), 2005, pp. 691-733.
- Ellingsen, G. *Global Reach, Local Use: Design and Use of Electronic Patient Record Systems in Large Hospitals*, unpublished Ph.D. Thesis, Norwegian University of Science and Technology, Trondheim, 2002.
- Ellingsen, G., and Monteiro, E. "Big is Beautiful: Electronic Patient Records in Norway 1980-2000," *Methods of Information in Medicine* (42), 2003a, pp. 366-370.
- Ellingsen, G., and Monteiro, E. "A Patchwork Planet: Integration and Cooperation in Hospitals," *Computer Supported Cooperative Work* (12:1), 2003b, pp. 71-95.
- Fomin, V., Keil, T., Lyytinen, K. "Theorizing about Standardization: Integrating Fragments of Process Theory in Light of Telecommunication Standardization Wars," *Sprouts: Working Papers on Information Environments, Systems and Organizations* (3:1), 2003, pp. 29-60 (<http://sprouts.case.edu/>).
- Forster, P. W., and King, J. L. "Information Infrastructure Standards in Heterogeneous Sectors: Lessons from the Worldwide Air Cargo Community," in *Standards for Information Infrastructures*, B. Kahin and J. Abbate (eds.) MIT Press, Cambridge, MA, 1995, pp. 148-177.
- Giddens, A. *Modernity and Self Identity: Self and Society in the Late-Modern Age*, Polity Press, Cambridge, UK, 1991.
- Graham, I., Lobet-Maris, C., and Charles, D. "EDI Impact: Social and Economic Impact of Electronic Data Interchange," EDI. TEDIS Project C9, report prepared for the European Commission, 1996 (http://homepages.ed.ac.uk/grahami/research/tedis_c9.html).
- Graham, I., Spinardi, G., Williams, R., and Webster, J. "The Dynamics of EDI Standards Development," *Technology Analysis & Strategic Management* (7:1), 1995, pp. 3-20.
- Gregory, J. *Sorcerer's Apprentice: Creating the Electronic Health Record: Re-inventing Medical Records and Patient Care*,

- unpublished Ph.D. Dissertation, Department of Communication, University of California-San Diego, 2000.
- Gregory, J. "When Logics of Illness, Patient Care Interactions, and Health Records Collide," paper presented at Public Proofs: Science, Technology and Democracy, 4S-EASST Conference, Paris, France, August 25-28, 2004.
- Hanseth, O. "Gateways—Just as Important as Standards," *Knowledge, Technology and Policy* (14:3), 2001, pp. 71-89.
- Hanseth, O., and Braa, K. "Hunting for the Treasure at the End of the Rainbow: Standardizing Corporate IT Infrastructure," *Computer Supported Cooperative Work* (10:3-4), 2001, pp. 261-292.
- Hanseth, O., Ciborra, C., and Braa, K. "The Control Devolution. ERP and the Side Effects of Globalization," *The Data Base for Advances in Information Systems*, (32:4), Special Issue on Critical Analysis of ERP Systems: The Macro Level, 2001, pp. 34-46.
- Hanseth, O., and Monteiro, E. "Inscribing Behaviour in Information Infrastructure Standards," *Accounting Management & Information Technology* (7:4), 1997, pp. 183-211.
- Hanseth, O., Monteiro, E., and Hatling, M. "Developing Information Infrastructure: The Tension Between Standardization and Flexibility," *Science, Technology, & Human Values* (21:4), 1996, pp. 407-426.
- Hawkins, R. "The Rise of Consortia in the Information and Communication Technology Industries: Emerging Implications for Policy," *Telecommunications Policy*, 1999, pp. 159-173.
- Hughes, T. P. *Networks of Power: Electrification in Western Society, 1880-1930*, John Hopkins University Press, Baltimore, MD, 1983.
- Keen, P. G. W. *Shaping the Future: Business Design through Information Technology*, Harvard Business School Press, Boston, 1991.
- Klein, H. K., and Myers, M. D. "A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems," *MIS Quarterly* (23:1), 1999, pp. 67-93.
- Latour, B. "Is Re-Modernization Occurring—And If So, How to Prove It? A Commentary on Ulrich Beck," *Theory, Culture & Society* (20:2), 2003, pp. 35-38.
- Latour, B. *Science in Action*, Harvard University Press, Cambridge, MA, 1988.
- Latour, B., and Woolgar, S. *Laboratory Life: The Construction of Scientific Facts*, Princeton University Press, Princeton, NJ, 1986.
- Law, J. "Landbroke Grove, or How to Think about Failing Systems," on-line papers, Center for Science Studies, Lancaster University, 2000 (available online at <http://www.lancs.ac.uk/fss/sociology/papers/law-landbroke-grove-failing-systems.pdf>).
- Law, J. *Organizing Modernity*, Blackwell, Oxford, UK, 1994.
- Law, J. "Traduction/Trahsion: Notes on ANT," on-line papers, Center for Science Studies, Lancaster University, 1999 (available online at <http://www.lancs.ac.uk/fss/sociology/papers/law-traduction-trahison.pdf>).
- Law, J. "Technology and Heterogeneous Engineering: The Case of the Portuguese Expansion," in *The Social Construction of Technical Systems: New Directions in the Sociology and History of Technology*, W. E. Bijker, T. P. Hughes, and T. Pinch (eds.), MIT Press, Cambridge, MA, 1987, pp. 111-134.
- Law, J., and Bijker, W. E. "Postscript: Technology, Stability and Social Theory," in *Shaping Technology/Building Society*, W. E. Bijker and J. Law (eds.), MIT Press, Cambridge, MA, 1992, pp. 290-308.
- Law, J., and Mol, A. *Complexities. Social Studies of Knowledge Practices*, Duke University Press, Durham, NC, 2002.
- Law, J., and Urry, J. "Enacting the Social," on-line papers, Center for Science Studies, Lancaster University, 2002 (available online at <http://www.lancs.ac.uk/fss/sociology/papers/law-urrry-enacting-the-social.pdf>).
- Mahoney, J. "Path-Dependence in Historical Sociologym," *Theory and Society* (29), 2000, pp. 507-548.
- McDonalds, C. J. "ANSI's Health Informatics Planning Panel (HISPP): The Purpose and Progress," in *Progress in Standardization in Health Care Informatics*, G. D. E. De Moor, C. J. McDonald, and J. Noothoven van Goor (eds.), IOS Press, Amsterdam, 1993, pp. 14-19.
- Mol, A., and Berg, M. "Introduction," in *Differences in Medicine: Unravelling Practices, Techniques and Bodies*, M. Berg and A. Mol (eds.), Duke University Press, Durham, NC, 1998, pp. 1-12.
- National Health Service. "The Clinical Development of the NHS Care Records Service," Shared Care Record Review Document, July 29, 2005 (http://www.connectingforhealth.nhs.uk/crdb/docs/scrrdocument.doc/file_view).
- Perrow, C. *Normal Accidents*, Princeton University Press, Princeton, NJ, 1999.
- Rolland, K. *Re-inventing Information Infrastructure in Situated Practices of Use*, unpublished Ph.D. dissertation, University of Oslo, 2003.
- Schneberger, S. L., and McLean, E. R. "The Complexity Cross: Implications for Practice," *Communications of the ACM* (46:9), September 2003, pp. 216-225.
- Shapiro, C. L., and Varian, H. R. *Information Rules: A Strategic Guide to the Network Economy*, Harvard Business School Press, Boston, 1999.
- Shapiro, S., Richards, B., Rinow, M., and Schoechele, T. "Hybrid Standards Setting Solutions for Today's Convergent Telecommunication Market," in *Proceedings of the 2nd Conference on Standardization and Innovation in Information Technology*, IEEE Computer Society Press, Los Alamitos, CA, 2001, pp. 348-351.
- Star, S. L., and Griesemer, J. R. "Institutional Ecology, Translations and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-1939," *Social Studies of Science* (19), 1989, pp. 387-420.
- Star, S. L., and Ruhleder, K. "The Ecology of Infrastructure: Design and Access for Large Information Spaces," *Information Systems Research* (7), 1996, pp. 111-133.

- Statens Helsetilsyn. "Pasientjournalen: Innhold, gruppering og arkivering av pasientdokumentasjon i somatiske sykehus," ("The Patient Record: Content, Grouping and Archiving of Patient Documentation in Somatic Hospitals"), Document Number IK-2451, Norwegian Board of Health, 1993.
- Timmermans, S., and Berg, M. *The Gold Standard: The Challenge of Evidence-Based Medicine and Standardization in Health Care*, Temple University Press, Philadelphia, PA, 2003.
- Timmermans, S., and Berg, M. "Standardization in Action: Achieving Local Universality through Medical Protocols," *Social Studies of Science* (27), 1997, pp. 273-305.
- Urry, J. *Global Complexity*, Polity Press, Cambridge, UK, 2003.
- Vercoulen, F., and van Weberg, M. "Standard Selection Modes in Dynamic, Complex Industries: Creating Hybrids between Market Selection and Negotiated Selection of Standards," NIBOR, Netherlands Institute of Business Organization and Strategy Research, Maastricht, 1998.
- Walsham, G. *Interpreting Information Systems in Organizations*, Wiley, Chichester, UK, 1993.
- Walsham, G. "Interpretive Case Study in IS Research: Nature and Method," *European Journal of Information Systems* (4), 1995, pp. 74-81.
- White House. "Transforming Health Care: The President's Health Information Technology Plan," 2004 (http://www.whitehouse.gov/infocus/technology/economic_policy200404/chap3.html).

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