The Electronic Patient Record
and the Hospital Information Infrastructure

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Context of study

Rikshospitalet and the Norwegian health care sector

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 increased efficiency, reduced costs and increased 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 question whether the lack of resources was the only problem, or whether a reorganization of the ownership and management structure was necessary.

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 and to documenting activities, use of resources and benefits. As we will show, the implementation of this health reform also has had major impacts on IT strategies and on how current IT implementations are run.

The information systems portfolio at Rikshospitalet

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 put together 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 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 MedInfo as the industry partner. The final product delivery was planned for December 1999, but to date (Summer 2003) the project is still running and the end has been postponed to beginning of 2004. More on the historical background for the current product can be found in Ellingsen and Monteiro (2002).

At the current stage, the IT department views the interdependencies of the various Information Systems as illustrated in Figure 1. At the center (and as the core) is the Patient Administrative System (PAS, also called Patient Information Management System, or PIMS). On the outskirt are the various clinical departments with their own Information Systems. These may be Laboratory Systems, Radiology systems (RIS), specific and local department clinical systems, and so on. The EPR would be a system second in hierarchy to PIMS, with a hospital wide scope (as PIMS) and with upward and downward integration. The upward integration with PIMS represents a prerequisite to run the EPR. Occasionally, departmental systems would have direct integration with PIMS.

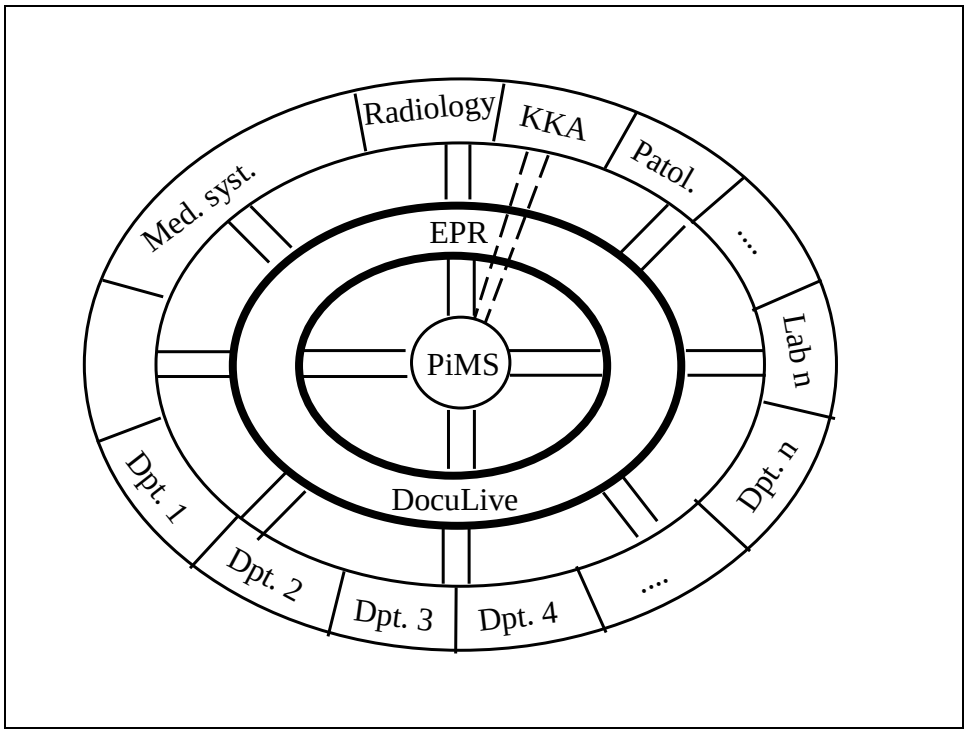

Figure 1 The Information Systems at Rikshospitalet as depicted by the IT department

Case description: Four Stories

We will structure the case in four stories. The aim is to provide an impressionistic account of the complexity of the observed phenomenon. The choice of the stories is in particular dictated by the aim to highlight those (side-) effects which influenced the overall risk of the implementation process.

The four stories provide a detailed historical and contextualized description of particular aspects of the implementation process both at a micro and macro level. While the first two (Fragmentation and Growing Complexity, and Crisis at the Archive Department) describe micro dynamics observed from within the physical boundaries of the hospital, the latter two (Growing Ambition and Going Global) try to provide a wider historical perspective on the role of the IT department in managing the Information Infrastructure in the hospital.

We will first provide some contextual information about the EPR implementation project.

A brief overview of the implementation of PreEPR

The implementation of PreEPR at Rikshospitalet started in 1997 with pilot projects at two clinical departments. The implementation proved problematic and proceeded slowly. There were various reasons for the delays: the system was not reliable, the implementation strategy had to be tuned, and other concurrent projects at the IT department were making the implementation of the EPR more complex. Regarding the latter issue, between 1997 and 1998 the IT department had to concentrate also on the

implementation of PAS (Patient Administrative System), and to manage an infrastructural transition from Windows for WorkGroups to Windows NT. Moreover, during the period 1998-2000 the hospital was relocated in new buildings. The relocation process created a "quarantine" period for every project, including the implementation of the EPR. The other four hospitals participating in the project were far ahead with the implementation compared to Rikshospitalet. By end of 2001 the implementation reached less than 500 out of 3500 target users.

In 2002 with the previously mentioned health sector reform, an increased focus on cost savings and efficiency pushed the administration to take action on the EPR project. It had either to work or to be suppressed. The decision was made to support it and to provide the IT department with the necessary resources. During 2002 a finely tuned implementation strategy and adequate support allowed the implementation to reach almost all the 3500 target users. Behind this apparent, though impressive, success, lays a series of compromises which make an evaluation problematic. The implementation strategy aimed at reaching the greatest number of users in the shortest time with the lowest effort possible. In order to achieve this, the implemented functionality was reduced to the necessary and all activities which would increase the complexity of the implementation were postponed, for instance integration with the various local systems.

In the negotiations around this, the systems that serve a distributed user base were prioritized. The local systems were co-existing with PreEPR, as their unique functionality supported the local work practices much better than PreEPR. If there was an overlap of the systems, extra work had to be done in order to duplicate the information, e.g. text were cut and pasted between systems. The more unique functionality remained supported by the local system. Initially the integration was often manually performed (manual replication and transfer of information from one system to the other) and technical integration (automated information transfer) was planned for a later stage.

The current version of the EPR is not fulfilling all the requirements set up by the project. A new version of the software (to be delivered during 2003) is promised to fulfill all the requirements and allow the project to end. So far, an installed base of users of PreEPR at Rikshospitalet has been successfully created. However, during the implementation process side-effects of the implementation started to show up. How and why the side-effects emerged and became manifested will be the main focus of our empirical material. We have organized this into four stories.

Story One: Fragmentation and growing complexity

In this story we will show how attempts to reach greater integration and coherence of clinical information and information systems end up generating greater fragmentation and complexity. First we show how the attempt to integrate and represent information on the EPR generated opposite effects of information fragmentation. The fragmentation occurred on two levels: on the level of how the information is represented, and on the level of how the information is used. Secondly we show how the attempt of integrating different systems under the umbrella of the EPR has indeed generated the need to

introduce yet another integrating system, ironically increasing systems fragmentation and complexity.

Information fragmentation

The aim of the project was (and still is) to create a complete digital version of the paper-based record. In order to achieve this, the information structure of the centralized paper record was replicated in PreEPR. The information in PreEPR is thus structured according the same chapter patterns as in the paper record: A for referral letters and similar, B for doctors' notes and so on. What resulted to be problematic was creating digital versions of the various forms contained in the chapters. For this purpose, special task forces were set up to design digital forms corresponding to the paper-based ones.

Despite the considerable efforts and almost eight years of work only some parts of the paper-record sections have been digitalized. While the national guidelines specified 66 document groups in the record, it has been evaluated that the current version of the EPR implemented at Rikshospitalet (PreEPR) covers just 18, which constitute about 20-30% of the total volume of an average paper-based record. The remaining document groups represent increasingly difficult design challenges, as the information is not only text based, but also graphical information in a variety of formats. Moreover, often technical equipment like ECG (Electrocardiogram) or ultrasound machines provide a digital recording of the measurements, but these are formatted according to proprietary standards and cannot be directly transferred to the electronic patient record system.

The result is that currently patient related information is produced and stored in a variety of media: as paper printouts, as electronic forms (implemented in the EPR), and in other clinical information systems. In particular, the physicians' notes are registered in PreEPR (this is demanded from the hospital's management) and signed (i.e. validated/verified) by the physician. Since PreEPR does not yet represent a complete reproduction of the patient record a paper version of the notes must be printed out and included in the paper-based record. Much of the information is thus duplicated, and use of the paper-based record is paramount. For the same reason, the paper record is often requested from the archive by physicians dealing with a patient. However, when physicians receive phone calls, e.g. from a referring physician outside the hospital, and need to look up information quickly, they primarily rely on the digital version if it exists.

The original plan of migrating from a coherent paper-based to a coherent electronic patient record seems to have encountered considerable difficulties along the way. As a result, the situation with respect to the record system is a mixture of digital and paper-based information. This means that all the benefits of a fully digitalized record system have not been realized. If we analyze the situation along several dimensions: for instance in terms of availability, accessibility, redundancy and consistency of information, we get the following table (Table 1):

	Distributed paper	Centralized paper	Envisioned EPR	Current situation
Availability	High	Available within	High	Mixed

(temporal)		2 days		
Accessibility (spatial)	Local	Central	Virtual	Mixed
Redundancy	High	Low	None	High (?)
Inconsistency	Possibly high	Low	None	Possible

Table 1 Analytical dimensions and benefits

The question is whether the current status represents just a transition toward the envisioned fully digitalized work environment or whether it indicates that the implementation process is progressing along a different path than the one planned.

The creation of the centralized archive was not perceived to be an improvement by most users. The physical distance to the records increased and therefore the availability decreased. The benefits of the local archives were perceived to outweigh the benefits of the centralized record by far for most cases. Also the merging of paper forms from different departments into one record implied that the record became larger in volume and thus less user-friendly. Usually a physician is interested only in parts of the information, the parts which is produced by this specific department. When papers from all departments were mixed, it was not as easy to find one's own information. There are now signs of a re-emergence of local (i.e. departmental) sections within this joint record, i.e. one department information is collected in separate covers/"soft binders" within the storage box. The introduction of the EPR should have changed this picture allowing immediate availability and accessibility.

The fact that the current picture is showing a "mixture" of the mentioned properties of availability and accessibility is just mirroring the "mixture" of media representing the information and the mixture of modalities with which the information is accessed and used. In other words, the attempt to reach a coherent and integrated representation and use of the information in digital form has encountered (and actually generated) increasing difficulties, which brought the plan in the opposite direction: fragmentation.

Growing systems complexity

Apparently the vision of a single hospital wide clinical information system (the EPR) integrated with existing system has been hard to reach. However, the number of systems has been growing in the years. As the implementation goes on, the number of interconnections to be created and maintained also grows. The original idea of a fully integrated infrastructure with the EPR on top of it is increasingly loosing its central role, as older and new systems get available on the local network and become integrated with work practices. In this picture the EPR is just but one other system. In order to manage the fragmented reality of hospital systems, the IT department is designing a portal solution which should "glue" the systems together in a sort of loose manual integration, providing access to a variety of information sources. The implementation of this portal may in principle allow a simplification of the access to the systems but it represents an added complexity and increased system fragmentation. Ironically it is introduced in order to reduce complexity and fragmentation.

Story Two: Crisis at the archive department

The following story reveals how past decisions propagated in time causing an unexpected crisis at the department where paper-based records are archived. The decision in 1995 of centralizing the paper record provided the foundations for side-effects to be caused by the parallel and incomplete implementation of the EPR and by the availability on-line and partial integration of a laboratory system for test results. Both actions, ideally aiming at reducing the production and circulation of paper, ironically caused the opposite effect contributing to the space and resources crisis in the archive.

We will first briefly describe the nature of the crisis. Secondly we will analyze two possible causes. Finally we will delineate the chosen intervention strategy and its challenges.

The paper record archive department is divided into two sections: one for recent paper records and one for older ones. The section containing recently opened or updated records is called the "active" archive, and it contains the records that are frequently or more likely requested. In total the archive covers a surface of 8000 shelf meters. It has been evaluated that since 2001 the yearly growth of the "active" archive amounts to approx. 1200 shelf meters. The growth is due to creation of new patient records, an increase in physical size of the existing ones, and a practice of documenting more than before. Both the growth of the paper record space demands and the frequency of requesting them are higher than estimated, and have created a crisis at the archive department. Regarding the former, even though the hospital recently (in 2000) moved to a new location with new buildings, the "active" archive is already full. More than 300 shelf meters of records are laying on the floor. Whereas for the latter, the archive department receives an average of nearly 800 daily requests of patient records, more than 30% of which cannot be satisfied. Reasons of this are normally the following: the paper record is in another clinical department; the record has been already collected by the same department requesting it; the record has been previously archived in the wrong way; the record does not exist because the patient is new. In addition to this and due to the huge workload the archive department is experiencing, the time needed to add to an archived record a new document can often span up to one month (in other words the time between the submission of the document to the archive by a doctor and the time of the actual archiving of the document). The paper archive department has received extraordinary funding in order to be able to offer the necessary services.

The current crisis at the archive department is a direct consequence of the decision to centralize the paper-based record taken in 1995. If the paper-based patient record had not been centralized, the archive department would not exist. But the crisis is also an indirect consequence of the implementation of the EPR and of the digitalization of other services such as the provision of laboratory results. Ironically, those systems, implemented in order to substitute paper, have markedly increased the production and use of paper, and thus the physical size of the records. Indeed, since the implementation and use of the EPR system, all the users are requested to keep both the electronic and the paper version of the record updated. Consequently, each time a clinical note is written in the EPR a paper

copy is printed and put into the paper archive. Moreover, since printout efficiency was not a design principle for the current EPR, the font size and the layout of the page templates cannot be adjusted in order to e.g. get a form onto one page (much "air" on pages). The result is that the amount of paper needed to archive the same amount of information is now larger.

Another factor contributing to this situation is a distributed information system connecting the laboratory test departments and the clinical departments. This system allows the users (physicians or nurses who is in charge of the patient) to read the test results online, as they are produced. This possibility also contributes to an increase in the physical size of the records. Since different tests require different time to produce results, all the results are not generated at once. Currently it is common practice among users of the system to print out the results sheet even if all test values are not available. The printed (and incomplete) results sheet is nevertheless sent to the archive department to be put in the corresponding record. As new test results are available, a new print out is generated and submitted to the archive. In worst cases the paper record may contain up to 12 test results sheets from the same test session, of which only the last one represents the complete test result. The redundant sheets should be discarded when archiving a more recent one, but this does not always happen.

Given the crisis situation quick action was to be taken to reduce or control the needed space in the archive and reduce or properly support the overwhelming number of requests. Two possible alternatives where considered. The first one aimed at addressing the crisis by allocating more space and workforce to the archive department. In addition to this, new printing practices would have to be designed and enforced in order to avoid unnecessary production of paper an unnecessary overload of paper record updating activities in the archive. In other words, the first alternative would use new resources to improve the existing situation without actually changing it.

The second envisioned alternative proposed to concentrate resources in new IT projects which would address the crisis by introducing new ways of updating the record. For instance, it was proposed that most requested paper documents should be scanned and linked to the EPR. The scanning would also help to complete the electronic version of a record (though in a less elegant way) allowing for "destruction" of the paper-based version. This second alternative was clearly proposing to invest the available resources in projects, which would align with the EPR vision. The choice was made to follow this second alternative and address the crisis by creating new functionality to be added to the EPR.

The scanning project implied a whole new set of problems and challenges to be addressed. Examples are: where should the scanners be placed and who should be responsible for them? How should the scanning practices be defined? How should they coordinate with the other practices on the use of the paper and the electronic record? Various options are available. The project is currently addressing them and aims at reaching concrete results by end of summer 2003. Additionally, the IT department initiated a project for changing paper-based record updating practices. The project, called

PaperSync, aims at defining best practices for rationalizing the updating activities, e.g. by organizing batches of updates instead of submitting them on a continuous basis.

Summarizing the above, the crisis at the archive department manifested as follows: (1) the archive space limits were reached; and (2) 30% of the 800 daily requests could not be satisfied. The two examples illustrated above show but two of the reasons of the critical state: inefficient printing functionality of the EPR and lousy practices for updating test results in the paper record. Taken singularly these two issues appear trivial. The reason why they are not relies in their spatial and historical interdependencies with other apparently trivial issues.

For instance, the EPR is not an efficient printing program because it was designed to be an efficient digital representation of the record. Ironically, it was designed to decrease the use of paper. Moreover, improving updating practices involves a full-scale users training effort. Unfortunately improving the practices does not address the real cause of this situation. In the particular case of the laboratory system, its on-line availability was part of a greater system integration effort aiming at substituting the production and circulation of paper from the laboratory to the various users of the service. Ideally the laboratory system had to be integrated with the EPR (and eventually it will be), but the current status is that it is not. The consequences of this state are twofold: no paper is produced and circulated between the laboratory and the doctors, but a lot more paper is produced and circulated between the doctors and the archive department. In other words, locally the intended effect of reducing paper production and circulation was reached, but the same action had an unintended consequence of increasing the production and circulation in another part of the system.

These represent just but two examples of unexpected side-effects of the introduction of a clinical information systems aiming at substituting the use of paper. The side-effects in this case are more evident in that ironically the systems cause the increase of use of paper instead of its substitution. The side-effect triggered by the EPR implementation process propagated in time and space causing the crisis at the archive department.

Story Three: Growing Ambitions

This story will try to highlight and explain the reasons of the considerable change experienced by the IT department at Rikshospitalet throughout the last fifteen years. In this time frame, the IT department has considerably transformed its core competencies, enormously increased its size and budget, and radically changed its mission and scope. We will show how possible causes related to this change can be identified in the growing complexity of the information infrastructure in the hospital and in the transformation of the competitive environment.

We will here recall the main questions emerged from the observed dynamics of the IT department. The role and function of the IT department have considerably shifted from purely technical support in early 90s, to encompass “high-risk” clinical information systems development. Why did this shift occur?

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. The budget for similar projects before 1995 was 0 MNOK. What caused this growth?

Finally, 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. After the health sector reorganisation, 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 clinical information systems. Why did this change in scope happen?

We may start our analysis by looking at how the role of the IT department has changed in time and how this relates to the development of the Information Infrastructure and to the transformation of the competitive environment caused by the Norwegian health reform.

The increase of complexity of the information 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 Patient Administrative System, Human Resource management systems and financial system. Accordingly, competencies in the IT department were limited to technical knowledge, and the type of service 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 department 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 EPR systems, sometimes with statistical functionality for research purposes. The systems were developed entirely inside the departments without any support of the IT department, if not for 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.

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 the PreEPR project was started with the aim of developing a hospital-wide EPR. At that time the IT department counted 19 people

including two developers. None of them had any formal background in clinical practice and was thus 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. The management of projects was reorganized in order to grant a greater involvement and responsibility of clinical departments. For the development of any new clinical information system, a project manager from the clinical department was appointed, and some end-users were possibly involved part-time in the project.

The IT department started to deal with projects with an increasing complexity. Some of them were rather straightforward, other required far more time and resources than planned (e.g. the development of PACS). All of them required innovative way of working. One key element was interdisciplinarity and co-responsibility. 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. The competence was shifting from one of purely technical knowledge to an interdisciplinary approach to the design, implementation and adaptation of clinical information systems.

With the PreEPR 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. The project represented a first attempt to coordinate the initiative of the five Norwegian regional hospitals, and can be seen as an attempt to define a national standard, possibly also in the light of achieving a future integration. Therefore, through this project the IT department of Rikshospitalet was suddenly becoming a player on a national scope influencing the future of a national standard. However, it is with the Norwegian health reform that the IT department faced the greatest challenge: the challenge of changing from a service department to a service company selling its service to its original home (Rikshospitalet) but also to all other hospitals in the same region.

The transformation of the competitive environment

Prior to the health reform that has taken place in 2002 there was great independence of each hospital from the other. As a result, also IT strategies were independent. Each hospital had its own IT department, which would run on a defined budget to provide services to that particular hospital. With the health reform and the reorganization of Norwegian hospitals under the umbrella of five health enterprises administrating five regions (north, south, east, west and middle Norway) the independence of IT strategies was broken and a new competitive environment was created. IT strategies started to be coordinated between the hospitals of the same regional health enterprise. Moreover, the IT department was no more the exclusive provider of IT services to the hospital hosting it. In this new scenario the IT department of Rikshospitalet had to react to the possible threat of competition from IT outsourcing companies and of competing IT strategies inside the health company. The first threat mainly affected the core competence the IT department was developing, whereas the second threat affected the size and ambition of projects. The department went through an organizational transformation from being a service department of a bigger organization to being an independent company acting on a

free market with an own strong marketing image. Their motto was: “We deliver!” Their core competence was now shifting towards the “use” of clinical information systems, with the aim to create a unique competence that could hardly be outsourced to competing companies.

As mentioned, besides competition from IT outsourcing companies, the health reform created competition between the IT departments of the hospitals owned by the same health company in a given region. The main reason for the competition lied in the attempt of the health company to manage the variety of health information systems standards existing in the current scenario. For hospitals, there were three different EPR systems in use in Norway: MedInfo’ PreEPR and other two Norwegian products, namely DIPS and Infomedica. In the region where Rikshospitalet is located the struggle is still between PreEPR and DIPS. In the neighboring health region (East) the decision has been already made to implement only one EPR system to be used by all its hospitals. The bid had been open and the contract was assigned to DIPS, which should now gain control over the development of the EPR in the whole region. It is likely that the health company owning Rikshospitalet will follow a similar attempt of standardization. The IT department in Rikshospitalet is thus facing the risk of seeing the work and investments of eight years vanished in the choice for a different standard than the one currently developed. Thus, in order to win the struggle, the strategy implemented by the department has been to grow in size and ambition of projects with the attempt to gain credibility and strategic alliances with other hospitals in the region.

For example, the IT department at Rikshospitalet has just reached agreements with other hospitals in the same region to create a strong alliance for developing a common IT strategy for the EPR. Three possible solutions were considered: (1) Rikshospitalet would support the implementation of the same EPR and PIMS solutions in the allied hospital keeping separate databases and being responsible for maintenance; (2) Rikshospitalet and the allied hospital would implement the same solution having separate databases but located in Oslo, this way Rikshospitalet would serve as an ASP (Application Service Provider); (3) Rikshospitalet and the allied hospital create a common database integrating the two EPRs and the PIMS in one. Of these three possible solutions the decision has been made to follow the third one. The third solution implies complete integration and standardization of the EPR and of the PIMS from the two hospitals into one information system representing some form of “virtual hospital”. The main motivations were the envisioned clinical and financial benefits and the perception that, given the increasing integration of basic infrastructures, this kind of integration was going to be an obligatory passage sooner or later. One of the challenges this solution is facing is the non-compliant legislation, which does not allow the information to travel or be shared between hospitals; main reason being issues of security. No need to underline that this strategy is the one pushing for greater standardization and integration, therefore the most ambitious of the three.

Summarizing, it may be now clear that it is interest of Rikshospitalet to convince as many hospitals as possible to acquire their EPR as standard. In the case the health company decides to standardize the EPR infrastructure across hospitals, it is likely that the chosen

standard will be the one with the larger installed base of users. Thus, in order to win allies, Rikshospitalet has to "sell" the standard convincingly. In order to sell it has to propose ambitious and appealing projects.

Origins of a growing ambition

We will try here to identify a pattern in the growing ambition of the IT department.

In early 1990s the clinical departments, the people, their practices, the IT department and so on, were initially loosely interrelated. The interdependencies between the IT department and the clinical departments were limited if not non-existing. In this setting the role of the IT department was fixed and defined by a well-established practice. The support and maintenance service was in this sense "low-risk" and hardly ambitious.

The introduction of a LAN and an infrastructure of PC represented a first effort of integration and standardization, which created a common Infrastructure for the whole hospital. The integration was so far on a quite technical basis, but provided the means to enable integration of practices between clinical departments. As a matter of fact, as a (probably expected) side-effect, local information systems started to pop-up and soon the IT department engaged in the development of clinical information systems. The LAN and the PC infrastructure (which represented a considerable step in integrating the departments of the hospital) enabled the flourishing of local systems, which generated the need of starting to integrate the systems and of introducing new types of systems. LAN and PCs represented a "low-level" technical integration but they created the need of a "higher-level" integration on the application level; which, in turn, generated the need of an even higher level of integration on the level of work practices.

In order to be able to follow and support the growing need of integration and standardization, the IT department engaged in a profound change of its organization. It acquired new competencies and it grew both size and budget. It created new organizational units, such as a R&D unit, a unique entity so far in Norway. Plus it had to face new challenges in complex and sometimes uncharted areas (from PACS solution to the EPR). The work the IT department was accomplishing was no more routine and it undoubtedly had a greater amount of uncertainty. Compared to the beginning of the decade, the ambition had grown from the one of providing reliable support service to the one of leading the change of the hospital clinical information routines.

This ambition was driven so far by the described evolution of the Information Infrastructure of the hospital. But the level of ambition escalated when a new challenging competitive scenario opened up with the health reform. Suddenly the IT department at Rikshospitalet was no more isolated but it became an actor affecting and being affected by a regional IT strategy. Indeed while the integration and standardization process was taking place inside the Rikshospitalet, the same was happening in all other hospitals in Norway and in the south region in particular. Moving one step back, one could see the same phenomenon of increased integration (through PCs, LAN, WAN and the Internet) happening in other hospital of the Norwegian system. This process of technical integration reached a point where the whole south Norwegian region (we refer here to the

hospitals in the Health Company South) was not just connected to the Internet, but it ran on an own huge LAN. The integration reached such a level that theoretically by digitalizing all information of all hospitals the entire south region could run as one single huge virtual hospital.

It is in this scenario that the IT department at Rikshospitalet was not alone anymore. The interdependencies of the hospitals in the system were so strong (at least potentially) that the main problem was no more limited to keeping up with challenging implementation projects but a question of survival. The strong interconnection and integration of the south region made the possibility of standardization and centralization of services too appealing to be let unattempted. In order to survive, the IT department had to become a stronger player, build allies, and show greater vision and insight than other potential competitors. Consequently it was forced to become more ambitious than ever engaging in increasingly risky projects.

Summarizing, it can be said that the IT department shaped and tried to cope with the growing complexity of the infrastructure and the increasingly turbulent competitive environment by reaching greater standardization and integration. In turn, the new situation in order to be managed required even more standardization and integration.

Story Four: Going Global

In mid 1990s, after buying its only competitor (the local project Medina), MedInfo became the main provider of EPR solutions in Norway (Ellingsen and Monteiro, 2002). At that point of time, it was the opinion of the IT managers at Rikshospitalet that a complex product needed a big company behind it with the appropriate financial resources. MedInfo seemed to have the right credentials, where potential competitors at the time were only small Norwegian based companies. Nevertheless, the involvement of MedInfo was limited to its local Norwegian subsidiary, and both the development and the target market were Norwegian.

During a conference on IT and healthcare in the UK, the IT managers of Rikshospitalet attended a presentation of an EPR system developed by MedInfo UK. Asking for more clarification to MedInfo Norway, they realized that within the organization there was more than one EPR development project going on. There were at least five of them: in Sweden (Melior), in UK, in Germany, in India, and in Norway. The IT managers realized that Norway was representing the smallest market. They perceived the risk of being overrun by another internal project, which may have aimed at a more profitable market.

The IT managers at Rikshospitalet realized that availability of financial resources was just one requirement that the vendor needed to fulfill in order to be credible. The other requirement that emerged to assure the sustainability and profitability of the Norwegian initiative was a sufficiently large customer base to allow economies of scale. Norway was evidently insufficient and an internationalization strategy could be the solution. The project committee together with MedInfo agreed to internationalize the Norwegian initiative by suppressing some concurrent projects in MedInfo and merging others. In particular an effort was made to merge the Norwegian project with the Swedish one.

Eventually the merger plans failed in favor of a totally new architecture. The architecture of the new international product contained in its DNA the Norwegian requirements.

The decision to "go global" and internationalize the product had major impacts on MedInfo, the project, and the final product. MedInfo had to bring the development and the marketing organization to cover an international scope. A global development team was created coordinating development activities between Norway, Sweden, Germany, and India. Additionally, in 2001 MedInfo operated a major acquisition in the US, acquiring Shared Medical Systems, one of the largest Information Service Centers in the US serving hospitals. Shared Medical Systems had a wide and deep competence on delivering services similar to the EPR. At the moment of the acquisition Shared Medical Systems served hospitals for one third of the US population. The newly acquired company counted 4500 employees, 200 of which were put full-time on the development of NeoEPR in MedInfo. In 2002 the Head-Quarters of MedInfo Medical Solutions (the medical division now owning Shared Medical Systems) were moved to Malvern, PA.

In 2001 the new global product started to get a shape and a name: NeoEPR. Beta sites implementations were planned in the US and Europe during 2002. The product was planned to go live on the international market in 2003 or 2004. MedInfo stated that "[…] NeoEPR was built from the ground up, leveraging MedInfo' development capabilities around the world including Scandinavia, Germany, the U.S. and India […]" (President and CEO of MedInfo Medical Solutions Division, from web press release, 23 October, 2001).

On the Norwegian side the escalation to an international project implied renegotiations of the project's objectives and of MedInfo's role. The end of the project was postponed several times to the current deadline in 2004. Additionally, with NeoEPR MedInfo had to respond to customers around the world and no more just to the five University hospitals in Norway. This had implications on the organization, coordination, and prioritization of requirements. A tangible effect of this new focus was that MedInfo loosened development efforts in the security area (one of the main concerns for the Norwegian customers) to concentrate on a different priority list. MedInfo was still bound to deliver what was stated in the project's contract. This represented a sort of warranty for the Norwegian customers to have their needs and requirements satisfied by the new product NeoEPR. The new international scope of the development had considerable effects on the architecture of the EPR system. MedInfo leveraged the knowledge acquired in the various sites were EPR projects were developed and tried to inscribe the knowledge in the architecture of the system. The Norwegian interests were well represented not just by the contract, which bound MedInfo to deliver what promised, but also by the valuable experience MedInfo acquired in one of the most advanced and complex markets for EPR systems. But whether the new global product will be able to adapt back to the Norwegian customers is not yet clear. Compared to the previous development (PreEPR) NeoEPR represents a totally new challenge. PreEPR was not developed under the most cautious bottom-up approaches, but was still a product very much aligned with whatever need or request the Norwegian customers could have. The adaptation of PreEPR to the local

context was already inscribed in the design process. NeoEPR represents a global standard with an inscribed flexibility that should allow local adaptation with limited costs.

The scenario presented in this brief historical reconstruction requires an analysis to understand what may be the mechanism, which has brought a local EPR system development to be the biggest global investment in an EPR solution. In particular we are interested in understanding what logic did the IT managers of Rikshospitalet follow to embark in such ambitious enterprise. As a starting point we may recollect some images of the evolving scenario of EPR projects since beginning of 1990s (Table 2).

	Before 1995	**PreEPR 1995-1999**	**NeoEPR 1999-…**
Customers	Norwegian	5 Norwegian	Global
Developer in charge	Norwegian Companies/ Organizations	Norwegian Subsidiary of International Corporation	International Corporation
Development	Norwegian	Norwegian	Global
Developed System	Medina and NORA project	PreEPR 4.x	NeoEPR
Funding	Local or NFR	MedInfo Norway	MedInfo Global
Rikshospitalet Influence	Total over AKIS	20%	0,X% but Contract

Table 2 Evolving scenario of EPR implementation

The question that arises is why Rikshospitalet would follow a strategy by which: (1) the influence or control over the project is drastically decreased; (2) the complexity of the project is considerably increased; (3) the financial investment in the project is also enormously increased.

We may try to sum up the motivations of the strategic decision to escalate the project from a local to a global level with the following assumptions:

- Assumption: The EPR is a complex information system to design and develop. Only a large vendor with adequate financial resources can manage the development.
  Analysis: Norwegian companies are too small.
  Action: An international company with a Norwegian subsidiary is chosen.
- Assumption: Given the complexity and costs of development of an EPR, any solution which is sold to the local market will not find adequate economies of scale to allow sustainability of the product in time.
  Analysis: The risk is that any new release will have the same cost of a development from scratch.
  Action: Become part of a bigger project with international development and marketing capabilities.

The first assumption addresses a question of feasibility, the second a question of sustainability. The managerial decision to follow the escalation of the project to an

international scope was partly driven by these considerations. There was also (at least from Rikshospitalet side) the consciousness that the new international setting risked hampering the influence the Norwegian customers could have on the development process. It was evaluated that the benefits from internationalization would largely overcome possible drawbacks from a limited control. Whether this is true or not is still to be seen. What is certainly true is that in order to manage the risk of a local complex task the implemented solution was to increase the risk by setting up a far more complex global task.

More in detail, the logic, which drove the Rikshospitalet to support the escalation of the project, may be described as follows. The development of an EPR is a complex task, especially if aiming at covering all the clinical information produced around a patient. In order to develop a system, which matches such complexity, a considerable investment is needed. In this perspective, the feasibility of the complex task is at least dependent on adequate financial resources. The return on investment is granted only with corresponding economies of scale, which in turn imply a larger customer base. Since Norway does not offer adequate economies of scale, new customers must be found outside its boundaries. The internationalization of the customer basis has effects on the management of requirements. Since the EPR is not a commodity a proper internationalization and local adaptation strategies must be put in place. Thus the larger customer basis increases the complexity of the task of developing the EPR. The escalation of the EPR project from a Norwegian to a global development and marketing effort may be explained as a self-reinforcing mechanism. The mechanism shows the reflexive nature of the analyzed process (Giddens 1990; Beck 1999): the problem (accomplishing a complex task) demands a solution that in turn increases the complexity of the problem.

In terms of risk, this logic suggests that in order to manage the risk of the development of an EPR, the solution is to increase the complexity of the development, thus increasing the risk. The risk of a local development is managed by creating a greater risk related to a global development.

There are basically two possible outcomes from the self-reinforcing process. Either the complexity level stabilizes below a hypothetical control threshold or the process gets out of control. In other words, the internationalization of the project may have increased the complexity (and thus the risk) but the available resources (financial and of competencies) may be sufficient to control it. Alternatively, the complexity has risen to a level where it can only apparently be controlled. In this second scenario, the major source of risk is not the complexity of the task itself (coordinating the various interdependencies) but the unintended consequences and side-effects that such a complex integrated global network of interdependencies may cause.

One fair question is whether the logic may have developed in a different direction. Could for instance the complex task (the development of an EPR) require a smaller investment? Could the evaluation of feasibility and sustainability drive the project to a different path? Compared to a more humble “bottom-up”, low-investment approach (such as in the

former Medina project), the PreEPR project, and the IT department of Rikshospitalet in particular, was driven by great ambition and increasingly influenced by a changing competitive environment.