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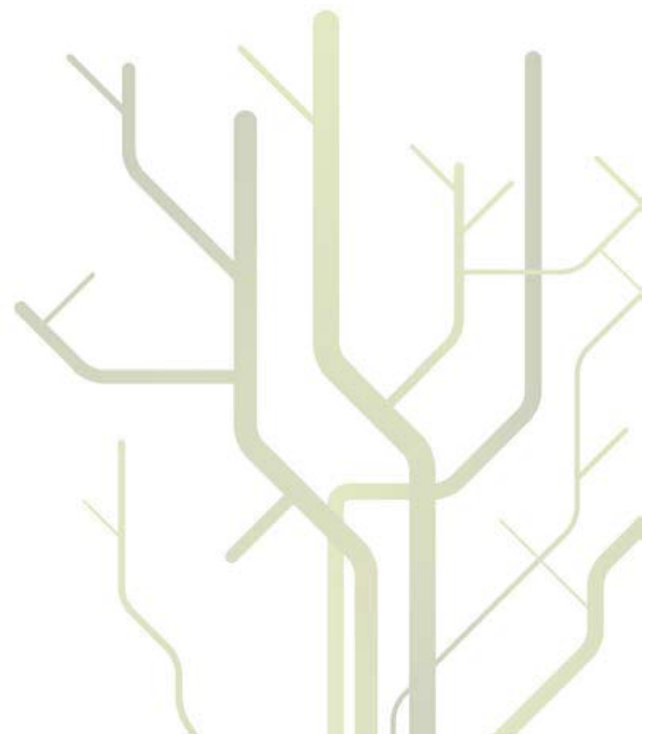
Clinical Nursing Terminology as Information Infrastructure

A socio-technical approach towards process oriented systems

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Abstract

This work deals with a socio-technical approach towards the implementation and use of ICT systems in health care. I have highlighted important initiatives that support the development of process oriented EPR systems in Norway through interpretive case studies with focus on standards in nursing and the secondary use of information. In short, information infrastructure has been used as a theoretical lens to investigate work practices in heterogeneous hospital departments, and with a focus on the technical and semantic interoperability of importance to the continuity of care. The results may be a small step towards process oriented EPR systems in Norway, but contain theoretical and practical implications that support and constitute this using information infrastructure as a theoretical lens.

The main contribution is the empirical investigation of efforts made in Norway to support the growth of process oriented EPR systems to secure the continuity of patient care with focus on semantic and technological interoperability. The overall message is that nursing as a profession and nurses' work practice constitute the most interesting area for investigating process oriented EPR systems in Norway, where data has been categorized to a certain degree and where terminology standards have been in practical use over time. This reflects that the future accomplishments in the development of process oriented systems in Norwegian healthcare should be built on fieldwork experience from investigating nursing practice in relation to the use of information systems.

The thesis has pinpointed some theoretical implications and considerations with focus on IS, STS, and CSCW concepts that serve to explain changes of information infrastructure development with focus on work process oriented standards, and human relations. The concepts have further been contextualized in a theoretical as well as a practical/methodical sense in order to indicate their contributions. Concepts such as universal locality and collective capability have pinpointed how manual work, and collaborative work among hospital workers solve problems related to semantic interoperability, which again contributes to our knowledge about the amount of work that stabilize challenges towards semantic interoperability. The thesis contributes to the general idea of information infrastructure as a framework for IS development with focus on work processes and clinical terminologies. While scholars of the IS community work in Scandinavia has focused on II in a strategically and organizational perspective (see, for instance, Hanseth and Monteiro 1997; Monteiro and Hanseth 1995; Hanseth, 2000; Bowker and Star, 1999; Sahay et al. 2009), this work sheds light on the work processes that go into information infrastructure. Bowker and Star (1999) discuss and put terminologies forward as information infrastructure, focusing on organizational implications. Clinical terminologies are elaborated on as information infrastructure, both as a working infrastructure to support daily routines and as a reference terminology to create semantic interoperability. Unlike in Bowker and Star, also the focus on terminology as infrastructure is discussed and developed around work process oriented standards and human relations.

Papers

Pedersen, Rune; Ellingsen, Gunnar. The Electronic Patient Record – sufficient quality for clinical research? *Association for Information Systems* 2011 ISBN 978-952-60-3574-1 (Nominated in the category Best Paper).

Pedersen, Rune; Ellingsen, Gunnar; Monteiro, Eric. The standardized Nurse: Mission Impossible? *IFIP International Federation for Information Processing 2011.* ISSN 1571-5736.s 163 - 178.s doi: 10.1007/978-3-642-21364-9_11.

Pedersen, Rune; Standardizing work in healthcare through architecture, routines and technologies. From Research to Practice in the *Design of Cooperative Systems (COOP): Results and Open Challenge.* Springer. 2012, pp 17-32.

Pedersen, Rune; Standardization strategies in healthcare practices? *Proceedings of the 15th International Symposium on Health Information Management Research – ISHIMR 2011,* Zurich, Switzerland, 2011, pp 458-466.

Pedersen, Rune; Meum, Torbjørg; Ellingsen, Gunnar. Nursing terminologies as evolving large-scale information infrastructures. *Scandinavian Journal of Information Systems* 2012; Volum 24 (1). ISSN 0905-0167.s 55 – 82.

Abbreviations

AHUS	Akershus University Hospital
CSCW	Computer Supported Cooperative Work
EPR	Electronic Patient Record
HOD	Norwegian Ministry of Health and Social Affairs
SHdir	The Norwegian Directorate of Health
II	Information Infrastructure
IS	Information System
STS	Studies of Science and Technology
UNN	University Hospital of North Norway
ICT	Information and Communications Technology
SNOMED-CT	Systematized Nomenclature Of Medicine Clinical Terms
TTL	Tromsø Telemedicine Laboratory
ICNP	International Classification of Nursing Practice
NIC	Nursing Intervention Classification
EMRAM	Electronic Medical Record Adoption Model
NANDA	Nursing Diagnosis
PPS	Practical Procedures of Nursing Practice
ICD	International Classification of Diseases
KITH	Norwegian Centre for Informatics in Health and Social Care
NST	Norwegian Centre for Integrated Care and Telemedicine
RM	Reference Model
NIKT	National ICT
WHO	World Health Organization
ICF	International Classification of Functioning, Disability and Health
HL7	Health Level Seven
ISO	International Organization for Standardization
RIM	Reference Information Model
NNO	The Norwegian Nurses Organisation
ICN	The International Council of Nurses
ERP	Enterprise Resource Planning system
CRF	Case report forms
OUS	The University Hospital of Oslo
IRIS	Information System Research in Scandinavia
ECTS	European Credit Transfer and Accumulation System
IFIP	International Federation of Information Processing
MIE	Medical Informatics Europe
ISHIMR	International Symposium on Health Information Management Research
COOP	Design of Cooperative Systems
CI	Cyberinfrastructure

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1 Introduction

1.1 Motivation

Western countries have throughout the past few decades faced increasing pressure to achieve a smooth information flow between the systems in the different health organizations (Larsen and Ellingsen, 2010; Aanestad and Jensen, 2011; Meum and Ellingsen, 2010). The motivation for this can be found in the need for streamlining work processes across organizational boundaries to follow the patient trajectory as well as for ensuring quality of patient treatment and care (Ellingsen and Monteiro, 2003; Timmermans and Berg, 1997; Kodner and Spreeuweberger, 2002). Another way to describe the main aim of my work; to support the continuity of care by applying information and communications technology (ICT) in healthcare with focus on nursing which is the largest group of professionals in any given hospital work practice. In this sense, new technological solutions, such as electronic patient record (EPR) systems as well as terminology standards, are among the most important tools to gain a more efficient course of interaction. More explicitly, the focus has been on nursing plans, which are a way of categorizing the content of nursing documentation, and the standards that support this nursing work. Further, health care is embedded in a highly institutionalized arena, where governmental and managerial rules, regulations, and politics are negotiated against local concerns and priorities (Timmermanns and Berg, 2003). Although much work follows routinized paths, the complexity of health care organizations and the never fully predictable nature of their reactions to interventions result in a diverging stream of sudden events (Berg, 1999). The variety and flexibility of collaborative work also make healthcare work an ideal and extremely challenging arena of study for collaboration (Kane and Luz, 2009). Considering this, health care is extremely heterogeneous and therefore an interesting arena for doing Information System (IS)-based research. To investigate how standards are perceived and obtained particularly, information infrastructure (II) is often used as the theoretical backbone in IS based research. II is used to analyse large-scale system portfolios that consist of information, artefacts, software, standards, and people (Berg, 2001). He further elaborates on how II changes organizations, and by means of whom. Firstly, the EPR system implementations can be intended strategically to help transform organizations (implementation of EPR systems). Secondly, the same process can only get off the ground when properly supported by both central managers and future users. Thirdly, the management of this IS implementation process is a careful balancing act between initiating organizational change and drawing upon IS as a change agent. Even though there are examples of successful designs of large scale IIs in general, with the Internet as the most used example, the failure to design large-scale IIs are far more common. In turn, the losses in foregone investments, opportunity costs, and political and social problems are massive (Hanseth and Lyytinen, 2010). A case that describes this well is the difficulties implementing a nationwide e-health system in the UK, which was a failure with enormous financial losses (Sauer and Willcocks, 2007; Greenhalg et al. 2008). In healthcare, such as in the UK, large-scale II implementation projects could easily lead to the opposite

of the intended effect (Hanseth et al. 2006). Based on this, health care information systems has increasingly become a part of an integrated portfolio of systems that supports different cross-organizational practices in hospitals (Star and Ruhleder, 1995).

The facilitation of openEHR archetypes is promising for bringing semantic and technological interoperability to EPRs to support process orientation (Chen et al. 2009). How do different pieces of software know what the data means, is give an increased opportunity for semantic operability "how to build a patient –centric longitudinal EPR across enterprises", and how to secure the sharing of data among stakeholders in different areas of healthcare. Templates based on archetypes deliver the real datasets, key clinical endpoint and starting point for the generation of technical artefacts. The openEHR archetypes also include the use of clinical terminology to support the semantic interoperability of its content, at the time using SNOMED-CT (Systematized Nomenclature Of Medicine Clinical Terms). It also has a potential to support nursing terminologies such as International Classification of Nursing Practice (ICNP) or Nursing Intervention Classification (NIC) and the Nursing Diagnosis (NANDA) (SNOMED –CT, 2005; NANDA International, 2007; Dykes et al. 2009; Bulechek et al. 2008). In practice, this will generate an automatic and reliable use of terminology for information that are sent and received between systems or health care deliverers.

1.2   The conceptualization of the socio-technical

This work deals with a socio-technical approach towards the implementation and use of ICT systems in health care. More specifically, you find an explicit interest in EPR-based nursing plans, standard nursing plans, secondary use of EPR-based information, and the use of clinical terminologies for nursing. Overall, the combination of structured documentation (the nursing plan) and the use of terminology to support structured data-capture, and the integration of other electronic and web-based solutions such as the Practical Procedures of Nursing Practice (PPS) make nursing the best example of process- and decision support in Norwegian health care today (PPS, 2013).

Which landscape of theory and what body of literature are approached? The introduction of EPRs in health care, introduced as large-scale infrastructures has brought challenges to what we know as severely heterogeneous organizations. Because of these challenges, there has been an increasing scientific interest in the socio-technical approach, which in turn focuses on the interrelation between technology and its social environment (Berg et al. 2003). The socio-technical approach is rooted in several research communities, such as information systems, and other directions such as Studies of Science and Technology (STS) and Computer Supported Cooperative Work (CSCW), which both have been inspiring this work. According to Hughes (1989), IS could be seen as a special case of technological systems. Firstly, newly introduced standards of technology in health care are not

objective, static entities, rather a dynamic interplay between introduced technology and work practice (Bowker and Star, 1999; Timmermanns and Berg, 2003; Ellingsen et al. 2007). As standards have the capability to transform work practice, new work process-oriented standards have the same effect on technology. Human relations are also explicit to the understanding of the socio- technical in work practices, for instance during interdisciplinary collaboration where lack of time has shown to be of the most critical factors (Kane and Luz, 2006). Documentation that is shared between groups of collaborators with different skills and interests demands focus on standardized formats such as for instance terminology to obtain semantic interoperability (Kane et al. 2011).

The notion of information infrastructure is used as a framework to conceptualize the design and evolution of large-scale integrated information systems (Hanseth and Lyytinen, 2004; Star and Ruhleder, 1996), and it has been extensively used in IS research on heterogeneous socio-technical systems such as those in health care. For definitions and clarification; STS is an interdisciplinary field of research whose fundamental claim is that technologies are entirely constructed in social activity, which again describes and covers the inherited roots of concepts such as the co-constructed (Latour, 1987). This is also a key issue in CSCW, design oriented disciplines that stress the relationship between the representation of cooperative work and the way it unfolds in everyday practice. The literature of importance seeks to describe how to fill this gap in practice (Orlikowski, 1992; Ellingsen and Monteiro, 2003b; Star and Strauss, 1999).

1.3   The crooked way towards process-oriented systems in Norway

Infrastructural arrangements, such as the electronic patient record, are crucial to the cooperation and coordination of work processes in hospitals. Historically, the EPR's advantage over paper records lies in the enhanced storage and retrieval functionality (Berg and Toussaint, 2003). This also includes instantaneous and multi-location access. Viewed against this, the restructuring of the care process is a central means to make health care more efficient, which again has increasingly amplified the focus on more process-oriented EPR systems. The focus on integrated care where the care processes are designed around the patients' needs based on the emerging evidence-based medicine and the development of guidelines and care paths that incorporate efficiency considerations a quality assurance have led to increased interest in process orientation (ibid). The accumulation of data during the patient trajectory is a powerful external memory that provides a specific structure and context to the data that is stored. For example, data is entered and become automatically placed in a large systematic reasoning process where data elements are structured and sequenced to support conclusions, policy, and coordination of activities.

EPR systems in their current form have existed for more than a decade now, and time has played its part in the development. When installed, integrated standards develop slowly and time dependant, which is the condition of integration. It is further argued that standardization attempts often result in new standards (Pollock et al. 2007). Already in the beginning of this decade, researchers in IS focused on the heterogeneous cases from health care interwoven with EPRs, and the focus increased with the change from paper-based to EPR systems, see for instance Hertzum and Simonsen (2008) for the clinicians view on this change-over. The scope was information system integration and increased collaboration across departments and hospitals contributing to the fields of CSCW, STS, and large-scale integration of EPR systems in heterogeneous organizations (Lærum et al. 2001; Ellingsen and Monteiro, 2002; Ellingsen and Monteiro, 2001; Ellingsen, 2003; Ellingsen, 2002a; Ellingsen, 2002b). Integration of standards, and the fact that EPR systems are supposed to span a multitude of contexts in-house, across hospitals, and globally is a significant part of what is relevant research topics in hospital based IS research. In the prolongation of this work, more specific contributions towards nursing specific information systems, and standards such as nursing specific terminology standards, were brought to the scene, see for instance (Munkvold et al. 2006; Munkvold and Divitini, 2006; Ellingsen et al. 2007; Munkvold and Ellingsen, 2007). The theoretical focus is in the same line, STS, CSCW, and information infrastructure. On the other hand, the focus of II is turned on tools for documentation and work process, which again arrays terminology; and thereby evidence based practice, process orientation, and decision support.

1.4   Introduction to terminology standards

In this thesis, much attention is drawn to the clinical terminology standard, which also is elaborated on as a standalone information infrastructure with explicit focus on work processes and human relation. Terminologies such as NIC/NANDA, ICNP, and SNOMED-CT have been developed for health care and used to ensure consistency of meaning across time and place in the EPR systems. This enables day-to-day planning for local users and offers large-scale statistical information for national health authorities and international health organizations. Moreover, it will facilitate communication across organizational boundaries such as between primary and secondary health care, and provide a more organized structure of EPR content. Accordingly, terminology makes the system capable of encoding commonly occurring data by using fixed lists of multiple choices for certain purposes, in addition to storing free text elements (Shortliffe et al. 2001; Dykes et al. 2009). The use of such terminologies would thus clearly support the way towards more process-oriented EPR systems, when integrated.

Internationally, hospitals with an EMRAM 7 (Electronic Medical Record Adoption Model) score, which is their highest level for grading "paperless", and process-oriented hospitals (HIMSS, 2013) use nursing diagnosis and interventions to categorize data for secondary use and to make standardized

nursing plans. Even though the primary scope of the EMRAM system is focused on replacing manual procedures and paper with ICT systems and support, the hospitals had excellent mechanisms for structured data and process and decision support. Overall, the best HIMSS/EMRAM hospitals in Europe use the same foundation of ICT tools as Norwegian hospitals when it comes to nursing documentation.

This thesis presents two scenarios that implicate the struggle to get clinical terminology into clinical use. Hence, the motivation also explains why the development of the last years in Norwegian health care has matured, which now makes us more predisposed to terminologies in action. The first scenario is about how NIC and NANDA have been adopted and used in Norwegian health care over time and thus gained a significant number of users. Scenario two is about the introduction of ICNP in Norway in 2009, when the Norwegian Nurses Organization (NNO) recommended ICNP for use in primary and secondary health care. I have followed this large-scale process, and discussed the specific challenges of this process, as well as the installed base of NIC and NANDA that has been actively used for almost a decade. The third scenario is discussed further in the next section of this introduction, the future use of SNOMED and other terminologies through the introduction of openEHR archetypes in Norwegian healthcare.

1.5   Aims and research questions; from application to thesis

The fast ageing of the population and the increase in chronic, long-standing illnesses, as well as people's rising expectations towards public services due to the fast development of the information society, put increased pressure on health care provision. There are reiterated ambitions of streamlining health care through views such as shared care, and continuity of care for patients that require complex and often long-term care. Standardisation of care through nursing plans is a materialisation of these ambitions. The use of nursing plans is closely aligned with the health authorities' ambitions towards process-oriented systems. Therefore, standardised care plans can serve as a complex workflow system across departmental, institutional, and professional boundaries driven by the ability of structuration, categorization, and terminology. Common nursing plans, with a standardized language, may ensure that information about chronic patients can be easily shared between home care services, nursing homes, and hospitals. The introduction of the nursing terminologies NIC and NANDA to classify this information was brought to the scene to materialize these ambitions from a user/vendor perspective. Different types of standards, technology, artefacts, and work process-oriented standards interact, and these interactions are essential to succeed. Care plans interact with standardized classification systems such as NIC, NANDA, and ICNP in standardized care plans, which again cope with the use of work process-oriented standards, such as silent report measured up against oral reports to increase the quality and efficiency even more. It was further interesting to look into how the use of care plans

could improve workflow between the care staff (nurses, assistant nurses, etc.), across professional boundaries (nurses, physicians, etc.), between institutions in-house, and between different layers of health providers. The focus on clinical research and secondary use of information is a materialization of the same ambition and requirements as with systems that follow the patient throughout the whole patient trajectory.

With this as a background, the following research questions have been outlined.

Research question 1	**What standards are important to ensure semantic interoperability in nursing?**
Research question 2	**What are the interrelations between terminology standards and nurses´ work and how these standards can support nurses´ practice?**
Research question 3	**How can terminology standards contribute to secondary use of information as in clinical research with a different rationale or in other clinical settings?**
Research question 4	**How are terminology standards negotiated between stakeholders?**

Table I: The four research questions

1.6 Results

My thesis is based on five papers, all of them published or submitted to conference proceedings and peer-reviewed journals in the period 2010-2012. The preliminary research questions and the research questions from the five papers are consistent and answer to the main aim of the thesis. The focus is as described in the section above on nursing documentation and related standards. The papers and how the contribution is spread are described in the table below (Table II).

Papers	RQ 1	RQ 2	RQ 3	RQ 4
The Electronic Patient Record – sufficient quality for clinical research?				
The standardized Nurse: Mission Impossible?				
Standardizing work in healthcare through architecture, routines and technologies.				
Standardisation strategies in healthcare practices?				
Nursing Terminologies as Evolving Large-scale Information Infrastructures.				

Table II: Describes how the papers and research questions correspond. The dark grey colour indicates a full match scaling to white that means no match.

1.7 Contribution

The main contribution of this thesis is the empirical investigation of efforts to obtain semantic and technological interoperability that supports the growth of process-oriented EPR systems in healthcare. The overall message is that nursing as a profession is the most interesting area to investigate process orientation in Norway, as the most prominent area in healthcare where data has been categorized to a certain degree and where terminology standards have been in practical use over time to establish semantic interoperability. Hence, this research contributes to shedding light on work process-oriented standards of importance towards process and decision support with focus on both semantic and technological interoperability.

Theoretically, the thesis contributes to the general idea of information infrastructure as a theoretical framework for IS research with focus on work processes and clinical terminologies. While much of the IS community in Scandinavia have been focusing on II in a strategically and organizational perspective (see, for instance, Hanseth and Monteiro 1997; Monteiro and Hanseth 1995; Hanseth, 2000; Bowker and Star, 1999; Sahay et al. 2009; Bygstad, 2008) this work shed light on the work processes that go into information infrastructure. New concepts from the IS, STS, and CSCW literature have been discussed as important to understand the development of information infrastructure with focus on work processes and human relations. Bowker and Star (1999) has discussed and put terminologies forward as an information infrastructure in a historical perspective based on the development of ICD-9 (International Classification of Diseases) and NIC, and discusses this with focus on organizational implications, and less or no focus around work processes. The clinical terminologies NANDA/NIC and ICNP are elaborated on as information infrastructure, both as working infrastructure to support daily routines and as a reference terminology to create semantic interoperability. Different from Bowker and Star, the focus on terminology as infrastructure is developed around work process-oriented standards and human relations.

1.8 The structure of the thesis

The thesis is structured as follows: Chapter two contains a journey through the development towards process-oriented ICT systems in Norwegian healthcare. Chapter three deals with the theoretical approaches used, and provides a more thorough and detailed theoretical picture based on an information infrastructure mentality. The primary theoretical focus has been on continuity of care, work processes of nurses and interdisciplinary groups, human relations, large-scale integration, and standards that include terminologies, artefacts, and technology. Chapter four describes the research

settings four arenas, hospitals and a national recommendation process was included. Chapter five presents the methodology, which includes the research design, data collection, reflections, and analysis. Qualitative interviews, document analysis, reading of logs, and observations of clinical work were included. Chapter six summarizes the findings and results of the five papers, chapter seven the contribution and implications of the five papers as a whole, and chapter eight is the conclusive remarks and chapter nine the references.

2 Norwegian healthcare

2.1 Process-oriented systems in Norwegian health care

In Norway, information technology has been used as an instrument to achieve health policy goals such as increased efficiency and better quality. This is resounded in several efforts from the national authorities, starting with the national strategy "more health care for each BIT" (HOD, 1996). Ever since, all initiatives have focused on shared and unified infrastructure, information, and data foundation. The development has been double-headed, with the Norwegian Ministry of Health and Social Affairs (HOD) responsible for the establishment of national strategies and the former Norwegian Centre for Informatics in Health and Social Care (KITH) as responsible for the national EPR standards that include the choice of terminologies. Hence, KITH, the Norwegian Directorate of Health (SHdir), and the Norwegian Centre for Integrated Care and Telemedicine (NST) as well have worked goal-oriented towards process orientation in EPR systems. Already in 1999, NST initialized the "Elvira" project, where the focus was an Internet-based and authorized access to patient information. The project was premature for the time, but the vision was similar to what today is called the "National core health record" in Norway.

A comprehensive focus on the priority areas of information and computing technology is regarded as the most effective measure for improving quality and effectiveness in the health and social sector, as stated in the Norwegian initiative Te@mwork 2007 (2007). Further, in an early stage of my PhD The Norwegian Directorate of Health released an action plan called Samspill 2.0 (2008), which was a national strategy for electronic interaction in health care. Both the primary and secondary health care services are challenged by the effect of that life expectancy increase in the population. The essence of Samspill 2.0 is an agreement to secure better communication between hospitals and municipalities using ICT.

Communication between heterogeneous wards and institutions, multiple vendors, and between the primary and secondary healthcare is challenging. In Norway there is much un-finished work to establish the technological and semantic interoperability needed for this mission. Focusing on sharing of information and decision support in health care services, it has become natural to include the use of terminologies and archetypes in EPR systems and for medical chart systems (Dykes et al. 2009; Chen et al. 2009). By using openEHR, it is possible to make EPR content structured in a multilevel modelling approach that includes templates, archetypes, and a reference model (RM) intended to improve semantic operability and reuse of data (Beale, 2008). This started with a chain of initiatives from National ICT (NIKT), first with initiative 10 called "Process supporting EPR systems: background, definitions, and objectives". This initiative pursued actions from Samspill 2.0 concerned

with a national strategy to support the development of more process-oriented EPR systems in the future. The report is focused around the health trajectory, shared care, and evidence-based care (NIKT, Tiltak 10, 2006). In the prolongation of this, National ICT has been working with Initiative 27, 39 and 41 (NIKT Tiltak 27; NIKT Tiltak 41; NIKT Tiltak 39) since 2009. Initiative 27 was a feasibility study done to overview the need for a catalogue of definitions for clinical variables and integrated terminologies in EPRs and connected clinical systems. The pilot project recommended further initiatives to pursue, translate, and use SNOMED-CT in future electronic clinical chart systems to secure the use of a common language to support sharing of information and research. In the prolongation of this, Initiative 41 was initiated to realize the development of a definition catalogue of structured data elements (archetypes) with associated terminology for use in the electronic chart systems and medical quality registers. The tools used in this project were based on archetypes/template methodology and terminology. Moreover, initiatives like this, and increasing use of the EPR, facilitated secondary use of health data for clinical research or health monitoring supporting a number of mandatory health registers. In term, this will make it possible to secure semantic interoperability in Norwegian healthcare. Hopefully, the definition directory will be available in an electronic version, so that vendors and health regions in Norway can implement pre-developed archetypes and templates easily using the XML-based translating tools. One example of a template could be a report to the national cancer registry, which in turn could give structured data that could be transmitted directly and collected automatically. So far, openEHR archetypes have been translated into Norwegian both by HOD, DIPS ASA, and by two of the Norwegian health regions. The plan made by the Norwegian Directorate of Health is to gather representatives from the four health regions, national registers, and the vendors involved are organizing a common platform/library for archetypes and templates. All involved parties will, in the future, be active translators of already existing archetypes, new archetypes will be made, and several templates of national character will hopefully be produced through this cooperation. Another key aspect of archetypes is that openEHR already has integrated SNOMED codes to clinical interventions within the archetype. This makes it essential that standardized terminologies for different domains can be integrated. Large scale II projects come with increasingly more integrated standards with terminology bindings that put pressure on the Directorate of Health to focus on terminology.

The purpose is to use archetypes and templates to categorize data-elements to get structured data output, which would make it possible to use data elements for decision support within the EPR. A well-known and used standard for interconnecting incongruent standards in health care is the HL7 (Health Level Seven) v3 standard (Nikt Tiltak 33.1, 2011). This technology standard makes it possible to exchange health care information between different systems/technologies, functioning as a messaging device. This is the receptor needed so that different vendors can receive and send

archetype-based templates. HL7 has been accredited by the American National Standards Institute, and it can be used to improve care delivery, optimize work flow, reduce ambiguity, and importantly, enhance knowledge transfer among all of the stakeholders involved (Kush et al. 2008). In 2011, KITH made an HL7v3 implementation guide for Norwegian health care. The intent of the document is to describe the key aspects of the services and the HL7 v3 documents related to them (NIKT Tiltak 33.1, 2011)

Other parallel projects of importance to the development of process-oriented systems in Norway are the National Core Health Record, Initiative 48 from National ICT (NIKT Tiltak, 48) Clinical documentation for overview and education, and last but not least, Stortingsmelding nr 9, which was introduced at the end of 2012 (Stortingsmelding 9, 2012). The National Core Health Record was anchored in Norwegian health care through a feasibility study that was accomplished in 2010 by the National Directorate of Health. The Core Health Record will be piloted and introduced in the next years to come. The pilot sites are already chosen, and the vendor has been selected through a procurement process. The idea is to get extractions of data elements seamless from the professional systems, both from the secondary and primary health care, to share vital information between the health services. The process of extracting data from the EPR systems should become automatic and without redundancy in the work processes of health care personnel. Secondly, it is important that information be returned automatically and seamlessly to the core health record as structured data.

Initiatives from NIKT have since Initiative 10 been focused around process-oriented EPR systems development. One initiative that has been introduced recently is Initiative 48 Clinical documentation for overview and education. Initiative 48 focus on how ICT support and evidence based instructions to improve patient safety, quality, and effective health care. The initiative is one step towards the realization of process-oriented systems in Norway. The main objective of the initiative is to build a roadmap for the functionality of EPR systems that support clinical documentation processes and to simplify them, primarily by combining evidence based knowledge and the clinicians' self-exploited knowledge. In turn, this could be secondary use of EPR elements for quality registers, a seamless and automatic extraction of data. In principle, this includes clinical validation of the functionality of the system to make the extraction possible, mechanisms for automatic importation of archetype-based templates, why a national repository for archetypes should be made, and how the same functionality could be used for decision support in the EPR system. The key issue is that public financed health services should be based upon evidence based knowledge, method, and technology. The use of archetypes to support process orientation could support this by offering decision support that gives clinicians a broad repository of observations, instructions, actions, and evaluations that would benefit

increasingly more patients. Due to this, the health care personnel are included as actors in the processes that develop and validate new knowledge and technology.

Thirdly, and most recently, Stortingsmelding 9 was unveiled with the name "One citizen – one EPR", which is focused on process orientation, decision support, and integrated care. This includes initiatives as the national core health journal, e-prescription, authorized access to health information, and different solutions to fill the gap that is existing today.

In summary, recent years of activity have increasingly moved attention towards process-oriented systems and continuity of care in Norwegian health care. Several initiatives on national and regional levels and among vendors seek to arrange for the further development on sharing of information, semantic operability, and the development of EPR systems. EPR systems in practical use in Norway today have very little or no possibility to extract categorized or structured data elements for sharing information locally, or to communicate with other hospitals or primary care units. It is possible to extract reports for organizational use; still the requirements for doing this are time consuming and depend on efforts from clinicians, local ICT, and vendors. The sharing of information has developed positively within the health regions, both North Norway Regional Health Authority and Health region West have used resources on common standards and ICT systems that make it possible to follow the patient through the patient trajectory in the secondary health services. Hence, the sharing of information between the primary and secondary health services is struggling with standards that make the process more problematic. Further, common terminology standards or reference terminologies for nursing or for health care in general for semantic operability are non-existing. Still, nursing terminologies are used in hospitals, and some experience has been gained among end-users, national authorities, and vendors. In clinical practice, the nursing plan has until now been the only content with a certain grade of structuration and categorization that fits with the expectations of process-oriented systems. The nursing plan makes it possible to categorize documentation based on diagnosis, interventions, and goals manually using free-text or by including the nursing specific terminology NIC and NANDA. Some hospitals have even integrated nursing procedures by attaching them to the NIC interventions with a shortcut to a web-based procedure. This way of structuring the nursing documentation has also been used internationally among highly respected hospitals in Europe. In the end, this made nursing and the specific content of its documentation the best and only arena to follow process-oriented systems in practice. The experience obtained by the users of standardized care plans in clinical practice, and thereby terminology standards, is important for future accomplishments. From a researcher's perspective, this work contributes to "the bigger picture", now that the development towards process-oriented systems is accelerating.

3 Theory

3.1 Standardizing work practice in nursing

Standards specify how we work and how technologies interact, they hold our sociotechnical societies together (Timmermanns and Berg, 2003), and they are the backbone of western health care infrastructures (Bowker and Star, 1999; Timmermans & Berg, 1997). They alsoare supposed to ensure quality of care through best practices development (Timmermanns & Berg 2003), increased efficiency as well as ensuring seamless patient trajectories over organizational boundaries. Historically, information systems research has a role deeply embedded in the ongoing transformation of modern organizations (Timmermanns and Berg, 1997). Standardization in IS has a long history, from programming language, to communication protocols, and exchange formats (Ellingsen et al. 2007). However, the tradition of de facto standards for applications, operating systems, and file formats are even stronger (Schmidt and Werle, 1998). An issue that has received considerably less attention in IS research is IS-based initiatives for the standardization of work and routines (Timmermanns and Berg, 1997; Ellingsen et al. 2007). Given the increasing importance of the service sector in IS research, it is vital to extend the focus from standardization of artefacts and products to include standardized, IS-embedded service work, such as work processes in hospitals (Ellingsen et al. 2007). This focus includes an increased attention to the role of humans and the social and organizational context in which information systems operate (Ash, 2010). In relation to the historical context which has entailed a technocratic top-down approach to standardization (Hepsø and Monteiro, 2009), the field has matured considerably. Standardizing the work of nurses, physicians, and other health workers has proven remarkably difficult to achieve, interwoven with efforts to improve efficiency and quality in health care (Timmermanns and Berg, 1997; Ellingsen et al. 2007; Hepsø and Monteiro, 2009). Modern nursing in particular is embedded in a highly institutionalized arena, where governmental and managerial rules, regulations are negotiated against local concerns and priorities (Ure et al. 2009). A fundamental characteristic of this work is its pragmatic, fluid character. Despite the obvious potential for improvements in efficiency, safety, and quality, standardization efforts seldom meet their objectives (Bowker and Star, 1999). One reason for this is that health care in general and hospitals in particular are characterized by highly specialized and unique routines and procedures that differ across wards, areas, and geography. Like other complex work activities, health care is characterized by the constant emergence of contingencies that require ad hoc and pragmatic responses. Although work processes in hospitals follow routinized pathways the complexity of health care organizations and the unpredictable nature of patients' reactions to interventions result in an on-going stream of sudden events (Timmermanns and Berg, 2003).

It is further relevant to point out that standardization attempts, or the introduction of new standards may result in the creation of alternative standards that impact on work practice (Pollock et al. 2007). Any given standard often needs to be shaped to be adopted on a local level showing the flexibility of the standard (Sahay, 2003). The context of large-scale heterogeneous networks or IIs is concerned with a collection of standards interconnected from the start that become increasingly integrated. The result is a complex network consisting of different components and links, which in turn causes a reflexive integration (Hanseth and Ciborra, 2007). Information infrastructures have reflexive dynamics, thereby implying that intentions to eliminate fragmentation by standardizing can be reflected back on the initial aims that could cause further fragmentation (ibid). In contrast to other views on integration, reflexive integration explains interactions across multiple systems and effects that these systems produce over time (Jarulaitis and Monteiro, 2009).

3.2   Terminology standards in nursing

The increased focus on process-oriented systems (Ouwens et al. 2005; Hellesø, 2005) across different health care organizations also presupposes standardization in the form of shared terminologies like NIC/NANDA, ICD, SNOMED-CT, and ICNP (Wade and Rosenbloom, 2009; Dykes et al. 2009; Hardiker et al. 2000; SNOMED-CT, 2005; NANDA-1, 2007). Terminology standards have received relatively little attention in the IS field, despite their importance in modern medicine (Timmermanns and Berg, 1997; Bowker and Star, 1999). These standards have been developed and used to ensure consistency of meaning across time and place. On one level, this enables day-to-day planning for local users, and on another level, it offers large-scale statistical information for national health authorities and international health organizations. All in all, this means that in addition to being a storing device for free text data the EPRs are capable of encoding commonly occurring data using fixed lists of multiple choices for certain purposes. In this way, data become more comparable and computable than free text would be (Shortliffe et al. 2001). Some key examples may be found through the global World Health Organization (WHO)-based ICD (WHO-1 2012), NANDA (NANDA-1, 2007) and SNOMED (SNOMED-CT, 2005). There are also terminological standards for more specific domains, such as the ICF (International Classification of Functioning, Disability and Health) for rehabilitation (WHO-2), as well as Sabaclass (Sabaclass, 2012) for ensuring standardized nursing care in primary care.

Health authorities worldwide have faced a growing pressure to accomplish a smooth information flow between the systems in the different health organizations (Larsen and Ellingsen, 2010; Aanestad and Jensen, 2011). The motivation for this can be found in the need for streamlining work processes across organizational boundaries as well as for ensuring quality of treatment and care of patients (Ellingsen and Monteiro, 2003; Timmermans and Berg, 1997; Kodner and Spreeuweberger, 2002). This makes it essential that standardized terminologies for different domains can be integrated. For instance, the

primary-care-based Sabaclass is currently incompatible with the hospital-based NANDA and NIC, even if both deal with the same patients when the they are transferred between hospitals and nursing homes. Increasingly, reference terminologies are considered to be a way to deal with such issues (Wade and Rosenbloom, 2009; Jiang et al. 2007; Bakken et al. 2002). A core characteristic of reference terminologies is that they are expected to map and integrate different systems residing in different domains. Conceptually, the integrated portfolio may serve as a common model while being able to co-exist in harmony with existing terminologies. Some examples of such systems are SNOMED-CT and ICNP, or Reference Information Model (RIM) in HL7 (Wade and Rosenbloom, 2009; Dykes et al. 2009; Hardiker et al. 2000). To illustrate this ICNP is a reference terminology that can act as a common point of reference for highlighting semantic overlap and difference, and emerge as a possible solution for mediation problems. It connects, translates, and maps different terminology systems. Although terminology standards are used on a daily basis in health care work, we know little about the processes of how these terminologies come into being and about how they are co-constructed with daily work, since these processes are often blurred by slow development over many years.

The increased focus on seamless care across different health care organizations also presupposes standardization in the form of shared terminologies of other characteristics in health care, such as environmental medicine, and in medicine such as ICD and SNOMED-CT (Wade and Rosenbloom, 2009; Dykes et al. 2009). While some terminologies focus on specific domains or practices (Dykes et al. 2009), others span professional, organizational, or national boundaries (Bowker and Star, 1999). The domains, the standardised terminologies, and the classification systems are in constant flux due to the development of new technologies, the changing demands of the public, and the need for increased collaboration across healthcare practices, and the increasing pressure to make more process-oriented systems. Terminology systems were used for classification a long time before technology and computers. The ICD was first published in 1893 and has currently passed its tenth major revision (ICD-10). The ICD is an example of a mono hierarchy where each code has only one parent code. As of this, the ICD is used with the perspective and purpose to classify disease for comparative statistical purposes (Shortliffe et al. 2001). Still, many terminologies are tightly embedded in practice, and the resources required for replacing one system with another may represent a substantial cost. In this regard, several standardised terminology systems have been introduced as reference terminologies (Wade and Roosenbloom, 2009; Dykes et al. 2009), developed to support smooth interaction with existing terminologies. SNOMED CT is an example of such a terminology. SNOMED CT is a poly-hierarchical terminology intended for multiple medical usage scenarios. The items in SNOMED CT, the Concepts, have multiple parent concepts and multiple kinds of relations to several other concepts. SNOMED CT contains more than 300 000 concepts. Integrated in an EPR system, one could be able

to retrieve or count all recorded data about acute disease for single patients or for a population of patients (Karlsson et al. 2012). Karlsen et al illustrate how you can improve the computability of data by using SNOMED CT, and demonstrate this with the concept Pain that can be qualified by severity (seven), pain character (152), body site (25888 sites), course (31) etc., given a total of around 800 million possible ways to express pain (ibid).

3.2.1   The evolving use of NIC and NANDA

Classification systems for nursing are a relatively new phenomenon. The first initiative dates back to the 1970s, when the North American Nursing Diagnosis Association developed NANDA (McCloskey and Bulechek, 1994). The further development has been made in a consensus decision-making, new and former diagnoses are presented and evaluated every second year and validated at NANDA conferences. NANDA brought about a major change in the nursing profession with the establishment of nursing specific diagnoses. This was done to promote the claim that nurses diagnose patients in certain domains of care (Bowker and Star, 1999). The latest version from the year 2009 contains 206 diagnoses, of which nine are revised from the previous edition from 2007. The current diagnoses (NANDA-1 2007) established by NANDA International brought about a major change in the nursing profession by establishing nursing-specific diagnoses. Research on the use of NANDA in the north of Norway has revealed local adjustment of diagnoses to fit local practice. Research identified the terms that were used instead of NANDA, and local diagnoses were mapped to NANDA. Local terms were compared with NANDA and characterized as "Same", "Similar", "Broader", "Narrower" or "No Match". NANDA diagnoses and local diagnoses mapped to NANDA constituted 95.5% of all the nursing diagnoses documented in 2007, a strikingly high coverage (Meum et al. 2011).

Similar to NANDA, the NIC classification system is continuously updated through on-going feedback from users and the review process. New versions are published every four years, and the latest edition, from 2008, contains 542 interventions (Bulechek et al. 2008). For each NANDA diagnosis, there are potentially several related NIC interventions, which provide information about what to do and how to deal with the patient's diagnosis. NIC is developed at the University of Iowa, with Joanna McCloskey and Gloria Bulechek as primary investigators. Experienced nursing researchers have built the system of nursing interventions. Based on hierarchical cluster analysis and similarity analysis, masses of interventions were grouped and reviewed to reassure clinical relevance and significance (Iowa Intervention Project, 1993). Further, the invented taxonomy was validated through surveys with nursing experts, and a coding scheme was invented. Ever since, the classification systems have been growing slowly through a wide-scale cooperative process. The interventions provide a list of what nurses do and what nursing is. NIC and NANDA are more than organizational tools they merge scientific knowledge, practice, bureaucracy, and information systems (Bowker and Star, 1999). NIC

coordinates bodies, impairments, charts, reimbursement systems, vocabularies, patients, and health care professionals (ibid p. 349). NIC further aims to portray the range of activities that nurses carry out in their daily routines and consists of a list of 486 interventions, each comprising a label, a definition, a set of activities, and a short list of background readings (Bulechek et al. 2008). Each of those interventions is in turn classified within the taxonomy of six domains and 26 classes (Bowker and Star, 1999). For example, one of the tasks nurses perform is preparing patients emotionally for a risky or painful treatment. Hence, the intervention "Preparatory Sensory Information" is defined as describing both the subjective and objective physical sensations associated with this (McCloskey and Bulechek, 1993). The interventions are followed by a list of activities that are related to the assessment of patients, situations, and care provision. The specific intervention is further classified in the classes of "coping assistance" that is classified under the domain of "Behavioral". It is important to note that, like other working classification systems, NANDA and NIC depend on a well-functioning ICT nursing module where it is easy to create, modify, and delete diagnoses and interventions for the patients involved. Such a nursing module is typically part of a larger EPR system.

3.2.2   The recommendation of ICNP

The translation of ICNP arranged by The Norwegian Nurses Organisation (NNO) started already in 1996 with the Alfa, and later, the Beta version. The early versions of ICNP were piloted in projects around the world, but never in Norwegian health care. The translation of ICNP started in early 2007 with one version; NNO commenced the work by translating the newest versions of ICNP, which in contrast to earlier versions have standardised sentences in catalogues divided between clinical specialities. Initial components and coded words are subjected to the seven-axis system, and the new version is also available electronically. The International Council of Nurses (ICN) has further developed a translation tool for several languages, including Norwegian, which eases the translation process, but the obvious software required for practical use is still missing. ICNP has been developed by the ICN in 133 nursing organizations worldwide, and the beta version has been translated into 20 languages (Wade and Rosenbloom, 2009; Dykes et al. 2009; Hardiker et al. 2000). ICNP as a whole was recently introduced as a part of the World Health Organization's (WHO) 'family of classifications', which also includes the International Classification of Diseases. ICNP focuses on the integration between terminology systems across professional boundaries. The essential idea is that users can continue to use the terminology systems they are used to (NANDA/NIC, Sabaclass, SNOMED-CT, etc.) while INCP, as a reference terminology can automatically map between the existing terminologies. However, if preferable, ICNP can also be used directly as an ordinary terminology (i.e. the nurses use ICNP directly in their work).

ICNP consists of nursing diagnoses, nursing actions, and nursing outcomes. ICNP is specified as a flexible system where concepts can be combined from different axes or dimensions. The seven predefined axes are time, means, location, judgement, focus, client, and action. In this way, ICNP serves as a unifying framework into which existing nursing vocabularies and classifications can be cross-mapped in order to enable the comparison of nursing data (Jiang et al. 2007). Compared with NANDA, different, but still coded (meaningful) combinations can be put together. Each combination must contain one word from the focus axis, one from the judgement axis for diagnosis, and a reasonable number from the other axes in order to become meaningful. An example (illustrated) for "pain" is:

Focus (pain), Judgement (acute), Location (right knee), Time (chronic), Client (single patient), Action (intervention).

The example illustrates that there are several possibilities; an increased use of judgements increases the specificity.

3.3   Organization and work practice

Standards such as terminology standards are tightly embedded in work practice and organization. Health care data is bound to serve multiple purposes, such as documenting care processes, facilitating management of care, identifying best practice, triggering of clinical guidelines, and facilitating communication within the health care team (Moen et al. 1999). This Compounds with Ure et al. (2009). The deep heterogeneity of social, technical, and organization of local action, the inevitable practical embedding of data, and the thick and distinctive histories constituting epistemic practice and culture in health related domains, work against any straight forward semantic or technical fixes for the coordination of problems between projects and fields.

The complexity of II is also uncovered between the complex work practice and the technology, which consequentially leads to complexity of interaction and an inherent increase of risk. Hanseth and Ciborra (2007) have researched the historical development of information infrastructure in companies, highlighting the tension between integration and fragmentation in implementation. Hanseth and Ciborra (2007) discuss this through a case on Electronic Patient Records. The reflexive integration in the development and implementation of an EPR illustrates a number of perspectives, intentions, constraints, challenges, and agendas in the social and technical network. For the complex relation between work practice and technical systems Perrow (1984) says that artefacts involved in II can be loosely or tightly coupled, which means that the degree of dependencies between the various

components will vary in large-scale systems. The well-functioning II is achieved when unnecessary dependencies are eliminated. On the contrary, a tight coupling leads to a decreased modularity of systems. In the same line with focus on organization and change of II, Volkoff et al (2007) discussed how technology influenced on human agency and/or social interaction. In an intensive longitudinal case study of an organization through an implementation of IT, they pointed out how embedded routines, roles, or data changed the use of the IT- systems, and how the employees enacted change. Boudreau and Robey (2005) discuss organization of II, emphasizing human agency, not technology and structure. Researching the use of an enterprise resource planning system (ERP), they observed inertia and work-around through system constraints in unintended ways. This fits with the scope on II and organization in this thesis, even though the focus of the work is more on classification systems as infrastructure.

3.4   Information infrastructure as a theoretical framework

Theoretically, all five papers in this thesis have the concept of II as the core theoretical framework. II has been used to describe how work practice, users, and technology are interconnected in organizational work. In addition, II has been used to explore and frame clinical terminologies as physical infrastructure in information systems. Based on this, II is conceptualized as twofold; firstly there is an explicit focus on work process-oriented standards, and secondly, on terminologies as infrastructure. II literature from the work of Hanseth, Berg, Star, Monteiro, and Lyytinen (Hanseth and Monteiro 1997; Monteiro and Hanseth 1995; Hanseth, 2000; Bowker and Star, 1999; Sahay et al. 2009) describe II and organization with focus on the interconnection of micro and macro aspects of work practice and large-scale technology. Primarily, Bowker and Star (1999) have been used to describe terminology as II, their work consists of elaborations that concern the working terminologies NIC and the ICD. As claimed, this thesis contributes to the general idea of information infrastructure as a theoretical framework for IS research by putting focus on work processes and clinical terminologies. While the IS community in Scandinavia, and especially Oslo focuses on II in a strategically and organizational perspective this work sheds light on the work processes that go into information infrastructure. Further, Bowker and Star (1999) has discussed and put terminology forward as information infrastructure based on the ICD-9 and NIC, and discusses this with focus on organizational implications. The clinical terminologies NANDA/NIC and ICNP are elaborated on as information infrastructure, both as working infrastructure to support daily routines and as e reference terminology to create semantic interoperability.

Information infrastructure was first used in the 1990s in political settings to secure interoperability for technical specifications to ensure a transparent and consistent interconnection for an anti-competitive behaviour for stakeholders in a marked, see for instance Bangemann (1994), and has, among other

things, become very useful in understanding the implementation and use of information systems. Information infrastructure researchers have applied the term in order to emphasize the difference between large-scale networks and ordinary information systems. The theoretical framework can be applied to complex socio-technical systems to improve our understanding of such systems, and by extension, used as a framework for conceptualizing the design and evolution of large-scale integrated information systems (Star and Ruhleder 1996; Bowker and Star 1999).

"Infrastructures should rather be built by establishing working local solutions supporting local practice which subsequently are linked together rather than by defining universal standards and subsequently implementing them" (Ciborra and Hanseth 1998, p. 315)"

Information infrastructure is conceptualized by Hanseth (2000) as an evolving, shared, open, and heterogeneously installed base. This definition conforms to the six aspects that Bowker and Star (1999) used in their work about defining information infrastructure. The six aspects are the enabling function, that it is shared, the openness, the socio-technical aspects, the connection and interrelation, and the installed base.

1. The enabling or supporting function means that an infrastructure can be used for a wide range of activities.
2. The aspect of sharing in this context involves the use of the same object by different user groups.
3. The openness of an infrastructure refers to the openness to the top number of users, stakeholder, vendors, nodes etc.
4. The word socio-technical stands for, as the word implies, the inclusion of technological components as well as humans and organizations.
5. The connection and interrelation deal with the different technologies that are brought together and their heterogeneity.
6. The installed base is the already existing infrastructure that can be extended and improved through further developments.

Early accounts on II have emphasised the need for understanding how the process of social and technical elements are assembled and negotiated to establish a sustained network (Hanseth and Monteiro 1997; Monteiro and Hanseth 1995). An information infrastructure is a loose entity without clear boundaries (ibid.)

In addition to the definition of infrastructure, Star and Ruhleder (1996) describe three levels or issues that should be addressed in the context of developing information infrastructures.

- First order issues are resources (money, time, and people) and training.
- Second order issues are the results of unforeseen contextual effects or the collision of two or more first order issues.
- Third order issues are the controversies and clashes that come up within the development of infrastructures.

A key characteristic of information infrastructures is that they evolve and grow slowly over time, as they become tightly embedded and adopted into practice in different ways. The infrastructure shapes and is shaped by the work practice in an on-going co-construction process between technical and social elements. In this regard, an information infrastructure represents a socio-technical system, where the technical issues are always seen in relationship to practice. Hence, the key question is "when—not what— is an infrastructure" (Star and Ruhleder, 1996). To understand the design or the change of IIs, the understanding of installed base, what already exists and is implemented, is crucial. Old infrastructure strongly influences how new elements can be implemented (Rønnebeck et al. 2007). The IIs are never built from scratch, rather in a process of building upon what already exists, and as the installed base grows, it becomes increasingly more difficult to change it. An infrastructure is an evolving, shared, open, and heterogeneous installed base (Hanseth and Monteiro, 1998). Further, it does not only represent the technology involved, but also the social factors such as work and procedures, and work practice (Star and Ruhleder, 1996). During the progression of an information infrastructure in any given context, with its existing portfolio of information systems, the installed base may become very large and will shape its environment. Similarly, the size and complexity of the installed base mean that it becomes difficult to replace or change.

The building of large IIs takes time, and all elements are connected. As time passes, the infrastructure has to adapt to new requirements that appear. Infrastructures are heterogeneous concerning the qualities of their constituencies; they encompass technological components, humans, organizations, and institutions. This is true for information technologies in general, as they will not work without the support of people. An information system does not work either if the users are not using it properly (Hanseth and Monteiro 1998). Information infrastructure conceptualizes the use of ICT as a heterogeneous interplay between socio- technical elements (ibid.). The heterogeneity of the II deals with equipment, information, applications, standards, and the people affected. In this case, heterogeneity is embodied according to the people behind the integration and the use of locally adopted standards, the number of users, and their effort to use it.

Typically, an information infrastructure is a large collection of interdependent systems and technologies that are embedded in various organisational practices. II is a relational concept, implying

that various artefacts, routines, and people are inseparable, hence mutually dependent on each other (Bowker and Star, 1999). Accordingly, for this kind of studies, it is not purposeful to focus on just one information system, one singular context in the given moment of time. Analyses of information infrastructures fundamentally need to take into account a broad range of socio-technical issues shaping the implementation process.

The strategic aim of implementing standardized terminologies is to share and compare information within and across domain-specific and organizational boundaries. The focus includes two types of terminology with particularly interested in working classification systems focused on specific domains and classes and even more specifically in reference terminologies with the capability to interconnect different existing classification systems. A key characteristic of reference terminologies is their capacity, as a mapping device, to interconnect different existing terminology systems without paying the price of replacing one of them (Coenen and Kim, 2010). This implies that reference terminologies are introduced as a purely technical operation, underestimating the associated social and political implications. Such processes are much more complex and they are infused with strong interests and politics, as suggested in comparable socio-technical studies (Bowker and Star, 1999; Sahay et al. 2009; Timmermans and Berg, 1997).

Several studies of socio-technical systems have pointed out how new systems co-construct with practices in different ways (Leonardi, 2009; Meum et al. 2011; Hanseth and Monteiro, 1997). These systems are far from neutral (Bowker and Star, 1999), but are always infused with interests inscribed by the designers and promoters. For instance, in their analysis of standardization processes in health information infrastructure in Norway, Hanseth et al. (1996) emphasized that behind a "neutral" technology, the participants involved played out different interests. In a study on information infrastructure integration, Sahay et al (2009) found that the interplay of political interests and technical configuration aspects shaped the integration process, as the stakeholders were associated with different powers of negotiation. In this regard, given the current introduction of reference terminologies into health care, it is particularly interesting to examine more closely how such terminologies are promoted, how they are received among existing users, and what consequences this has for existing terminologies and practices. Due to the heterogeneous character of different information infrastructures, *gateways* have been promoted as a strategy to establish some interconnection between them (Hanseth and Lyytinen, 2004; Aanestad and Jensen, 2011; Edwards et al. 2007). A gateway may both be a piece of technology or a social arrangement that serves the purpose of interconnecting different infrastructures. Hanseth and Lyytinen (2010, p. 7) provide the following example of a gateway an "IT capability which supports multiple e-mail services running on different e-mail protocols". Edwards (2007) illustrates the gateway concept using Google Scholar.

In clinical health care work, almost everything depends on vast social and technical infrastructures, which, when they work, are largely invisible. Science data for secondary use is no exception to this. Modern science is possible only because we have built the infrastructure to support it: this includes classification systems, international standards, peer-review, and funding agencies for interoperability. Star and Ruhleder investigate the infrastructure that supports scientific work and is embedded in other social and technical systems, which becomes invisible when we come to rely on it. The process of learning how to make use of a particular infrastructure is, largely, what defines membership in a particular community of practice (Star and Ruhleder, 1995).

3.5   Reuse of data, health grids of information infrastructure

Reuse of EPR data for research purposes to support scientific work in other settings and for other purposes is one way to describe the complexity that the sharing of information between heterogeneous practices unfold. In turn, this complexity also counts for the sharing of information between hospitals, and between the primary and secondary healthcare systems that includes the use of terminology and archetypes to secure interoperability. Bygstad (2008) discusses II as organization, but takes a slightly different perspective with focus on the reuse of data as the health grids of II. The concept is a response to the accelerating progress in biomedical research and health care delivery, which calls for radical changes of the ways in which research is conducted, including how researchers share and reuse data and how to collaborate to collect research data (Jirotka et al. 2005). The role of the healthgrids becomes to harness innovations in digital infrastructure that could enable the seamless access to sharing and reuse of clinical data (Ure et al. 2009). In turn, this is about how data should be standardized and categorized to a larger degree. To explain some of the challenges for instance with using terminologies to solve semantic challenges, Ure et al (2009) show examples of how implemented classifications are used in locally adapted manners created bottom up to fit local practice.

"The experience of various HealthGrid projects shows clearly that there is a tension between the technical ideal of a stable, interoperable infrastructure for data sharing and reuse and the reality of knowledge as evolving, socially and locally constructed, and often disputed (Ure et al. 2009)."

Another challenge is those related to technology, or the technical ideal of a stable interoperable infrastructure. When two differently designed systems need to exchange information, they need to agree on different things in order to succeed. One way is to agree on a common message format and create import and export algorithms. These are rules and software programs that for example convert the format of one system to the agreed message format, and the other system has an import algorithm that converts the message to its internal format. This is a known approach used in many applications of the HL7v3 standard, and it is one of the target use cases of the International Organization for

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Standardization (ISO) 13606 standard (Kalra, 2006). OpenEHR archetypes have specified data structures and supporting semantics for the content of EPR systems. Using openEHR, it is possible to make EPR content structured in a multilevel modelling approach that includes templates, archetypes, and a reference model intended to improve semantic operability and reuse of data (Beale, 2008). A study by Garde et al. (2009) concerns the modelling of clinical content of EPR systems that could become available internationally. The study shows how clinical content can be made available using archetypes and templates from openEHR and ISO 13606. Through this, the openEHR platform could become the foundation for safe sharing of the information the clinicians need as tool for decision support inside the EPR system (ibid). Another study by Chen et al. (2009) describes how chemotherapy guidelines could be established using openEHR, which provides decision support and facilitates the use of clinical guidelines in clinical treatment. Apparently, the use of archetypes could possibly solve one of the bottlenecks reported by Pedersen and Ellingsen (2011) when describing the use of EPR data for research purposes in cancer research.

The general idea of templates and archetypes is a modelling that separates technical infrastructure concerns from clinical concerns, making it possible to create templates configurable in the clinical environment (Beale 2008). A well-known and used standard for interconnecting incongruent standards is the HL7 v3 standard. This technology standard makes it possible to exchange health care information between different systems/technologies, functioning as a messaging device. The American National Standards Institute has accredited HL7. HL7 can be used to improve care delivery, optimize workflow, reduce ambiguity, and importantly enhance knowledge transfer among all of the stakeholders involved (Kush et al. 2008). HL7 v3 has also been projected and found reliable as a national standard by the National ICT (NIKT tiltak 33.2).

3.6 Clinical terminologies as infrastructure

In the section above HL7v3 and archetypes has been discussed as means to secure interoperability between stakeholders and different healthcare providers. These tools secure that interconnection of incongruent standards (HL7) and ways to provide templates that includes data that has been added by clinicians using evidence based methods to secure interoperability (archetypes). In extension to this, terminology as SNOMED-CT has been added to the has been added to the content of the archetype to support this, and which in turn could be a promising way to include terminologies in clinical work.

There is a growing trend towards uniformity, globalization, and standardization as a means to increase efficiency of healthcare (Rolland and Monteiro, 2002), which in turn makes the gap between local and global solutions become even larger. In turn, the construction of large-scale information infrastructure compromises on the functionality and how this balances with local variation and needs. Under such

conditions, Bowker and Star (1994) underline the fact that there is a tension between the desire to standardize on a global level and the need for flexible local standards. New infrastructure changes the very nature of "what it is to do work" and what kind of work will count. As for this, Bowker and Star (1999) say that NIC (the terminology) is an actively developing infrastructure which is fed into a clinical decision support system that directs nurses on which activities to perform, and further fed into a hospital accounting system. It lays claim to a professional territory for nursing with increasing possibility to succeed with research programs, the effort to communicate health information over professional boundaries, and stabilizing current in-house nursing interventions. Bowker and Star (1994) saw similar events in the development of the International Classification of Disease, which is definitely a larger and globally more used epidemiological information system. In all, political, cultural, ethical, social, economic, and institutional factors play a role in the development of the terminology.

To shed light on such processes and to identify some implications for the implementation of reference terminologies, the concept of information infrastructure is promising. In the IS field, the information infrastructure concept addresses the challenges of implementing large-scale information systems (Aanestad and Jensen, 2011; Hanseth and Lyytinen, 2010; Pollock and Williams, 2010), but amazingly few studies on information infrastructure focus on the emergence of large-scale terminology systems such as ICNP, NIC/NANDA, and SNOMED-CT. See also Bowker and Star (1999) on the development of the ICD-9. Terminologies are crucial to organizations, work practices, and occupations; they are the place where distinctions in knowledge are made (ibid). A typical topic for investigation is for instance local modulation of systems to fit pre-existing practices and beliefs. New infrastructure has powerful ramifications, and it is capable of changing both work practice and knowledge fundamentally and inscribing a moral order. Bowker and Star (1999) compare this with the railroads using (Friedlander, 1995) the allocation of resources; where will the railroad go, which cities and towns are the most important? Further, there are three areas of challenge in producing the classification scheme that will fit the work stream and agenda of making everything from in-house stability of nursing too research and sharing of information. These challenges are comparability, visibility, and control. Comparability over sites to ensure regularity in semantics is crucial to improve the possibilities for research. Common standards are also crucial when hospitals wish to be interconnected on a regional and a national level. These are not only technical standards, but also standards that secure consistent diagnosis, and interventions. If work just is done, it has found no voice in the classification scheme. Invisible work is unclassifiable and is caused by different relations in work practice, from a team that has worked together for so long that they no longer need to classify instructions (Bowker and Star, 1999) or to expert nurses that influence how novice nurses perform work. For classification systems to work in practice, they must not be too fine-grained or arcane in

their distinctions, and fit with the way work is organized. The classification system is in the same time standard enough to appear the same in every setting, and stable over time (Bowker and Star, 1999).

Based on this, working infrastructures like terminology standards are deeply embedded in both practice and technology. Their history cannot be told independently of the work practices that they constitute or the media in which they are inscribed (ibid). Bowker and Star (1999, pp. 61) offer a fine-grained analysis of the nature of information infrastructures such as classification systems and demonstrate how they simultaneously represent the world "out there", the organizational context of their application, and the political and social roots of that context. When formal characteristics are inscribed in hospital software standards, the compelling power of those beliefs is strengthened considerably. It comes to be considered as natural, and no one becomes able to disregard or escape them (ibid). Still, many work around the formal restrictions (Hunn, 1982).

Classification systems are bound to be used in various contexts by different users (ibid). There is a tension between the need for coordination on a global level and the need for flexible solutions on the local level. As the need for uniformity, globalization, and standardization to increase efficiency grows the gap between the local and the global increases (Rolland and Monteiro 2002). Further, the infrastructure occurs when this tension is resolved (Star and Ruhleder, 1996). Bowker and Star (1994) discussed this tension in their view on the development of the ICD, where it has been an important infrastructural component to collect medical and epidemiological data electronically. The description shows that this task has been difficult, cooperation has for instance been hampered by differences in how to record and report in different cultures. There has also been variation in interests among stakeholders, from organizational and reimbursement in local use, between physicians and statisticians, and/or the pharmaceutical industry. In relation to large-scale terminology systems (the information infrastructure), the installed base is of a particular concern, as it needs to maintain consistency over time and place. Therefore, newer versions are adjusted or changed carefully in order to maintain backward compatibility with previous versions (Bowker and Star, 1999). This is a process recognized as an on-going negotiation and compromises in order to achieve stability or alignment (Latour, 1987).

ICNP is a reference terminology that can act as a common point of reference for highlighting semantic overlap and difference, and can emerge as a possible solution for mediation problems. It connects, translates and maps different terminology systems. We know little about the processes of how these terminologies come into being and how they are co-constructed with daily work.

An information infrastructure typically is a large-collection of interdependent systems and technologies that are embedded in various organizational practices. Accordingly, for these kinds of studies it is not purposeful to focus on just one information system, one singular context in a given moment of time. Analyses of information infrastructures fundamentally need to take into account a broad range of socio-technical issues shaping the implementation process.

Taking into account the theoretical considerations in this chapter, this thesis focuses on work processes as a distinguished part of information infrastructure, and the terminology standard as infrastructure. Given the increasing importance of the service sector in IS research, it is, as pinpointed, vital to extend the focus from standardization of artefacts and products to include standardized, IS-embedded service work such as work processes in hospitals (Ellingsen et al. 2007). This focus includes an increased attention to the role of humans and the social and organizational context in which information systems operate (Ash, 2010). Hence, this research contributes to shedding light on work process-oriented standards of importance to process and decision support of hospital work. The standardizing of the work of nurses, physicians and other health workers has proven remarkably difficult to achieve, interwoven as it is with efforts to improve efficiency and quality in health care (Timmermanns and Berg, 1997; Ellingsen et al. 2007; Hepsø and Monteiro, 2009). As highlighted earlier, there is also a strong connection between terminologies and work practice. According to Moen et al. (1999), standards such as terminology standards are tightly embedded in work practice and organization. Health care data is bound to serve multiple purposes, such as the documentation of care processes, facilitating management of care, identifying best practice, triggering of clinical guidelines, and facilitating communication within the health care team. In all, the focus changes from a traditional view on information infrastructure and organization towards focusing on work practice and human agency. For instance, Boudreau and Robey (2005) discuss organization of II emphasizing human agency, not technology and structure. This focus fits with our work, as the written accounts cover the use of EPR systems in large-scale hospitals and how different types of standards interplay.

4　Case selection

4.1　Research settings

This chapter describes the three research sites that were approached to get qualitative data for this thesis. It further provides an overview of different standards and user contexts that are applicable for each of the three cases. The three settings illustrate the use of different standards in work practice and a national effort of standardization. First, I present three different cases from the University Hospital of North Norway (UNN) with focus on the user context and installed standards, especially the EPR nursing plan and surrounding standards. The second case is from Akershus University Hospital (AHUS), which also is focused on user context, the installed ICT based standards, and new work process-oriented standards, but on an interesting physical architecture. Both cases describe how the standards are used in practice, and how work practice changes with the introduction and use of new standards. The third case is based on the national recommendation of a clinical terminology for nursing. The case consists of interviews with persons central to the process.

Common for all three cases is the focus on the nursing plan, and the standard plans made over the use of clinical terminology. Nursing documentation has increasingly become a fundamental part of the EPR. In Norwegian health care, a nursing module that includes care plans and a classification system has been used since 2003, introduced by a vendor that holds more than 70 % of the EPR solutions for hospitals. The use of classification systems specific for nursing has followed the integration of nursing documentation with The Nursing Intervention Classification and The North America Nursing Diagnosis Association in hospitals. Care plans were increasingly made to replace the use of free-text in nursing documentation, foremost to establish a more common formalized language based on best practice. Each diagnosis, dimension, and action is firmly attached to the plan with a start and a stop date. When these plans are standardised, the nurse can easily choose several actions from a pre-defined list for the applicable diagnosis. By doing this, the nurse saves time and it works as a quality indicator. To facilitate the production of new plans, the nurses use a standardized plan. The standardized plan represents a carefully selected combination of NANDA diagnoses and NIC interventions for a given medical diagnosis or a clinical speciality. A number of plans are made by and for each speciality. Some plans are also generic, covering different wards for patients with composite diagnoses. The plans are in continuous development, governed by selected nurses locally at each hospital. Overall, the standardized nursing plan is by far the closest Norwegian health care has come towards process and decision support in existing EPR systems.
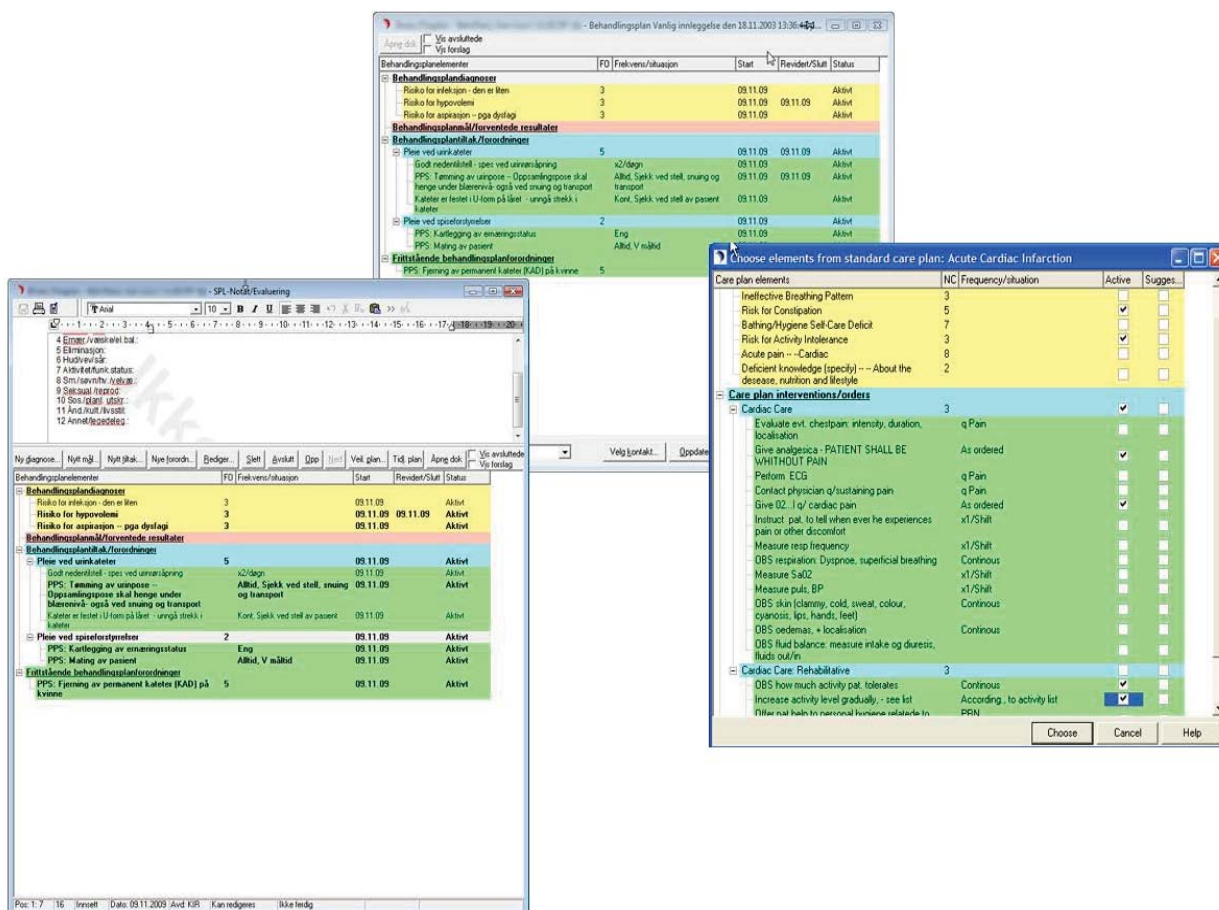
Figure I: The care plan and the standardized care plan

4.1.1 The UNN case

A part of the research was conducted at the University Hospital of North Norway, owned by the Northern Norway Regional Health Authority (Helse Nord RHF), which is one of four regional health authorities in the Norwegian secondary health care system. UNN is geographically distributed over four locations including Tromsø, Harstad, Narvik, and Longyearbyen. UNN has about 5,900 employees, including 450 physicians and 1,000 nurses at the time of research. The hospital has an extensive activity and treats patients from the Northern health region, which includes 462,000 inhabitants distributed over the span of 112,950 square kilometres. Hence, the vast geographical distances are challenging. In January 2004, the University hospital of North Norway implemented a new large-scale EPR named DIPS EPR, delivered by the vendor DIPS ASA. The hospital UNN located in Tromsø is the largest hospital of the Northern Norway Regional Health Authority. DIPS ASA was the dominant player in the Norwegian health care sector, with the largest customer base in the EPR field. The so-called DIPS paperless EPR concept has been implemented at more than 30 hospitals in Norway and has increasingly reached more than 50,000 users. Similar market penetration

by paperless EPR has not been seen anywhere else in the world. Compared to the former paper journals, it supports a holistic approach to the patient where it was easy to obtain and retrieve relevant information.

The first data collection took place at the Oncology Department, which is the Regional Centre for Medical Oncology and Radiation Therapy in Northern Norway. The Department was established in 1985, with 120 employees in four units, the inpatient ward, the Radiation Department, the Outpatient clinic, and a Clinical Research Unit. The ward has 30 beds distributed around singular, double, and four-bed rooms. The average "bed time" is 6.2 days. The ward has 43 nurses, all personnel included, and 3 assistant nurses. Patients often receive their first treatment at the ward, and are later transferred to the outpatient clinic or their local hospital for further treatment. This constitutes one of the major challenges, namely collecting data from different sources at different hospitals. Collecting data from small local hospitals is challenging due to the absence of a research culture and clearly defined procedures.

The second data collection took place at the Geriatric Department, which is a Regional Centre for Medical Geriatrics and Gerontology in Northern Norway. The Department had an extensive activity and treats patients from the entire health region. The Geriatric Department used the care plan with a certain amount of locally developed standards. They did not use the integrated classification systems NIC and NANDA or any kind of standardized plans such as described in the AHUS case. The patients at the Geriatric Department have a complex range of needs in addition to a multiple range of medical problems that require tight surveillance and repeated measurements of blood pressure, temperature, glucose levels, etc. Most of the patients require help to cover their primary needs such as eating, dressing and undressing, personal hygiene, and elimination. This wide range of complexity requires different input to how to perform care.

The psychogeriatric ward at UNN had since the implementation of the EPR in 2003 put a lot of effort into using NIC and NANDA in terms of separate NANDA diagnoses and applicable NIC interventions from the translated NIC book. In the period 2005-2006 they implemented mandatory use of classifications in the care plan. To be able to apply to these strict guidelines, the nurses and other personnel were offered an introduction to the content of the guidelines to ensure that all employees had the basic knowledge of classification and how to integrate NANDA and NIC. Six key users were trained to provide guidance in day-to-day work practice. Finally, a Key Project Administrator was engaged directly at the Department as the driving force for further development. After this, nursing documentation became a central part of the interaction between interdisciplinary collaborators. Care

plans became embedded and used as a support in daily documentation. Contrary to the AHUS case, this Department had a care plan for all their patients within 24 hours after hospitalization.

The success was based on a determined bottom up driven engagement from the organizing nurses. The integration became a success because of an engaged project management that succeeded in keeping up the focus on the use of NIC and NANDA.

4.1.2   The AHUS case

A significant part of the research was conducted at the Akershus University Hospital, which had about 4,700 employees and 820 beds at the time of the fieldwork. AHUS is one of the largest hospitals in the South Eastern part and in Norway overall and it delivers health services to more than 460,000 people. Our study took place at the Division of Cardiology and, more specifically, at the Department of General Cardiology, which consists of 28 beds. The new hospital that opened in 2008 is built over a model from Johns Hopkins Hospital in Baltimore US, which is globally acclaimed for its exceptional services and program known worldwide to strive for standardization and efficiency in health care. See Figure II below to get an overview of the process.
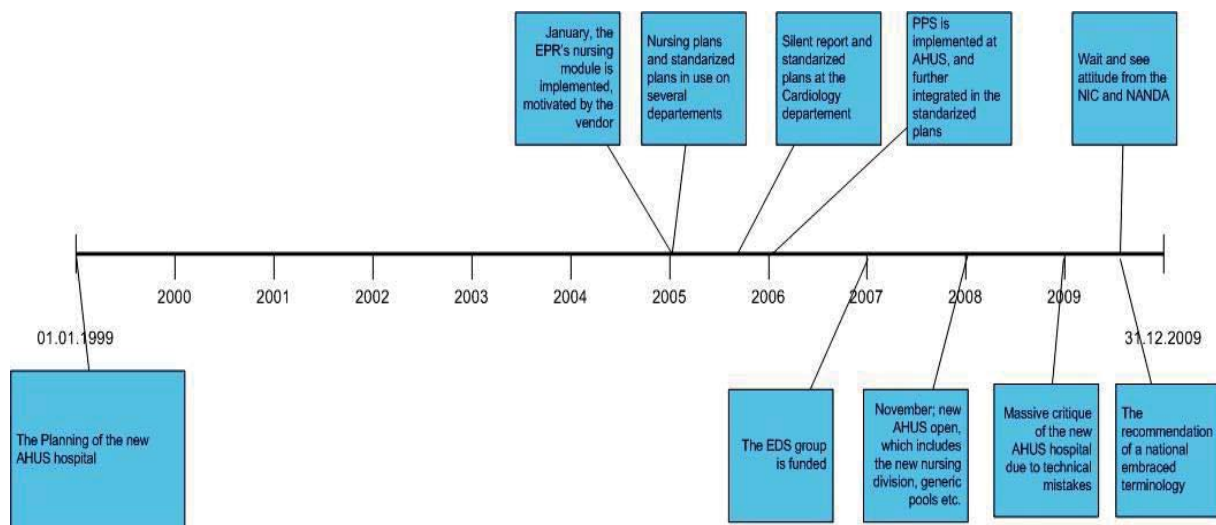
Figure II: The timeline shows the development on the use of EPR based nursing plans, standard plans, the opening of the new AHUS hospital, and the recommendation of ICNP.

The reallocation of AHUS to the new hospital during 2008 brought in additional initiatives to standardise nursing work, particularly for avoiding bottlenecks caused by overly specialized services. One measure was to establish standardized beds and nurses for patients, i.e., the capacity to allocate patients to beds outside 'their' wards and having nurses work in wards other than their 'own'. To allocate patient beds, a new unit for patient logistics was established, with the responsibility for

booking beds for the patients. As a rule, this unit would try to assign patients where they normally belonged. In cases of over-bookings, "the patient logistics unit prioritizes the serious incidents" and moves less serious cases out of the 'home' wards and into any of two generic bed wards. Here, nurses have special training in caring for patients with a wide variety of conditions, but who are not seriously ill. Key mechanisms for volunteering nurses to circulate into other wards have been the incentives offered: salary and flexibility. Salaries are increased by an extra 5% for those who choose to circulate. It is equally important, especially for family-oriented nurses, that signing up for circulation give nurses greater control over when they are at work.

The primary scope was to follow the use of standardized documentation for nurses, which also came to include interdisciplinary work, through handover routines. The standardized care plan, a computer-mediated nurse-nurse and interdisciplinary handover, and integrated Practical Procedures for Nursing were of special interest from the beginning. In collaboration with other hospitals in the South Eastern health region, AHUS had taken a new strategy focusing particularly on care plans, standardised care plans, with integrative initiatives over hospital boundaries. A number of plans were made by and for each speciality, with 17 for cardiology, 406 plans in total. Hence, throughout the observations and interviews, other standards, mostly work process-oriented ones, captured my interest.

Since 2007, the responsibility for collecting blood specimens was overall decentralized to a departmental level and delegated to the hospital's nurses. The potential effects of this were related to efficiency. Previously, technologists from the medical biochemistry laboratory collected blood specimens on fixed rounds three times a day, which resulted in delays and rigidity in the routines. In particular, blood specimens collected on an ad hoc basis or in emergencies had to be handled manually. However, collecting blood specimens is a resource-demanding procedure. Still, the time from requesting a laboratory analysis until the result is available has greatly decreased throughout the first year. In addition, there are positive side effects. The nurses spend more time with the patients, and the patients no longer have to interact with so many different personnel.

4.1.3 The national level

The recommendation of ICNP was brought to the scene in February 2009 when a nationally appointed terminology board recommended ICNP for future clinical use in Norwegian health care, which included both primary and secondary health care. See Figure III for an overview of highlights during the process. The triggering factor for our involvement was the newsletter released. In turn, we have employed three modes of data collection, which span the area between national decision makers, users in different work practices using NANDA and NIC, as well as other practices promoting ICNP. The Norwegian Directorate of Health and KITH are responsible for the validation and approval of

standards, and the recommendation of ICNP was approved. Historically, KITH has played a significant role in the assessment of standards and the maintenance of clinical terminologies. With regard to earlier adopted terminologies such as the ICD and ICF, the authority approved, and financed future updates and translations. ICNP has not been approved for use and maintenance, which in practice means that a national integration process is not yet funded by the Government. Despite this, there has been a significant circulation of classification systems in nursing divided between the vendor of nursing plans (NIC/NANDA) and the Norwegian Nursing Association with the development of ICNP.

The vendor behind the nursing plan, that includes the use of NIC and NANDA has estimated that there are currently approximately 25,000 users of their nursing module nation-wide, and that more than 50 percentage use the clinical terminology integrated into the vendor's EPR. As earlier noted, this vendor was the driving force behind the integration of NIC and NANDA in clinical used EPRs. The open possibility for use has created an interest for classification that is widespread in clinical environments in the different RHFs. Both UNN and AHUS, and more recently Haukeland University Hospital as well, are large-scale hospitals with thousands of nurses using the nursing module, and increasingly the terminologies. In the situation, the Terminology Board's recent recommendation on implementing ICNP has spawned a lot of uncertainty among the NIC and NANDA users.

The translation of nursing classifications arranged by NNO started already in 1996 with the Alfa, and later, the Beta version of ICNP. The NNO has also a department for ICT and documentation that participates in national and international arenas to promote the use of terminologies for nursing. The early versions of ICNP have been piloted in projects around the world, but never in Norwegian health care. The latest version was never seen in practical use at the time of the recommendation, but promising results have been stated from projects in several European countries according to representatives from the Terminology Board.

The translation of ICNP started in early 2007, and the NNO commenced with the work on translating the newest versions of ICNP, which have standardised sentences between clinical specialities. In 2008, the Directorate of Health commissioned the NNO to outline a strategy for the use of nursing terminologies in Norway. Based on this, the NNO established a Terminology Board, which was given the operational assignment. The board consisted of health care personnel that covered the four RHFs and the chain of health care delivery, from the secondary, to the primary health care, led by a representative from the NNA. The University Hospital of Oslo (OUS) was also represented by a PhD student with a speciality in clinical terminology.

Further, our case shows that the process that started with the recommendation of ICNP created a tension between the NIC/NANDA user groups and the Terminology Board recommendation. At the same time, the government was in no rush in getting a terminology for nursing as long as a national terminology for general health like SNOMED was not in place. This tension has brought forth a set of critical questions concerning different layers of the process, which is further elaborated on.
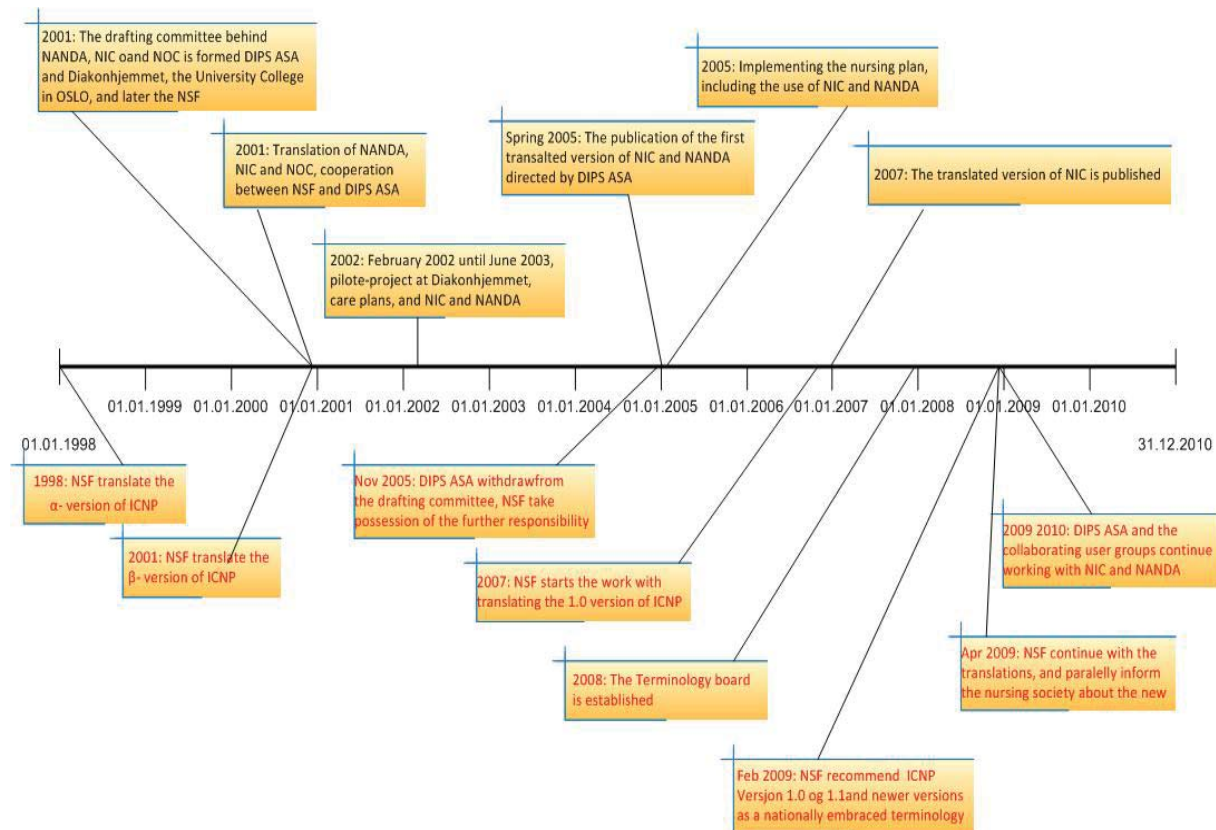

Figure III: Describes the time span between highlights during the development of the two terminology standards interesting to our case. NIC and NANDA are firmly described above the timeline and ICNP under the timeline.

5 Research method

The interest in qualitative research in information systems took off in the mid-1980s, and today it is accepted as being able to provide important insight into the IS phenomena. This research involves qualitative data such as interviews, documents, and participant observations. In the 1990s, the focus broadened from management of IS to the relationship between IS and the organization as a whole. The field of study has expanded to include communication and collaboration between people in organizations (Myers and Avison, 2002).

To make a clear distinction between qualitative research in general and interpretive research, it is important to define the specificity of the interpretive approach explicitly. Interpretive is, for instance, not a synonym for qualitative. Chua (1986) classifies research epistemologies into positivist, interpretive, and critical. This implies that qualitative research can be positivist (Yin, 1994), interpretive (Walsham, 1993), or critical (Clark, 1972). The positivist approach is described as drawing on a formal language of definitions and accepted quantitative expressions. Realities are objective in such a sense that the relationship between the researcher and the phenomena being researched is detached. It is fundamental to the research process to identify and test cause and effect relations between entities by drawing on statistical procedures and generalization, and to make it deductive, which implies testing of hypothesis (Lee and Baskerville, 2003).

The methodological scope of this thesis is interpretive, and thereby qualitative, based on interviews, participant observations, and document analysis, which includes reading of logs. This strand of research underscores that reality is socially constructed and emphasises the close relationship between what is studied, the influence of the context, and the researcher in person. In practice, the flow of health care work activities is often much less linear than it is in other arenas which has more flexibly defined roles.

Interpretive methods of research in IS are aimed at producing the information system, and the process whereby the information system influences and is influenced by the context. Interpretive research can help the IS researcher to understand human thought and action in social and organizational context (Klein and Myers, 1999). Further, Baroudi and Orlikowski (1991) define interpretive research as follows: interpretive studies assume that people create and associate their own subjective and inter-subjective meanings as they interact with the world around them. The interpretive researcher thus attempts to understand work practice through accessing the meanings participants assign to them. Qualitative research techniques can provide deep insight, identify problems, and answer the "why" and the "how" questions that quantitative studies cannot answer (Ash et al. 2004). IS research can be classified as interpretive if the knowledge is gained only through social constructions such as

language, consciousness, shared meanings, documents, tools, and other artefacts (Klein and Myers 1999).

There are two types of studies associated with interpretive research: ethnography and in depth case studies. A typical case study is associated with focusing on a single case or a minor number of related cases that spawn several types of analyses (Eisenhardt, 1989; Robson, 2002). Compared to this, ethnography is targeted towards producing an in-depth understanding of the social processes that take place in various settings (Forsythe, 1999). However, ethnography may also prove efficient in identifying, analysing, and evaluating changes in work practices that emerge from using the IT system as part of the design and implementation of the system (Simonsen, 2009).

Ethnography produces in-depth understanding of real-world social processes. Properly done, it provides detailed insight into the concepts and premises that underlie what people do – but that they are often unaware of (Forsythe, 1999)

When it comes to pinpointed questions about the use of information systems, how knowledge is acquired, integration policy, the emergence of EPRs in hospitals, in-depth case studies promote a thorough understanding of the organization studied paired with different meanings as encouraged when reality is considered to be socially constructed. In their well-known paper, Klein and Myers (1999) discuss the conduct and evaluation of interpretive research in information systems. A set of seven conduct and evaluation principles is proposed along with their philosophical rationale. The principles outlined and suggested apply mostly to the conduct and evaluation of interpretive research of a hermeneutic nature.

A manageable set of principles for those who accept philosophical hermeneutics as a foundation for interpretive research (Klein and Myers p. 87).

The first principle, 'the fundamental principle of the Hermeneutic circle', is foundational to all interpretive work of this nature; it is, in effect, a meta-principle upon which the following six principles expand. The whole idea of the hermeneutic circle proposes that we come to understand a complex whole from preconceptions about the meanings of its parts and their interrelationships (Klein and Myers 1999). Or as Hepsø et al (2009) interpret it, "how our understanding of the "whole" is linked to our understanding of the parts". Accordingly, because of a number of iterations of the hermeneutic circle, a complex whole emerges, which again is used when the principle of interaction is

applied between the researcher and subjects. The following six principles are elaborated on in the analysis related to the cases of this thesis.

Qualitative interviews are used in qualitative research of all kinds, positivist, interpretive, and critical. The qualitative interview is a powerful research tool and an excellent means for gathering data (ibid p.23). Further, it is used in case studies, action research, grounded theory, and ethnographies. For interpretive research, and especially ethnographies, see for instance (Klein and Myers 1999; Myers, 1999). In their paper, Myers and Newman (2007) address problems and pitfalls of the qualitative interview and propose a model providing a set of guidelines to accomplish positive results.

The unstructured and the semi-structured interviews have been the focus of the paper collection of this thesis. In these types of interviews, the researcher has typically prepared some questions in advance, but with a need for improvisation. The interviews are further elaborated on in the section "data collection", specified for each case. Thus, there are many potential difficulties, problems, and pitfalls in using the qualitative interview; Myers and Newman (2007) summarise those of importance, which are further compared with and measured up against the interviews that make up the backbone of my thesis.

Ethnographic techniques as participant observations, document analysis, and reading of logs are used in addition to interviews. This is for instance well known in the CSCW literature, where participant observations are used to explore the cooperation between hospital staff in work place studies (Suchman, 2007). Participant observations and document sources used in combination with interviews enable researchers to detect consistent patterns of thought and practice and investigate the relationship between them. This has great importance, since what people say, and what they actually do, is not always the same (Forsythe, 1999).

5.1 Data collection

The focus of this fieldwork has been on the challenges constructed by the heterogeneity of hospital work in daily practice, with emphasis on IT, information systems standards such as the Electronic Patient Record based nursing plans, and interconnected work process standards such as generic pools for beds and personnel. All empirical data sampled and used in the five papers has been conducted in the period from January 2008 to January 2011. The three cases presented are used both separately and in combination in the five papers, and in addition, the cases consist of data from more than one department that includes interviews with project leaders or different resources in different regions and with different background. I also completed a large data collection at the Geriatric Department at UNN

HF, 12 interviews and 180 hours of observations. This data was collected and used as background material for the developing process of fieldwork. The somatic part of UNN did not use the classification systems NIC and NANDA as a part of the structured nursing plan. The idea was to compare data from this department with another hospital department that used classification systems, standard care plans, or a computer-mediated handover. This work was never done since other more interesting problem descriptions occurred. This part of the fieldwork is therefore considered as an "exercise" to shape the skills for conducting observations, interviews, and document analysis for accomplishing future fieldwork. See Table III below for an overview of all clinical data.

	AHUS	UNN	Recommendation process
Semi-structured interviews	14	28	8
Duration of interviews	60-90 minutes	60-90 minutes	60-140 minutes
Observations	206 hours	400 hours	
Log reading	10 hours		
Time period	2009 - 2011	2008 – 2010	2009

Table III: Describes the amount of interviews, observations, and the reading of logs that make up the case of the thesis.

5.1.1 The UNN case

My first approach was at the Oncology Department at UNN, where I had worked as a nurse, research associate, and leader for more than 9 years. This experience, which also included interviews and observations, turned out to become an important part of my thesis, where the paper slowly evolved from a working conference publication in 2008 to a conference paper in 2011. Secondly, as described earlier, I collected a significant amount of data at the Geriatric Department. This work is to be considered as a learning period while waiting for the fieldwork at AHUS and the national recommendation of ICNP. Thirdly, 13 semi-structured interviews were collected at the psycho-geriatric ward at the University Hospital of North Norway, and 200 hours of in-house observations and a document analysis were conducted. This work was done by my fellow PhD student Torbjørg Meum, and the case is presented and compared to data from the AHUS case. The case is rewritten, and approved by the authors.

The first of the three approaches (Oncology Department, Geriatric Department, Psycho-geriatric ward) at UNN was from the Oncological Department, which resulted in the paper (Pedersen and Ellingsen,

2011). The empirical data was focused around clinical research and secondary use of EPR information for clinical research purposes. I have nine years of experience as a nurse, research associate, and leader at the Oncology Department, which was included in the empirical work. Observations and interviews were conducted from January to March 2008. This fieldwork was a product of the exam on one of the STS courses mandatory for PhD students. The purpose of the course and the exam was to do observations and interviews in an organization familiar to the student. For me, as a former staff member, it was easy to get access to the ward, personnel, and data based on self-experienced knowledge. The observation period was short, focusing on observation of how the nurses and physicians worked in situations where clinical research patients were handled. I also spent some time on talking to and following the nurse that was working in my former position as a research associate. It had been a year since I left the position, but there were little or no changes in the workflow at the time. The observations that were performed during the study were primarily focused on how the nurses, physicians, and secretaries were following the research procedures and if there were any changes in the routines. During the observation period from January to March 2008, handwritten field notes were transcribed shortly after the information was gathered. The content of observations contained information about patients who had agreed to participate in clinical research, how they were handled at the hospital and between hospitalizations. My newly adopted knowledge described different problems occurring in the Outpatient Clinic, the ward, at the Radiology Department, in the Clinical Laboratory, between hospitals, and between nurses, physicians, and secretaries. The workload attached to the position contained anything from organizing clinical studies at the hospital, finding the right patient, organizing cooperation with other clinical Departments locally and in other hospitals, giving treatment to patients, and regular follow-ups of patients.

Five interviews were conducted. The interviews lasted on average from half an hour to one hour. In addition, I was in regular contact with the Clinical Research Coordinator on email during this period. The other four interviews were with three experienced nurses at the Department and the Outpatient Clinic, and with one physician with special interest in clinical research. In addition, I had an informal interview and contact via email with one physician who at the time had a PhD position working with categorisation of data in terms of building clinical health registers. Pictures of work practice harvested throughout my working experience were also used to describe the complexity of the work practise. The questions were few, open, but at the same time specific towards clinical research. In order to avoid being too specific, I tried to ask these open ended questions and let the nurse talk as freely as possible. For instance, one question was about how they as nurses found the patient trajectories different, while treating clinical research patients.

The content of the interview with the physician was of strategic value, where we discussed strategies for the development of the EPR to fit clinical research in the future, but also how documentation could be better at UNN.

The second case at UNN was the one at the Geriatric Ward. As described earlier, this data was collected while waiting for getting access to AHUS, but also in order to have data from a somatic department that used the EPR nursing documentation traditionally without using classifications, or without a computer-mediated handover. This work was valuable in the sense of getting to know how work practice functions without using the standardized care plan, and thereby the clinical terminology. The data set consists of 180 hours of observations and document analysis, and 12 interviews with nurses and physicians from the ward. The data collection took place at the Geriatric Department, which is a medical treatment and rehabilitation unit with three subunits. The department has an extended activity and treats patients from the North Norway Regional Health Authority. The department has an extended activity and treats patients from the region. The ward is further divided into three separate units: one rehabilitation unit focusing on interdisciplinary action, one stroke unit with focus on the acute treatment of stroke, and one general geriatrics unit focusing on the acute phase of general diseases. The Geriatric Department used the care plan with a certain amount of locally developed standards. They did not use the integrated classification systems NIC and NANDA or any kind of standardized plans described in the AHUS case. The patients had a complex range of needs due to a multiple range of medical problems, which required tight surveillance and repeated measurements of blood pressure, temperature, glucose levels, etc. Most of the patients require help to cover their primary needs such as eating, dressing and undressing, personal hygiene, and elimination. This wide range of complexity requires different input to care.

13 semi-structured interviews were collected at the Psycho-Geriatric ward at the University Hospital of North Norway, and 200 hours of in-house observations and document analysis were conducted at this institution, all accomplished by my fellow PhD student in the same period of time. See table III for more information.
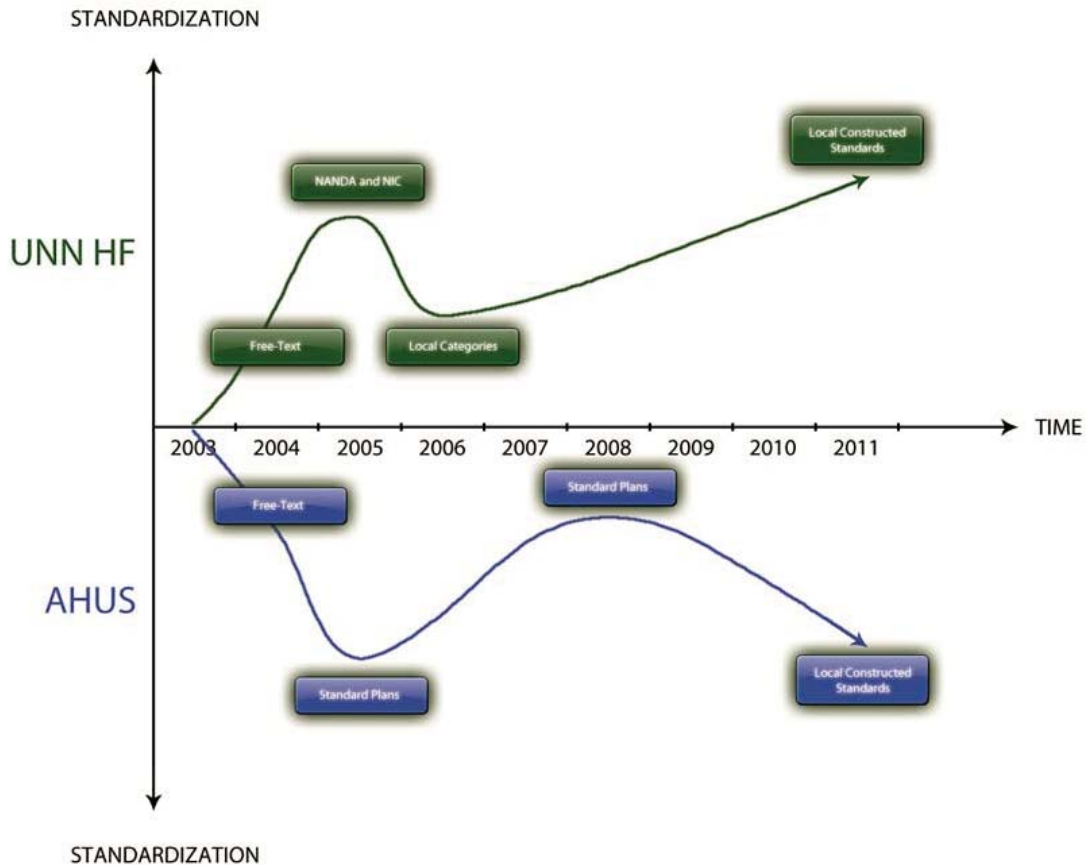
Figure IV: Describes different approaches towards standardization at two large scale hospitals

5.1.2 The AHUS case

In the AHUS case, I have employed four modes of data collection during the period from September 2009 – March 2011: observations, semi-structured interviews, document analysis, and analysis of central logs with general numbers on the use of nursing care plans. In total, I conducted 206 hours of observations and 10 semi-structured interviews with an average of 80 minutes at the Cardiology department at AHUS. In addition, four Project Managers were interviewed, and several physicians were asked direct questions about the architecture of the hospital via email. The project managers were involved in standardized care plans, PPS integration, and blood specimen collection. The third author of one of the papers in the thesis conducted six interviews at the Department of Pulmonary Medicine at AHUS concerning the standardization of work processes, and more specific on generic beds and personnel. As the fieldwork progressed, I also recorded informal meetings and some short oral handovers that often happened throughout the shift. I further analysed and was guided through a number of formal and informal paper-based and electronic documents. These were mostly daily

routines or legal forms that followed the patient from secondary to primary health care, to and fro. I also used my digital camera, mostly to give the readers of my papers a visual impression of the interesting architecture at AHUS, and the technological installations. I also had daily contact with several of the nurses and project leaders that provided information relevant to the case, answers to more specific questions about the organization, and last but not least, various attempts to get the physicians interested in the project.

The first two days of the observation time were spent getting a proper introduction at the Department. I was first introduced at the short morning and afternoon meetings; the rest of the time was spent only walking around, talking to the nurses, and answering questions about my presence. The 206 hours of observations were conducted on a 24/7 basis, still more than 50 % were carried out during the daytime, and especially in the hours around the shift handovers. It was a challenge to be an observer in the small areas where the handover process took place which was narrowed down to the limit, and it was therefore not possible to be a "discrete listener". The time of handovers was a focus, and most of the activities were documented. Since most of the handover was computer-mediated, I used these situations to ask short direct questions that could fill out the blank spots in my handwritten case description. I would typically sit down beside the nurse to watch how the documentation was carried out, and how the nurses shared the duty between them. The log contained data about how the nurse manoeuvred in the EPR system, which documents were in focus and what factors this focus depended on. Further, I focused on types of interruptions, small oral handovers, and other artefacts used. After or between the handovers, I spent time on conducting interviews, following some of the nurses in their daily routines, and sitting around in the Department (ward) just to get an overview of the "big picture" of the work practice.

The length of the observations varied from one to eight hours. The observations included tracing patient trajectories through the hospital to understand the adoption and use of IT-based information carried out by nurses and physicians in different circumstances, such as between people, people and technology, and people and artefacts.

The handwritten field notes taken throughout each shift were transcribed immediately after each session. The early transcription of the data made it possible to plan the next day simultaneously, what situations to seek out, and what questions to ask. Each day at the department gave about 15 handwritten pages. As the fieldwork evolved and the interview processes had started, I was constantly seeking answers to questions harvested from the last interview. In some cases I asked the nurses directly in the handover situation; other times, depending on the question, I just sat down observing

the routines. This could typically be questions about how the nurses cooperated around their documentation routines, or which kinds of interruptions they were exposed to.

I always used around one week at each site before doing any interviews, and in addition to this, a short protocol or the reason for me being there was sent out to all personnel on email before my visits. Another thing is the fact that my background as a nurse could have a positive effect, making me less of a stranger to the nurses and physicians. In my case, it was always difficult to plan a long lasting interview in advance because of the lack of time that the personnel experienced on their shifts. Most of the interviews were planned during lunch breaks or after the shift, while the remaining nurses were covering the interviewee's patients. Despite this high grade of planning, some interviews were interrupted or stopped prematurely. In these cases, follow-up questions were sent by email to clarify or fill in "black holes".

The level at which the researcher enters the organization could be crucial, as entering at a lower level could make it difficult to interview senior managers later. The AHUS case was problematic in this sense; at the time, AHUS had introduced a new level of management, the Division of nursing, where the head nurse was placed in line directly under the director. When my application for doing research at AHUS was processed, it was approved at this level. Retrospect to this, it almost became impossible to get interviews with the physicians, who only answered questions on email or with the head nurse at the ward as a courier.

The purpose of research was advertised in advance, which could give an opportunity to change practice in a more appropriate direction. At AHUS, I used logs from the IT department to see if the numbers (users of nursing care plans) observed actually fitted with reality, measured some months before my observations and interviews. On the other hand, the nurses spoke freely about the fact that my presence had influenced them to think more thoroughly through the topics of my project.

The formal interviews at the Cardiology Ward and four with project managers at AHUS were carried out at one of the offices in close connection to the ward. A tape recorder was used in all the interviews. I always asked for consent before using the tape recorder, and made an agreement about how the data was to be used, that it was made neutral, not used by others, and directly transcribed. One of the nurses asked to see the transcriptions and afterwards made no changes to the content. When I started with the interviews after approximately 7 days of observation, I had no formal interview guide to follow. Some broad open questions of an obvious character had emerged throughout these first days, topics that would start a discussion. In most cases, the discussion around the different topics gave the possibility to ask more detailed questions. In turn, the questions and answers revealed new interesting problems

that became the focus of the next day's observations. This circulating evolvement in retrieving information gave an increasing number of additional questions for most of the interviewees. In the later interviews, I used more time on the evolving questions, while rushing through the standard opening lines as far as the nurse answered in line with the other nurses. I also had a shift of focus during the interview period because of the questions and answers retrieved. I started out with interviewing experienced nurses who had been working at the ward before and after the change of premises at the new AHUS. The main reason was the work done in advance with making, using, and maintaining the standardized care plan and the computer-mediated handover. After three interviews, I understood that the experienced and the less experienced (novices) had different skills, weaknesses, and strengths. In every situation, the questions were related to the EPR based nursing documentation, the handover, the interdisciplinary handover, the architecture at the ward, and work process-oriented standards. Typical questions were further related to the pre-new hospital efforts, how it was before compared to after the new hospital, expectations towards the different standardization efforts, effects of the different efforts that had been running for some time, and what had succeeded and failed during this period. The novices had other experiences, and the questions asked were focusing on in house training on making nursing plans, the handover process, and PPS education from the university college. In terms of this, the gradual evolvement continuously gave more specific questions.

5.1.3   The recommendation of ICNP, a national perspective

The interviews conducted after the recommendation from the NNO were performed during the period from February 2009 to June 2009. We conducted eight semi-structured interviews of personnel who had practical importance to the process of a common national terminology. The interviews lasted between 60 and 140 minutes, with an average length of time of 100 minutes. The strategy was to interview considerable numbers of personnel as soon as possible after the recommendation in order to get first impressions and evolving thoughts about the process. We employed three modes of data collection, which span the area between national decision makers and users in different work practices using NANDA and NIC, as well as other practices promoting ICNP. My fellow PhD student and I travelled around conducting six of the interviews. All the six interviews were held at the interviewees' offices. There were few or no interruptions during the interviews. We had a guide of 10 open questions and added new questions after each interview, based on new information added by the interviewees. The interview inspired to add more and more questions to the list, and some questions were directed back to some of the earlier named interview objects. We always used a tape recorder to capture the interviews.

5.2 Data analysis

Throughout the papers that form the scope of this thesis, I draw selectively and sequentially on relevant methodological principles outlined by Klein and Myers (1999). Most articles that report on the use of interviews simply state how they were conducted, who conducted them, and who the interviewees were (Myers and Newman 2007). The papers presented in this thesis are affected by this impression mostly because of the limited space and the balancing of content to fit the conference templates. In terms of this, outlining the relevance of the principles balances, clarifies, and shapes the overall contribution of the papers presented.

The overall process of collecting data has been open-ended and iterative, with a gradually evolving focus on specific situations from work practice. Crucial to the evolving questioning have been interviews, both among experienced nurses and novices, physicians, project managers, board members, and secretaries. The analytical categories emerged from internal discussions and reading of field notes. The process of becoming a researcher has also been iterative; I have attended courses to collect ECTS (European Credit Transfer and Accumulation System) points, participated in focus groups where key issues of importance to IS research have been discussed and attended workshops and conferences. In all, my research has been a continuous process of feedback from colleagues, supervisors, and interdisciplinary research communities, which has resulted in work in progress, short versions, and final versions of the papers. The analysis has been regarded as an iterative process, moving "from a precursory understanding of the parts to the whole and from the global understanding of the whole process back to an improved understanding of each part". (Klein and Myers, 1999, p. 71), aimed to obtain a historical and contextual understanding of the use of standardized terminologies in nursing, which in turn is used to gain rich insight into the process of recommending a new standard.

The data analysis is a process bound for making sense of the collected empirical material and its relation to existing theory of relevance. For this thesis, the loose guidelines (Klein and Myers, 1999; Walsham, 1995) are used to structure transcribed interviews in combination with hundreds of pages of handwritten field notes. In turn, a set of rules or guidelines developed by Miles and Huberman (1994) reflects the process of analysis.

- The material was coded with colours, depending on situations or the belonging of situation or interview object.
- Comments and reflections were added to the coded sentences or paragraphs.
- The sets of data, interviews, observations, and documents were examined to identify similar patterns, themes, relationships, and differences.

- The patterns observed were further used in the next observations and interviews in an iterative process.
- A set of generalisations of the consistency of data was gradually elaborated.
- Linking the generalisations to a formal body of knowledge in the form of constructs, like for instance "an interesting case" and theories from IS, STS, and CSCW.

Analysis of longitudinal research is a continuous and iterative process with an ever-changing intensity. As Klein and Myers (1999) suggest, it can be understood as a hermeneutic circle that refers to relating the whole to the part, and the part to the whole. The part is not a fixed unit, but flexible, that is allowing changes to the unit of analysis for a given purpose. The analysis has been carried out in two stages. The first was the analysis of data from the various care settings, data that was collected separately. The next step was analysing the historical development of the use of standardized terminologies in Norway.

In addition to the collected interview data from key personnel, official reports, work-flow, and documents, events and milestones were highlighted, and they became the starting point for questions in the interview guide. This part of the analysis was also an iterative process in which transcribed data was discussed, leading to further focus in the next interview, and so on. Subsequently, data from the three care settings was analysed with knowledge about former relevant research in mind. The analysis was a process back and forth between the different cases in order to gain a better understanding of the whole process. The different data sources (interviews, observations, documents) and the various contexts provided opportunities for systematic comparison of multiple perspectives on events and processes. In addition, it gave the opportunity to identify and uncover tacit assumptions and "invisible" practices that were often taken for granted (Forsythe, 1999).

The role of theory in interpretive research is a sensitizing device that makes it possible to view the world in a particular way (Klein and Myers, 1999). However, there are different views on the role of theory in different research directions, the role of theory in the guide to data collection. Walsham (1995) has outlined three ways to see the use of theory in IS research: as initial guide to design and data collection, as a part of an iterative process of data collection and analysis, and as the final product of research as in the main contribution. Further, Dourish (2006) is concerned about the strong tendency for interpretive studies to be reduced to a mere "toolbox of methods for extracting data from settings". I agree with Dorish's general concern about making ethnographic research more relevant for the design of information systems. For instance, in the situation at hand, where the vendor/user struggle with how to react towards the recommendation of ICNP, we were acting as a relevant discussant and a mediator between the users and the vendor. This role is a result of the connection

made after interviews with several users, the vendor, and the Terminology board, and discussions about how to react and future achievements on the use of NIC and NANDA.

The findings have been discussed among fellow students, as well as between the three authors of the papers, who all have a thorough understanding of and experience in working with information system studies, and also more specifically, with nursing plans, handovers, and nursing classifications. Throughout the PhD thesis, the participating researchers discussed data from the different cases for the purposes of critical thinking and reflection in the interpretation process (Klein and Myers, 1999). Similarly, the combination of observation, interviews, and document analysis provided the opportunity for reflection, elaboration, and clarification of narratives collected from the participants. In addition, the data was considered in terms of its sensitivity for possible bias (ibid).

5.3 Reflections on method

The study was part of a longitudinal research project on the use of electronic documentation in nursing, based on field-data collected by my supervisor in a period between 2003 and 2005. The data and case studies used have been random as well as deliberate. The recommendation of ICNP was, for instance, a random case of interest to the project, where we got interested through media. The AHUS case was difficult to access and was delayed, which resulted in the case from the Geriatric Department. Essential to the cases, from an interpretive perspective, are the subjective and inter-subjective meanings taken by experienced nurses and novices, and the interdisciplinary cooperation between nurses and physicians.

Handwritten field notes were transcribed shortly after the data was gathered. All transcriptions of the interviews were done immediately subsequent to the interviews themselves, as, according to Malterud (2003), early transcription is crucial in order to clarify uncertainties and the meaning of unclear sentences. The interviews were done using a tape recorder, and posed only a few open-ended questions that were semi-structured and shaped according to how the interviews evolved.

The understanding and reflection on theory have a prominent role in the process of becoming an IS researcher (Walsham, 1995). From my point of view, it was important to get the understanding of how to use IS, STS, and CSCW theory as a kind of guidance for making the cases interesting. Even though the different cases were impossible to foresee, my increasing understanding of theory helped me to become a better observer and interviewer. This has made the fieldwork experiences an iterative process, where a broad approach to the research field especially has changed and been narrowed down to be specific about work processes, terminology, and human relations. From being a nurse with

experience in using EPR systems in different settings and for different purposes, I had a practical view on the use of information systems from my field of knowledge. Despite this, the early focus on theory and analysis of theoretical implications concerning the use of EPRs and standardisation the prejudgements towards the field were few. The presentation of the different field experiences has undergone challenges, and as Forsythe (1999) says, it has challenged me to analyse and produce field data through a systematic comparison between my insider and outsider view.

5.3.1   How to collect the data

The following elaboration around the six remaining principles of Klein and Myers is used to reflect on the choice of case, the interaction with clinical staff, how to generalize on interpretive results, finding the right interview objects, and the multiple interpretations.

The second principle is the principle of contextualization, which requires critical reflection on the social and historical background of the research settings, so that the audience get a picture of how the situation has emerged.

Interpretivists argue that organizations are not static and that relationships between people, organizations, and technology are not fixed but constantly changing (Klein and Myers, 1999)

This thesis has several angles of incidence towards how the relations change throughout the field experience. Firstly, interpretive researchers consequently always seek to understand a moving target. Hence, the result of fieldwork is constantly influenced by the total history of the organization, and the research itself becomes part of the very organization. The AHUS case has, for instance, a historical reference point at the opening of the new AHUS hospital, and several organizational, technical, and work process-oriented adjustments were executed several years before in order to cope with greater restructuring at the time of opening. Another reference point used is the change from paper based patient records to the use of EPRs, several IS publications deal with all the expectations related to this (Ellingsen and Monteiro, 2002). The case of ICNP and the recommendation process in Norway also had a historical perspective on the development and use of NIC and NANDA that was crucial to know about in terms of influence and understanding. Further, researchers ought to see the people in organizations as the producers and not just as a product of history, and the description of the historical context should reflect this. In the AHUS case, the nurses have been divided in two groups depending on their experience. While doing the interviews and observations, it became clear that this difference (historical/personal) was interesting, especially because of the changes done before and after the new AHUS hospital.

The principle of interaction between the researcher and the subjects requires critical reflection on how the research material/data was socially constructed through the interaction between researchers and participants. The nurses and physicians are interpreters, where we as researchers alter their horizons by the appropriation of concepts used by IS researchers, consultants, vendors, and other parties interacting. As a researcher, and while making an effort to "embrace the context" (ibid) in which my research was conducted, the understanding of challenges, the importance of experienced versus inexperienced nurses, was brought into consciousness.

Walsham (1993) argues that the validity of inferences drawn from a case does not depend on the representativeness in a statistical way, rather the plausibility and cogency of the logical reasoning used in describing the result from the case (Walsham, 1993). He further argues that there are four types of generalizations from interpretive case studies: the development of concepts, the generation of theory, the drawing on specific implications, and the contribution of rich insight. Theory is therefore important in interpretive research, not for falsifying it, but more as a Sensitizing device" to view the world in a certain way.

Interpretive research in information systems tend not to generalize to philosophically abstract categories but to social theories such as structuration theory or ANT (Klein and Myers p. 75)

In addition, I have experience as a nurse, and thus have an insider's knowledge with an analytic outsider's view (Forsythe, 1999). In interpretive research, prior knowledge and preconceptions are not considered a bias, but are the necessary starting point of our understanding (Klein and Myers, 1999, pp. 76). Our prior knowledge and experience provided the lenses and a sensitizing device, through which our field data were constructed. Furthermore, our understanding was expanded and revised through interaction with the participants in our fieldwork, where issues such as co-construction, integration, and the use of gateways emerged. These issues have been explored further in the case description and discussion. Being a nurse has also been an advantage in terms of getting access to the field. The process of gaining access to research sites is according to Walsham (2006) a continuous process, which needs to be maintained throughout the study. Gaining access is also reported to be a time consuming effort (ibid). Gaining access is binary, either you get it or you do not, but as access is received, the role can change in several directions. The basis of interpretive research is to make the historical intellectual basis of the research as transparent as possible. Prejudgement plays an important role in the interpretivists' understanding, contrary to the positivist way of thinking, where prejudgement is seen as a source of bias. The five papers presented are all built on solid cases with a strong historical anchorage, where each case is presented with a time line and interview objects are chosen because of their knowledge about the past. Such interviewees are for instance the experienced

nurses at AHUS and the advisors at DIPS ASA, who initialized the NIC and NANDA program. Further, the theoretical perspective in the papers presented has emerged as a consequence of contradictions or unforeseen events.

The principle of multiple interpretations requires sensitivity towards possible differences among the participants:

The principle of multiple interpretations requires the researcher to examine the influences that the social context has upon the actions under study by seeking out and documenting multiple viewpoints along with the reason for them (Klein and Myers p. 77).

This analysis includes seeking to understand conflicts related to power, which becomes clear in the paper "ICNP", where much effort was put into finding the right interview objects to illuminate the different political aspects of the case.

The interview involves interrogating someone who is a complete stranger, and asking subjects to give or create opinions under time pressure. It was therefore important to plan the interview firmly by first getting to know the informant, talking about what I was interested in, and setting up the interview outside the ward to avoid interruptions. The "Lack of trust", has a similar character as the previous principle, but could be extended to account for a concern for sharing sensitive data. It was therefore important to sign a "consent of trust", or as in the case of IS research, to inform about the purpose of the interview, in written form or by using email directly to the ward, where it was further distributed. The same accounts when entering the research site (Tuckett, 2004). Another challenge when entering a new site was to avoid being guided towards interviewees who were selected by the department. This is called the "elite bias", where the researcher fails by interviewing only certain people with high status (key informants) and therefore fails to gain an understanding of the broader situation (ibid). The gatekeeper bias was a challenge in the same sense, where administrators, managers, and team leaders could control the sampling of interviewees (ibid). In the AHUS case, I started out with interviewing only experienced nurses; it was actually because of the nurses' interpretations that I started to interview novices, or less experienced nurses. It was the different knowledge levels on the use of care plans that led to this shift. Contrary to this, in order to cover all interests, I was especially focused on the "broad approach" when I started interviewing people who were related to the recommendation of ICNP.

I spent much time in the start wondering about what "sign" that would make me understand that the last interview was made. Sampling and data saturation are about the comparison of data, or how to make the decision that data saturation or data redundancy is reached. Combined with field observations, the interview is suitable to measure data, not the amount of data, but the richness of data, and not the total counts, but the detailed description (Tuckett, 2004). The AHUS case was balanced between data based upon two groups of nurses: the experienced and the novices. This was from an outset where the first interview was based on observations made during the first week to the point where no new data was captured.

6 Findings

This thesis includes five papers published in conference proceedings or peer- reviewed journals and is organized as follows:

1.Pedersen, Rune; Ellingsen, Gunnar. The Electronic Patient Record – sufficient quality for clinical research? *Association for Information Systems* 2011 ISBN 978-952-60-3574-1 (Nominated in the category Best Paper).

2.Pedersen, Rune; Ellingsen, Gunnar; Monteiro, Eric. The standardized Nurse: Mission Impossible? *IFIP International Federation for Information Processing 2011*. ISSN 1571-5736.s 163 - 178.s doi: 10.1007/978-3-642-21364-9_11.

3.Pedersen, Rune; Standardizing work in healthcare through architecture, routines and technologies. From Research to Practice in the *Design of Cooperative Systems (COOP): Results and Open Challenge*. Springer. 2012, pp 17-32.

4.Pedersen, Rune; Standardization strategies in healthcare practices? *Proceedings of the 15th International Symposium on Health Information Management Research – ISHIMR 2011*, Zurich, Switzerland, 2011, pp 458-466.

5.Pedersen, Rune; Meum, Torbjørg; Ellingsen, Gunnar. Nursing terminologies as evolving large-scale information infrastructures. *Scandinavian Journal of Information Systems* 2012; Volum 24 (1). ISSN 0905-0167.s 55 – 82.

Before presenting a summary of the individual papers, I would like to underscore that they all have gone through a process where preliminary versions have been sent to or appeared in other settings than what is finally reported. The first paper, listed as paper 1, was originally presented as work in progress and included in the proceedings at the 32th Conference on Information System Research in Scandinavia (IRIS) in 2008 The final version of the paper was accepted for the European Conference of Information Systems, Helsinki, Finland, in 2011 and published in the proceedings. The paper was further nominated for best paper as one of four in the category, competing against 330 accepted papers. A short version of paper 2 was first published at the Information Technology in Health Care: Sociotechnical Approaches (ITHC) Conference in Aalborg, Denmark, in 2010. Paper 2 was further accepted and published in the proceedings of the International Federation of Information Processing (IFIP) 8.2 in Turku, Finland, 2011. Working Group 8.2 focuses on information and communication

technologies and organizational change. Preliminary results from the paper were presented for the EPR users and the vendor at DIPS-Forum 2010 in Bodø, Norway and at AHUS during the MIE (Medical Informatics Europe) 2011 conference, were AHUS had been the focus of fieldwork on information systems. Paper 3 was accepted and presented in the proceedings of the 15th International Symposium on Health Information Management Research (ISHIMR) in Zurich, Switzerland, in 2011. The findings in this paper have been discussed and presented among fellow students. Since a significant part of the case presented and used came from my supervisor and fellow PhD students' earlier work, it was particularly important to discuss the results before publication. Paper 4 was accepted and presented at From Research to Practice in the Design of Cooperative Systems (COOP) in Marseilles, France, in 2012, and included in the proceedings. The fifth paper was accepted for publication in the Scandinavian Journal of Information Systems 2012, and preliminary results were presented at DIPS forum 2010. The paper had gone through several review processes before publication.

The collection of papers is presented in a chronological order, not based on publication date, rather on when the work with each paper started. Some papers went through more complex revision processes than others, meaning that the time from start to publication varied. The collection of papers serves to present two purposes. Firstly, it portrays the learning process, the journey I have experienced as a PhD student. Secondly, it reveals how the contribution of the thesis has evolved in time between research sites and my personal maturation as a contributor to the IS field of research.

Further, the five papers are interconnected theoretically and methodically, see table II for the correspondence between the papers and research questions outlined for the thesis. The focus has primarily been on nursing work and the standards that make up the backbone of nursing. Still, interdisciplinary work and common standards are interconnected to nursing when it comes to integrated care and process-oriented systems in health care. Based on this, the thesis is a journey between general interdisciplinary challenges to achieve process- and decision supported ICT systems in paper one, specific examples on the development of nursing-specific standards in paper two, three, and four, and a national perspective based on the recommendation of a terminology standard for nursing in paper five. Common for the papers is the focus on work processes, human relations, and terminology standards with information infrastructure as a theoretical lens.

The five papers present literature drawing on II, as listed in the theory section, which also includes more recent literature on II, standards, and integration (Leonardi, 2009; Meum et al. 2011; Sahay et al. 2009). I have discussed an interpretative case study where standardization of nursing work has been achieved to an interesting degree. I have analysed the process of co-construction of the standards,

which describes how standards interrelate in practice. These standards are partly imposed from the top, and partly legislated through the active involvement and the ingenuity of users. New standards that are work process-oriented, are introduced and included. In one paper that also focuses on the co-construction of standards, I use sociomateriality as a lens to move away from the view that technology can shape organizations in predefined ways, towards examining how materiality is intrinsic to everyday activities and relations. I pinpoint that the result is depending on development and change over time. A third paper describes the slowly evolving nature of large-scale terminology-based information infrastructures and introduces the "gateway" concept to illuminate how the heterogeneous character of different information infrastructures, or gateways, have been promoted as a strategy to establish interconnection between them (Hanseth and Lyytinen, 2004; Aanestad and Jensen, 2011; Edwards et al. 2007). Based on this and the fact that these systems are far from neutral but always infused with interests inscribed by the designers and their promoters, gateways introduce that these processes often are infused with politics (Bowker and Star, 1999). A fourth paper on secondary use of EPR information for clinical research purposes presents the concept of "universal locality" in order to emphasize how local heterogeneous practices, including the largely hidden work performed by nurses, are performed in IIs, generating research data that is standardised and comparable across different local sites.

Boudreau and Robey (2005) discuss organization of II with emphasis on human agency, not technology and structure. Their focus is in line with my work, as the written accounts cover the use of EPR systems in large-scale hospitals and how different types of standards interplay. In all, the focus of this thesis has primarily been on human agency and work process-oriented standards. Further, our research group has chosen to focus much of our research on terminologies/classification systems, both as integrated standards discussed in relation to human agency and work practice and as a standalone information infrastructure.

6.1 Paper 1: The Electronic Patient Record – sufficient quality for clinical research?

The first draft of this paper was delivered as an exam at an ECTS course in information systems and then further developed. Although the scope has a slightly different angel than the rest of the papers, it fits with the overall purpose of supporting the development of process-oriented systems and integrated care together with secondary use of information for research purposes. This is followed by a need for semantic interoperability that could be solved by using terminologies such as NIC and NANDA, or archetypes and templates that also solve problems due to technological interoperability.

The paper discusses how Electronic Patient Records have many purposes in hospitals and are expected to be a foundation for clinical treatment and care processes, reimbursement issues, and research purposes (Pedersen and Ellingsen, 2011). See Table III for further information. We found a gap between the information in the EPR and the information required for clinical research and investigated what this gap consists of, how it is managed, and who is responsible for closing it. In order to do so, we focused our fieldwork on the work that goes into the processes between the research staff, nurses, physicians, and clerks. Based on the results of the observations and interviews and the presumption that research data is not automatically given as long as a hospital-wide EPR is in use, we outlined the following research questions: What is the nature of integrated systems in clinical research based on the notion of quality as well as secondary use of documentation?

To demonstrate this, I have presented a case from UNN where interpretations from research staff (myself included), physicians, clerks, and nurses from the Oncological Department were included. Firstly, the case gives a clear picture of the flow of information between the EPR system and the clinical research Case Report Forms (CRF) and the actors that perform the work. Secondly, the department has a long tradition of participating in clinical research. Theoretically, I used the information infrastructure literature (Ellingsen and Munkvold, 2007), supplemented by Orlikowski's (2002) notion of collective capability, in order to pinpoint the effort that goes into generating research data. Further, Ure et al (2009) found recurring socio-technical problems in the development of infrastructure for sharing and reusing data across sites for e-health research. Based on a case study of two standardised medical protocols, Timmermanns and Berg (1997) had earlier introduced the notion of 'local universality' to pinpoint how a protocol (i.e. a standard) always has local variants and both shapes and is shaped by the local practice. Much of the data included in clinical studies requires a certain level of standardisation and quality that goes beyond a single research site, where there are strict guidelines on how to collect and process the research data. These guidelines also go beyond what is required in daily clinical practice as local variants, thus enforcing a strict level of standardisation that cuts across many research sites, countries, and continents. Consequently, many clinical studies may rather be described as a "universal locality" to emphasize how local heterogeneous practices, including the largely hidden work performed by nurses. I express the need for terminology, which immediately comes to mind with regard to the content of the EPR that is the presence of many health-related terminologies and classification systems, which ensure consistency and comparability across institutional and national borders and that in the end would secure semantic interoperability. Even though archetypes are only briefly elaborated on, the paper has stated that their function could support both semantic and technological interoperability.

Contained by the context of the thesis, the paper serves several purposes. The concluding part discusses the concepts of universal locality and collective capability as fundamental to succeed with secondary use of information, based on the work performed by humans. This pinpoints the importance of work processes and human relations for understanding the development of information infrastructure.

6.2   Paper 2: The standardized Nurse: Mission Impossible?

The focus of the paper is many-sided; firstly, it explores how nursing classifications have been adopted and used as a part of the nursing care plan. Secondly, it explores numerous standards, work process-oriented and technological ones, and artefacts. Thirdly, it looks into how work practice, the EPR, and the standards constantly shape or are being shaped by each other (Pedersen et al. 2011).

The purpose of this paper was to emphasize the importance of a theoretical perspective for the standardization of information system embedded service work. Based on this, the key questions addressed are: First, how can processes for standardization of health care work be described socio-technically? Second, how can practical key implications of heterogeneous work practices be identified to promote IT-based standardization? The case for this paper is from AHUS that contains a number of interviews and observations. See Table III for further information. The focus has particularly been on IS-based initiatives for the standardization of work and routines (Timmermanns and Berg, 1997; Ellingsen, Monteiro, Munkvold, 2007). Given the increasing importance of the service sector in IS research, it is vital to extend the focus from standardization of artefacts and products to include standardized, IS-embedded service work, such as work processes in hospitals, and human relations, for instance novices and expert nurses (Ellingsen, Monteiro, Munkvold, 2007). Exploration of the effects of these standards made it clear that the achieved effect, in relation to increasing both efficiency and quality of work processes, could end up being inherently positive. These standards show the interdependent effect on the IT-based standards installed because of a positive contribution to an easier work practice for nurses. According to the Dreyfus model, nursing practice is shaped and developed by expert nurses, and a nurse in general passes through four steps of "education" before becoming an expert (Benner, 1984).

Contained by the context of the thesis, this paper serves several purposes. The paper pursues the focus on work practice and information infrastructure from paper 1, but now with a specific focus on nursing practice work processes, human relations, and routines. It explores how numerous different standards shape and are shaped, the co-constructed of standards, it explores how standardization is a mutual process between formal standards, and it explores situated knowledge. We explore how the novice and expert nurses are influenced by technology; novices become experts due to new technology. Last but

not least, it contributes to the future development of process-oriented systems. By focusing on nursing work and standard care plans, we have a foundation for future research on systems that to a large degree are process-oriented in Norwegian health care. The use of NIC, NANDA, and PPS for semantic interoperability makes the care plan structured to an interesting degree.

6.3   Paper 3: Standardization strategies in health care practices?

In this paper, the focus is on a particular instance of standardization, namely the implementation of nursing care plans in two university hospitals in Norway. See Table III for further information. It argues that standardization is manageable through discussing two interpretive case studies from two large-scale hospitals (Pedersen, 2011). Nursing care plans were viewed as a means for making nursing work more effective, offering both quality assurance and future research capabilities. The two hospitals approached the implementation (standardisation) differently. One hospital pursued a managerial strategy, while the other largely adhered to a user-led approach. With this as a backbone, the following research questions were asked: how to proceed to standardize nursing practice? What actors are important? What strategy to apply? Key issues in this paper have been the reconstruction of standards in situated action and how working infrastructures transform both the new infrastructure and the local practice over time.

Users create workarounds when working with an information system, see for instance (Azad and King, 2008a; Suchman, 1995; Ciborra, 2002; Orlikowski and Lacono, 2001). Workarounds by users can further be conceptually linked to the notion of 'interpretive flexibility' described by Orlikowski (1992), accounting for information infrastructures as an attribute of the relationship between humans and technology, where interpretive flexibility is influenced by the characteristics of the context where the technology is used. Further, previous studies have shown how implementation of new technology in complex, dynamic organizations has led to reconfiguration of work processes (Timmermans and Berg, 1997; Ellingsen et al. 2007). Sociomateriality is used as a lens to move away from the view that technology can shape organisations in predefined ways, towards examining how materiality is intrinsic to everyday activities and relations, pinpointing that the result is depending on development and change over time. The notion of sociomateriality is distinguished from earlier attempts to move beyond the separation of the technical and the social (Orlikowski and Scott, 2008; Azad, 2008a).

Contained by the context of the thesis, this paper serves purposes alternative to the former publications. The paper pursues the focus on work practice and information infrastructure from paper 1 and 2. In addition, this paper highlights the collective reconstruction of clinical terminologies that emerges with time and integration approach. Further, I have used concepts such as sociomateriality and interpretive flexibility to enlighten my point of view.

6.4 Paper 4: Standardizing work in healthcare through architecture, routines and technologies.

In this paper, the handover is treated as particularly interesting because it is typically time-consuming and crucial for patients' safety and the quality of care (British Medical Association, 2004; Riesenberg and Leisch, 2010). It further discusses interdisciplinary collaboration and a challenging physical architecture as co-constructed to this (Kane et al. 2011). The case is from AHUS and contains interviews, observations, and discussions with staff, project organizers, and management. See Table III for further information about the case.

This paper discusses standardization after the introduction of a computer-mediated nurse–nurse/interdisciplinary handover in a cardiology ward and its effect on collaborative work activities. Standardization plays out in the physical architecture adopted by the hospital, which impacts on how collaboration is in progress in work practice, i.e. the impact of standardized spaces (physical architecture) (Pedersen, 2012). The number of involved standards is central, as well as how altering some work impacts on other processes, especially interdisciplinary collaboration, social relations, and informal learning. We need a broader view on standardization based on the increasing number of installed standards, where success in one area of standardization tends to bring about consequences in others. Based on this, we asked: How does the variety of standardization initiatives shape health care work, and particularly, the collaboration between the professionals?

Theoretically, the chapter draws on standardization literature and literature from Computer Supported Cooperative Work on collaboration, and sociomateriality as a tool to understand organizational work (Orlikowski, 2007). Further, standardized architecture is discussed, which confines and/or substantiates work process-oriented standardization. The physical layout of the hospital wards, the architecture, becomes a key element of the socio-material, and thereby essential in integrated standardization efforts. The view on architecture as a material factor overemphasizes virtual spaces against the material and social conditions of technological infrastructures (Monahan, 2008).

Contained by the context of the thesis, this paper serves purposes alternative to the former publications. The paper pursues the focus on work practice and information infrastructure. Sociomateriality is used to illuminate the fact that standardization efforts cannot be investigated on as isolated labours, rather as one of several social and material interconnected standards. The number of standards is essential to this case, as recent research in IS has showed that standardization of hospital work increasingly includes more interconnected standards. The case has further pinpointed how physical architecture or "space" contributes to the standardization of work practices when striving for efficiency, and how it further becomes a conflicting standard in interdisciplinary collaboration. In all,

this brings interdisciplinary collaboration to my research, and physical architecture (space) as a material standard.

6.5 Paper 5: Nursing terminologies as evolving large-scale information infrastructures.

This paper describes the slowly evolving nature of large-scale terminology-based information infrastructures. This is examined empirically through a threefold case based on data from three Norwegian university hospitals, where we also tracked a national recommendation of a reference terminology (Pedersen et al. 2012). Through the empirical study, I have learned that the introduction of gateways in national implementation processes is far from straightforward. We traced key events throughout the last decade and aimed at responding to the following research question: How is a nationwide terminology system adopted in practice, and what are the implications of introducing reference terminologies in such a setting?

Theoretically, we focused on information infrastructures that offer a lens to study large-scale interconnected information systems (Bowker and Star 1999; Sahay et al. 2009; Hanseth et al. 1996; Aanestad and Jensen, 2011), although in this case the technological components are the involved terminology systems. Terminology standards have received relatively little attention in the IS field, despite their importance in modern medicine (Timmermanns and Berg, 1997; Bowker and Star, 1999). An increasing pressure to achieve a smooth information flow between the systems in health organizations (Larsen and Ellingsen, 2010; Aanestad and Jensen, 2011) and a motivation for this can be found in the need for streamlining work processes across organizational boundaries to ensure quality of treatment and care of patients (Ellingsen and Monteiro, 2003; Timmermans and Berg, 1997; Kodner and Spreeuweberger, 2002). This makes it essential that standardized terminologies for different domains can be integrated (Wade and Rosenbloom 2009; Jiang et al. 2007; Bakken et al. 2002). Bowker and Star (1999) discuss and put terminologies forward as an information infrastructure, focusing on organizational implications and less or not at all on work processes. In this thesis, the terminologies NANDA, NIC and ICNP are elaborated on as information infrastructure, both as a working infrastructure (NANDA) to support daily routines and as a reference terminology (ICNP) to create semantic interoperability. The focus on terminology as infrastructure is developed around work process-oriented standards and human relations. Due to the heterogeneous character of different information infrastructures, gateways have been promoted as a strategy to establish some interconnection between them, and we have experienced that the introduction of gateways has political implications interesting to such processes (Hanseth and Lyytinen, 2004; Aanestad and Jensen, 2011; Edwards et al., 2007).

Contained by the context of the thesis, this paper serves purposes alternative to the former publications. The paper pursues the focus on work practice and information infrastructure. Hence, this paper describes the slowly evolving nature of large-scale terminology-based information infrastructures. We describe the concept of gateways, which may be both a piece of technology and a social arrangement that serves the purpose of interconnecting different infrastructures. We further explore how reference terminologies have been presented as a purely technical neutral technology (as gateways), but are more complex in reality: integration processes like this require considerable adaptations, negotiations, and manual maintenance

7 Contribution and implications

The main contribution of this thesis is the empirical investigation of efforts made in Norway to support the development of process-oriented EPR systems to secure the continuity of patient care with focus on semantic and technological interoperability. Accordingly, some of the implications are automatically given in the five papers, through the choices of scenarios and cases that pinpoint areas of importance to process orientation. The practical message is that nursing as a profession is the most interesting area for investigating process orientation in Norway, being the most prominent area in healthcare where data has been categorized to a certain degree and where terminology standards have been in practical use over time to establish semantic interoperability. This reflects that future accomplishments in the development of process-oriented systems in Norwegian healthcare should be built on this experience. Other implications, like those that are particularly relevant to theory, design, method, and practice, are further elaborated on in this section. In turn, these focuses concern the use of standardized care plans in large-scale hospitals, work process-oriented standards, terminology standards, and material standards to support the continuity of care.

7.1 Theoretical implications

The quality and efficiency of healthcare has proven to be difficult to improve by applying to standards (Timmermanns and Berg, 1997). Process-oriented systems that provide health care with semantic and technological interoperability that makes data readable for others by also applying terminology standards to support the continuity of care have been continuously pursued in Norwegian healthcare for a decade. The findings presented in the five papers deal with different theoretical aspects towards using terminology, building on information infrastructure theory and the socio-technical dynamics of ICT based networks in healthcare. Essential to this is the explicit focus on work processes, human relations, terminologies as infrastructure, and concepts that explain particular situations and context of the II.

7.1.1 The gateway as a political device

My work concerns standardization of information system embedded service work and how these processes can be described socio-technically or socio-materially. In this regard, an information infrastructure represents a socio-technical system, that is, where the technical issues always are seen in relationship to practice (Star and Ruhleder, 1996). From a co-constructive perspective on standardization, where standards and work practice mutually shape and constitute each other, standardized work always involves 'local universalities'. Global standards both shape and are shaped by local work practice (Berg, 1997). Consequently, the co-constructed focus lies in the work process-oriented standard that has been installed. It is the effect of an array of coordinated standardization efforts that are seemingly interdependent, new work process-oriented standards co-constructed with

technology, artefacts, and material standards (Leonardi, 2009; Meum et al. 2011; Hanseth and Monteiro, 1997). In turn, this study focuses on new standards, the number of standards, and the co-constructed of standards. Hanseth et al. (1996) emphasized that behind a "neutral" technology, the participants involved played out different political interests. Sahay et al. (2009) found that the interplay of political interests and technical configuration aspects shaped the integration process, as the stakeholders were associated with different powers of negotiation. Because of this, and the heterogeneous character of information infrastructures, gateways have been endorsed as a strategy to establish some interconnection between integrated systems (Hanseth and Lyytinen, 2004; Aanestad and Jensen, 2011; Edwards et al., 2007). The gateways are both pieces of technology and a social arrangement that serve the purpose of interconnecting different infrastructures. Hanseth and Lyytinen (2010, p. 7) offer an example of a gateway as an "IT capability that supports multiple e-mail services running on different e-mail protocols". Further, Edwards (2007) illustrates the same concept using Google Scholar, and argues that it functions as a gateway between electronic journal publishers, university libraries, digital books in Google Book or the Hathi Digital Trust, and individual researchers. Gateways represent a key principle of infrastructure development: Plugs and sockets that allow new systems to be integrated in an existing framework without constraint, often wrongly understood as being a technology, hardware or software alone. A more precise approach conceives gateways as combining a technical solution with a social standard, which both must be integrated into existing communities of practice. Gateways offer flexible pathways for II expansion and navigation (Hanseth, 2001; Edwards et al. 2007).

In the context of my research, I view the gateway as being political in the constituency of its integrating capability, where existing domain-specific terminologies in heterogeneous work practices can remain intact while the reference terminology arranges for mapping between them. The national process leading towards the adoption and use of a national terminology standard explores this, and connects the gateway concept to information infrastructure and the installed base. This is, where the reference terminology is the II, the focus is on work processes, human relations, and the installed base of existing working terminologies.

7.1.2 Technological interoperability, health grids of information infrastructure

The ability to share EPR content between wards, hospitals, and/or secondary and primary healthcare systems is of great importance, and it is a big challenge in Norwegian healthcare. This is the technical interoperability of process-oriented work. The bottleneck has been caused by a combination of legal and technical challenges in Norway, and the projects that concern sharing of information between hospitals and/or hospitals and municipalities are struggling to be efficient. Paper one is about this challenge, focusing on reuse of information for research purposes, and it elaborates this further to

include terminology standards, messaging devices, and exchange standards for sharing of information. By using a large-scale EPR, it should be possible to extract information applicable for research purposes and decision support that copes with the fundamental principles of continuity of care. One problem is that the EPRs today are not organized in such a way that structured data elements could be extracted, compared, accumulated, and summarized (Berg and Goorman, 1999). Ever since its introduction, the EPR has been expected to respond to the call for large-scale information infrastructures such as Cyberinfrastructure (CI) (Ixchel et al. 2010; Ure et al. 2009; Edvards et al. 2009) or eScience (Ixchel et al. 2010; Ribes and Lee 2010), which would support such activities. Experience from various HealthGrid projects shows clearly that there is a tension between the technical idea of a stable, interoperable infrastructure for data sharing and reuse and the reality of knowledge as evolving, socially and locally constructed (Ure et al. 2009). When two systems such as vendor specific EPRs need to exchange information, they need to agree on technical formats in order to succeed. One way is to agree on a common message format and form import and export algorithms that support this without exposing system secrets. For instance, software programs that convert the format of one system to the agreed message formats where the other system has an import algorithm that converts the message to its internal format.

There are a number of reasons for bottlenecks related to sharing of information, but there are still other work processes or human related efforts that support this work. On way to describe this is through the significance of the concept "universal locality" in paper 1. The concept emphasizes how local heterogeneous practices that include the largely hidden work performed by nurses, physicians, and clerks participate in the effort of generating research data that is standardised and comparable across different international research sites. Universal locality describes how clinical routines, such as those for radiology and laboratory samples, diverge between clinical practice and clinical research. The standard routine for research leads to manual work for nurses or physicians. The processes that go into sharing of research data are valuable sources of data when it comes to getting a complete understanding of the work that needs to be managed to obtain semantic interoperability, but that could be solved by using clinical terminology.

7.1.3   The terminology standard as information infrastructure

Paper 5 in particular describes the slowly evolving nature of large-scale terminology-based information infrastructures. Other studies describe the nature of working terminologies as changed by work practice through a time dependent evolving process (Meum et al 2011; Pedersen, 2011). The strategic aim of implementing standardized terminologies is to share and compare information within and across domain-specific and organizational boundaries, which in turn is essential for the continuity of care in process-oriented system. The terminology standards are further mentioned as a formalised

way to overcome the challenges of semantic interoperability in healthcare, and thereby they are used as a tool for a common language in shared information. More specific, both the working terminology (NANDA) and the reference terminology (ICNP) are considered to be a way of dealing with shared information to fulfil the need for process-oriented systems (Wade and Rosenbloom 2009; Jiang et al. 2007; Bakken et al. 2002). An important characteristic of reference terminologies is that they map and integrate different terminologies located in different domains. Conceptually, the integrated portfolio serves as a common model while being able to co-exist in harmony with existing terminologies. A reference terminology is not expected to generate enormous translation costs, and one may continue to use two different terminologies as suggested in paper 5, NANDA (hospitals) and Sabaclass (primary care), using the reference terminology ICNP as a mapping device between the two. SNOMED CT and ICNP are introduced as examples of reference terminologies in this thesis. These terminologies can act as a common point of reference points for highlighting semantic overlap and difference, and emerge as a possible solution for mediation problems that often appear when heterogeneous health services are sending and receiving messages between each other.

The information infrastructure concept addresses the challenges of implementing large-scale information systems (Aanestad and Jensen, 2011; Hanseth and Lyytinen, 2010; Pollock and Williams, 2010), but few of these studies focus on infrastructure as the emergence of large-scale terminology systems, which has been the primary technological component in parts of this thesis. One example of this is taken from Bowker and Star (1999) and the development of the ICD. Different from Bowker and Star that have an organizational view to terminology as infrastructure, the view of this work has been on the work processes and humans that shapes and is shaped by II. There are several implications of seeing information infrastructure through terminology standards. Firstly, it gives an opportunity to view the content of the II to a larger degree through the structure of diagnosis and interventions and the unified language. The terminology standard is intuitive, guiding clinicians towards the right diagnosis or interventions as an evidence-based tool that supports the personal knowledge base of the clinician. For instance, through the standardized nursing plan, where the choice of diagnosis predicts a number of interventions applicable for the given diagnosis. The openness of terminologies as infrastructure also demonstrates the challenges when striving for semantic interoperability between heterogeneous work practices, where terminology and work practice shape and are shaped by each-others presence.

7.2   Practical and methodological implications

After having outlined some implications for theory, I find it appropriate to outline some practical and methodological implications concerning the human actor of the socio-technical society, and how the findings of this research could influence future accomplishments in Norwegian healthcare. The

theoretical implications suggest concepts that seek to complete the understanding of information infrastructure in certain areas. The nursing terminologies have been enhanced, given their role as information infrastructure in different dimensions, and there has been a strong focus on work processes and human relations as important to standards. User involvement is a known phenomenon in IS research, see for instance Johannessen and Ellingsen (2008) researching the design, implementation, and use of a single-site product in healthcare. New research on the development of large-scale information infrastructure is based on a dynamic approach, and the STS and CSCW literature (Hanseth and Lundberg, 2001; Pollock et al. 2007) promotes an approach towards standardization consistent with II development. Hanseth and Lundberg (2001) say that in organizations with particularly complex work practices, such as hospitals, the users themselves would be the only ones to know the practice well enough to design a system for the organization, resulting in a bottom-up approach to standardization.

For future practical achievements: The empirical investigation of efforts made in Norway to support the growth of process-oriented EPR systems to secure the continuity of care with focus on the work processes of nurses has great importance for future accomplishments. Thus, the message is that nursing as a profession, nurses' work practice, and the collaboration between staff constitute the most interesting area for investigating process-oriented EPR systems in Norway. This is where data has been categorized to a certain degree, and where terminology standards have been in practical use over time. This reflects that all future accomplishments towards development of process-oriented systems in Norwegian healthcare should be built on experience from investigation of nursing practice.

7.2.1 A contextual view on work processes and clinical research

As described in paper 1, the design and development strategies that manage to adopt to local needs, so that the technical infrastructure is correctly aligned with the human infrastructure, are essential to processes where EPR content is shared between different contexts. This view is problematic for research studies spanning several countries, where data is supposed to be used independent of a given context. Contextual conditions such as these require more granulated and slightly differing data, as well as data that have a higher quality than what is needed in daily clinical work.

It is not entirely clear what an EPR system designed to support research purposes better should look like, what the content should be, and how it simultaneously could support both daily practice and clinical research. One way of doing it, with regard to the content of the EPR, is the presence of many health-related terminologies and classification systems, and structured data which includes archetypes for semantic and technological interoperability. In present time, secondary use of information forces clinicians to obtain this work manually, and some of the differences will never equalize.

The notion of information infrastructure is here supplemented with Orlikowski's notion of collective capability in order to pinpoint the effort that goes into generating research data (Orlikowski 2002). To put focus on the context of interdisciplinary work, the concept of collective capability has been used to describe the work processes that include healthcare personnel and the research staff. In turn, this context and the standards included is an interesting area for doing research on interdisciplinary use of information, secondary use of information, and semantic interoperability. The way nurses and physicians work to obtain information with the quality and grade of standardization for research data is comparable to the amount of manual work needed to obtain what clinical terminologies are integrated to solve when sharing information.

7.2.2   Levels of skilled performance

In her book on the process of developing from a novice to an expert, Patricia Benner (1984) has described how beginners and experts do things differently, and how nurses' competence changes as their clinical career develops. This approach is described as underpinning the role of core personnel in the organization. The theory builds on the Dreyfus model, which illustrates the situational, experience-based premises that differentiate the levels of skilled performance. Learning from theory and from the context-dependent judgement and skills are vital to this. Hughes (1988) has documented how experienced nurses often help inexperienced residents by suggesting the way towards the diagnosis, or by hinting at the necessary treatment.

In all work practices, including hospital departments, there is a differentiation in skills among personnel. For instance, as pinpointed in paper 2, novices enter the work practice with skill in the use of PPS. Based on this, this research has explored how the introduction of a silent handover first made it important to structure nursing documentation by using standardized nursing plans for documentation. In turn, PPS for instance became operative within the standardized nursing plans, which made it possible to enter the procedures from the nursing plan.

The Dreyfus model does not consider the possibility that the novices could be experts in certain areas, such as in the use of PPS, which is interesting in terms of balancing the skills of nurses. In this way, the expert versus novice relation became a bidirectional synergic process, where the novices entered the work practice as skilled PPS users and with additional knowledge that the experts could learn from, which again could balance the novice-expert relation. Hopefully, this restructuring will prove fruitful in the future, building on the novices skills in using IT based tools for standardization of nursing plans and the way interdependency gradually makes them become equals.

8   Conclusion

This thesis has highlighted important initiatives that support the development of process-oriented EPR systems in Norway. This is managed through interpretive case studies, ethnographies with focus on work process-oriented standards in nursing, human relations and collaboration, and secondary use of information. In short, information infrastructure has been used as a theoretical lens to investigate work practices in heterogeneous hospital departments, and with a focus on the technical and semantic interoperability that is needed to obtain continuity of care. The results may be a small step towards process-oriented EPR systems, but they contain theoretical and practical/methodological implications that support and constitute this work using information infrastructure as a theoretical lens.

The main contribution is the empirical investigation of efforts made in Norway to support the growth of process-oriented EPR systems to secure the continuity of patient care with focus on semantic and technological interoperability. The overall message is that nursing as a profession and nurses' work practice constitute the most interesting area for investigating process-oriented EPR systems in Norway. This is the most promising area in healthcare, where data has been categorized to a certain degree and where terminology standards have been in practical use over time to establish semantic interoperability. This reflects that the future accomplishments in the development of process-oriented systems in Norwegian healthcare should be built on experience from investigation of nursing practice.

Secondly, I have pointed out some theoretical implications and considerations with focus on IS, STS, and CSCW concepts and literature that serve to explain changes of information infrastructures when it is exposed to work process-oriented standards. The concepts have further been contextualized in a theoretical and a more practical sense in order to indicate the contribution. Gateways represent a key principle of infrastructure development: the approach conceives gateways as combining a technical solution with a social standard, which both must be integrated into existing communities of practice, and offer flexible pathways for II expansion and navigation (Hanseth, 2001; Edwards et al. 2007). I view the gateway as being political in the constituency of its integrating capability where existing domain-specific terminologies in heterogeneous work practices are interconnected. Sahay et al. (2009) found that the interplay of political interests and technical configuration aspects shaped the integration process, as the stakeholders were associated with different powers of negotiation.

HealthGrid projects show that there is a tension between the technical idea of a stable, interoperable infrastructure for data sharing and reuse and the reality of knowledge as evolving, socially and locally constructed (Ure et al. 2009). The processes that go into sharing of research data are a valuable source of data when it comes to getting a complete understanding of the semantic and technical interoperability. This includes the use of archetypes for information, the HL7 standard for

communicating information, and the terminology standard for a common language. Manual work performed by clinicians and the way information is standardized differently contribute to the understanding of terminology use. I have viewed terminologies, both working terminologies and reference terminologies, as information infrastructure and argue that it gives an opportunity to view the content of the II to a larger degree through the structure of diagnosis and interventions and its unified language. Further, I have pinpointed that this view on infrastructure with focus on work processes is underdeveloped in literature, both in Scandinavia and in the IS society globally.

Finally, I have outlined some implications for practice concerning the human actor of the socio-technical society. User involvement is a known phenomenon in IS research, see for instance Johannessen and Ellingsen (2008) researching the design, implementation, and use of a single-site product in healthcare. Information infrastructure is here supplemented with Orlikowski's notion of collective capability (Orlikowski, 2002) to pinpoint the effort that goes into the generating of research data with focus on the context of interdisciplinary work. I have also explored how technological standards that have followed nurses through their education become an interesting factor in the relation between novices and experts in nursing. The model does not consider the possibility that the novices could be experts in certain areas, such as with the use of PPS, which is outbalancing the relation and making the novices experts in certain areas.

For future accomplishments, the origin of clinical terminology is situated backwards in time; new terms are a constant result of clinical research. Data captured for secondary use, and data that follows the patient trajectory could be aligned to a larger degree. Anyhow, this would call for more focused research on the origin of clinical terms to understand the difference of data used in two different settings. This is also interesting considering semantic occurrences when nursing terminologies has been implemented and used at hospital wards. The way clinical terminology has been changed to fit local work-practice.

The work that includes openEHR archetypes for technical and semantic interoperability in Norwegian healthcare is promising. In present time, vendors use archetypes for getting access to structured data-elements, for obtaining data to quality-registers, and to support clinicians as decision-support. Future research achievements should include a broad focus on the development of archetypes (the clinical view), and to explore how archetypes also can ease the sharing of information between healthcare services.

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Paper I

Paper II

Paper III

Paper IV

Paper V

Required enclosure when requesting that a thesis be considered for a doctoral degree

Declaration describing the independent research contribution of the candidate

In addition to the thesis, there should for each article constituting the thesis be enclosed a declaration describing the independent research contribution of the candidate (problem formulation, method, data collection, analysis, interpretation, writing etc.)

For each article the declaration should be filled in and signed by the candidate, then circulated to the other co-authors for signatures.
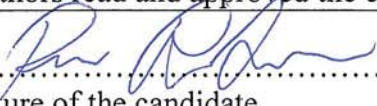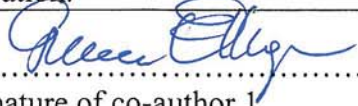

Article no: 1
Authors: Rune Pedersen, Gunnar Ellingsen
Title: The Electronic Patient Record – sufficient quality for clinical research?

The independent contribution of the candidate:

The paper is written in close cooperation with my supervisor which also is the second author. The candidate has done much of the writing, but with frequent guidance with formulation of problems, methods, and analaysis by the second author. The paper is based on a fieldwork, data that was collected by the candidate during the course and based on my former practice as a research associate at the University hospital of Tromsø. Interviews and observations collected by the candidate were supplemented with nine years of working experience. Both the authors read and approved the content before publication.

....	....
Signature of the candidate	Signature of co-author 1
Name (bold letters): **Rune Pedersen**	Name (bold letters): **Gunnar Ellingsen**
Any Comments:	....
	Signature of co-author 2
	Name (bold letters):
	....
	Signature of co-author 3
	Name (bold letters):
	....
	Signature of co-author 4
	Name (bold letters):

Declaration describing the independent research contribution of the candidate

In addition to the thesis, there should for each article constituting the thesis be enclosed a declaration describing the independent research contribution of the candidate (problem formulation, method, data collection, analysis, interpretation, writing etc.)

For each article the declaration should be filled in and signed by the candidate, then circulated to the other co-authors for signatures.
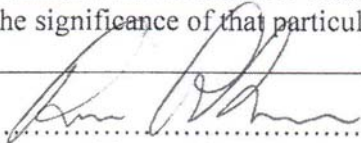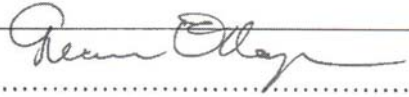

Article no: 2
Authors: Rune Pedersen, Gunnar Ellingsen, Eric Monteiro
Title: The standardized Nurse: Mission Impossible?

The independent contribution of the candidate:

I have done most of the writing with guidance from the second and third author on formulation of problems, methods, and analysis. The introduction and parets of the theory section is written by the second and third author.. The paper is mostly based on a fieldwork, data that was collected by the candidate. All the authors read and approved the content before publication. The third author contributed with a part of the case and a theoretical focus based on the significance of that particular case description.

.... Signature of the candidate Name: **Rune Pedersen**	.... Signature of co-author 1 Name: **Gunnar Ellingsen**
Any Comments:	.... Signature of co-author 2 Name: **Eric Monteiro**
	.... Signature of co-author 3 Name (bold letters):
	.... Signature of co-author 4 Name (bold letters):

Declaration describing the independent research contribution of the candidate

In addition to the thesis, there should for each article constituting the thesis be enclosed a declaration describing the independent research contribution of the candidate (problem formulation, method, data collection, analysis, interpretation, writing etc.)

For each article the declaration should be filled in and signed by the candidate, then circulated to the other co-authors for signatures.

Article no: 3
Authors: Rune Pedersen
Title: Standardization strategies in healthcare practices?

The independent contribution of the candidate:

In this article the candidate performed the entire process. The candidate have coordinated the process, carried out the data collection, and done the writing which included the formulation of problems, methods, theory, and analysis.

.... Signature of the candidate Name: **Rune Pedersen**	.... Signature of co-author 1 Name (bold letters):
Any Comments:	.... Signature of co-author 2 Name (bold letters):
	.... Signature of co-author 3 Name (bold letters):
	.... Signature of co-author 4 Name (bold letters):

Declaration describing the independent research contribution of the candidate

In addition to the thesis, there should for each article constituting the thesis be enclosed a declaration describing the independent research contribution of the candidate (problem formulation, method, data collection, analysis, interpretation, writing etc.)

For each article the declaration should be filled in and signed by the candidate, then circulated to the other co-authors for signatures.

Article no: 4
Authors: Rune Pedersen
Title: Standardizing work in healthcare through architecture, routines and technologies.

The independent contribution of the candidate:

In this article the candidate performed the entire process. The candidate have coordinated the process, carried out the data collection, and done the writing which included the formulation of problems, methods, theory, and analysis.

.... Signature of the candidate	.... Signature of co-author 1
Name: **Rune Pedersen**	Name (bold letters):
Any Comments:	.... Signature of co-author 2
	Name (bold letters):
	.... Signature of co-author 3
	Name (bold letters):
	.... Signature of co-author 4
	Name (bold letters):

Declaration describing the independent research contribution of the candidate

In addition to the thesis, there should for each article constituting the thesis be enclosed a declaration describing the independent research contribution of the candidate
(problem formulation, method, data collection, analysis, interpretation, writing etc.)

For each article the declaration should be filled in and signed by the candidate, then circulated to the other co-authors for signatures.

Article no: 5
Authors: Rune Pedersen, Torbjørg Meum, Gunnar Ellingsen
Title: Nursing terminologies as evolving large-scale information infrastructures

The independent contribution of the candidate:

As the first author I have been participating in all the sections of the paper. The first and the second author have done most of the writing together with guidance from the third author on formulation of problems, methods, and analysis. The candidate brought a former version of the paper to the cooperation process. All the authors read and approved the content before publication. The third author my supervisor has primarily been guiding us through the writing process, being a discussant particularly due to theoretical implications, and contributed to parts of the theory section and introduction.

Signature of the candidate	Signature of co-author 1
Name: **Rune Pedersen**	Name: **Torbjørg Meum**
Any Comments:	Signature of co-author 2
	Name: **Gunnar Ellingsen**
	Signature of co-author 3
	Name (bold letters):
	Signature of co-author 4
	Name (bold letters):