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Nursing Terminologies as Evolving Large-Scale Information Infrastructures

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Abstract. This paper describes the slowly evolving nature of large-scale terminology-based information infrastructures. The strategic aim of implementing standardized terminologies is to share and compare information within and across domain-specific and organizational boundaries. We are 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. We examine this empirically through a threefold case based on data from three Norwegian university hospitals, where we also track a national recommendation of a reference terminology. The reference terminology, which was initially promoted as a means to achieve integration and harmonization, is increasingly perceived as competing with other terminologies. This "gateway" has been presented as a purely technical and politically neutral system, but may be more complex in reality: such integration processes require considerable adaptations, negotiations, and manual maintenance.

Key words: Nursing terminologies, classification systems, electronic patient records, information infrastructure, integration, reference terminologies, standardization.

1 Introduction

Standardization is the backbone of Western healthcare infrastructures and is intended to ensure quality of care through best practices and increased efficiency as well as to ensure seamless care across different practices (Timmermanns and Berg 2003; Hanseth et al. 2006; Ellingsen et al. 2007; Bowker and Star 1999).

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The increased focus on seamless care across different healthcare organizations also presupposes standardization in the form of shared terminologies such as International Classification of Diseases (ICD), Systematized Nomenclature of Medicine—Clinical Terms (SNOMED-CT), and International Classification for Nursing Practice (ICNP) (Wade and Rosenbloom 2009; Dykes et al. 2009, Hardiker et al. 2000).

While some terminologies focus on specific domains or practices (Bulechek et al. 2008; Dykes et al. 2009), others span professional, organizational or national boundaries. 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. Because of the gradual modernization and transformation of Western healthcare systems, the existing standards are under scrutiny. An illustration is the recent criticism that the nursing terminology systems North American Nursing Diagnosis Association (NANDA) (NANDA-1 2007) and nursing intervention classification (NIC) (Bulechek et al. 2008) are unable to meet the need for more streamlined collaboration between hospitals and primary care.

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 and ICNP are examples of such terminologies. 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. We believe that such processes are much more complex and that they are infused with politics, as suggested by comparable socio-technical studies (Bowker and Star 1999; Sahay et al. 2009; Timmermans and Berg 1997).

We examine this further through a longitudinal empirical study from Norway, where nurses in hospitals have been using the international terminology systems NANDA and NIC for a decade as a way to ensure consistency in nursing documentation. Recently, the Norwegian Nursing Association (NNA) decided to recommend the implementation of the reference terminology ICNP to support integration across existing different terminology systems, including NANDA and NIC. However, through our empirical study, we learned that such a process is far from straightforward. We trace key events throughout the last decade and aim to respond 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?

Specifically, we address the following themes: First, we discuss the prolonged organizational complexity of establishing a terminology system in practice and we emphasize the work and socio-technical transformation involved in this. Second, we discuss the reference terminology's role as a mapping device and pinpoint the implicated resources associated with the actual integration between existing different terminology systems. Third, we challenge the assertion that reference terminologies have a politically neutral role (Bowker and Star 1999). In this connection, we

elaborate on how a reference terminology is promoted to the nursing field, how it is received among the stakeholders, and how its role is not fixed, but is transformed throughout the process.

Conceptually, we draw on a particular branch of the IS field, namely information infrastructures, which offers 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 our case the technological components are the involved terminology systems. Because of the limited extent to which standardised terminologies have been applied as an empirical case for studying information infrastructures, we also aim to contribute with insights on infrastructures from this angle.

2 Theory

Standardization related to healthcare-based information systems takes many forms. From a purely technical perspective, standardization enables smooth integration of various information systems through standards such as EDIFACT or HL7 (Kalra 2006, p. 136). Other standards are implemented to ensure that patients get treatment and care based on best practice, which in turn requires standardization of work and routines (Timmermanns and Berg 1997; Ellingsen et al. 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. 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.

However, in recent years many Western countries have 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). 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 patients 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.

However, although terminology standards are used on a daily basis in healthcare 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.

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 strikingly few studies focus on the emergence of large-scale terminology systems—the primary technological component in our study. However, see Bowker and Star (1999) on the development of the ICD.

An information infrastructure typically is a large-collection of interdependent systems and technologies that are embedded in various organisational practices. Accordingly, for these kinds of studies it is not purposeful to focus on just one information system, one singular context in 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.

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, that is, where the technical issues always seen in relationship to practice. Hence the key question is "when—not what— is an infrastructure" (Star and Ruhleder 1996).

During a progression of an information infrastructure in any given context, the existing portfolio of information systems—the installed base—may become very large and will shape its environment to an increasing degree. Similarly, the size and complexity of the installed base mean that it becomes difficult to replace or change. In relation to large-scale terminology systems (i.e., the information infrastructure in our case), this is of particular concern, as these need 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 recognised with on-going negotiation and compromises in order to achieve stability or alignment (Latour 1987).

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). Gateways may both be a piece of technology or a social arrangement that serve the purpose of interconnecting different infrastructures. Hanseth and Lyytinen (2010, p. 7) provide an example of a gateway as an "IT capability, which supports multiple e-mail services running on different e-mail protocols". Edwards (2007) illustrates the gateway concept through the use of Google Scholar:

> "Google Scholar (...) 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 joined to an existing framework easily and with minimal constraint. Gateways are often wrongly understood as 'technologies,' i.e., hardware or software alone. A more accurate approach conceives them as combining a technical solution with a social choice, i.e., a standard, both of which must be integrated into existing users' communities of practice. Because of this, gateways rarely perform perfectly. These offer flexible pathways for II expansion and navigation (Hanseth 2001; Edwards et al. 2007). An example of a gateway would be an IT capability, which supports multiple e-mail services running on different e-mail protocols. By introducing gateways for joining different information infrastructures, these infrastructures are expected to reside side by side without complex mutual alignment processes.

In this context, we may see the reference terminology ICNP as an instance of a gateway where existing domain-specific terminologies in heterogeneous practices can remain intact while the ICNP provides the mapping between them. Therefore, a reference terminology is not expected to generate enormous conversion costs. Instead, one may continue to use two different terminologies, for example, NANDA (hospitals) and Sabaclass (primary care), and use the reference terminology ICNP as a mapping device between the two.

Despite the positive connotations of the gateway concept, we are not convinced that it fully addresses the practical complexities that are involved in the establishment of fully integrated information infrastructures. We are more inclined to believe that interconnecting different but well-functioning infrastructures may require considerable adaptations, negotiations and manual maintenance work (D'Adderio 2008; Pollock 2005).

Consequently, this challenges the concept of neutral and harmonized interaction associated with gateways for the interconnection of different information infrastructures. The danger is that the users involved are not taken into account in the strategic decisions because *the different practices are supposed to remain stable per se*. 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). This will also be the case with technology/terminologies serving as gateways. 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 Norwegian healthcare, Hanseth et al. (1996) emphasized that behind a 'neutral' technology, different political interests were played out by the participants involved. 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 healthcare, 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.

3 Method

This article concerns the adoption of a common reference terminology for nursing in Norway. The data collected have three major focus areas that include three hospitals and people that were important in the recommendation process. We used mixed methods, including semi-structured and open-ended interviews, observations, document analysis, and reading of central log documents. First, we have data from two participants from the board of recommendation. These included representatives from the Norwegian Directorate of Health, which had the overarching authority in the process. The NNA had the executive role, and headed the board. Second, we have collected a report from Rikshospitalet (Oslo University Hospital) that cover a similar ICNP adoption process, with data from three different care settings. Third, we have a project report from the Norwegian Centre for Informatics in Health and Social Care (KITH), which contributes to coordinated and cost-efficient application of information technology in the health and social care sector with a focus on codes and terminology. We have data from the vendor behind the integration of NIC and NANDA in existing systems for electronic patient records (EPR), and from regional spanning user groups.

3.1 Research approach

The importance of social issues related to computer-based information systems has increasingly been recognized over the last decade, and this has led IS researchers to adopt empirical approaches that focus on human interpretations and meanings (Walsham 1995). Interpretive research can help the IS researcher to understand human thought and action in social and organizational contexts (Klein and Myers 1999). Orlikowski and Baroudi (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 through accessing the meanings participants assign to them. The essential objective is not to identify causes of behaviour, but rather the meanings people assign to actions and events (Walsham 1995). The interpretive research approach denies the existence of an objective reality that can be discovered by researchers and replicated by others (Klein and Myers 1999). Our study adheres to an interpretive research tradition of this nature. Interviews, observations, document analysis, and reading of central logs at different locations have focused on the key actors in the work with bringing forward classification as a way to standardize documentation for nurses. Qualitative research techniques can provide deep insight, and can both identify problems and answer the 'why' and 'how' questions that quantitative studies cannot answer (Ash et al. 2004). We are further inspired by ethnography, and largely on participant observations for the cases at three different hospital wards where observations and interviews were carried out simultaneously (Fettermann 1998). An ethnographer typically assumes inconsistency between what people say they do, and what they actually do, on the basis that people act according to formal rules or standards, or because aspects of activities have become invisible even to themselves. Participant observation and documentary sources used in combination with interviews enable the fieldworker to investigate these relationships (Forsythe 1999).

3.2 Data collection

We used four 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. Data were collected from four different sources: Akershus University Hospital (AHUS); University Hospital of North Norway (UNN); Hospital of Southern Norway (SSHF); recommendation process for a new standard in nursing (see Table 1). Access to the data sources was gained through the vendor of the EPR, where the third author previously conducted research, and by introducing ourselves by telephone and email as researchers interested in the recommendation process. The first and second authors were mainly responsible for data collection, while analysis of data was a collaborative process between all authors.

	AHUS	*UNN*	*SSHF*	*Recommendation process*
Semi-structured interviews	10	19	6	8
Duration of interviews	60–90 minutes	60–90 minutes	30-90 minutes	60–140 minutes
Observations	206 hours	200 hours	140 hours	
Time period	2009–2011	2008–2010	2010	2009

Table 1. An overview of our empirical sources.

The first part of data collection was carried out at three different hospital departments, where the first author was responsible for data collection at AHUS and the second author for data collection at UNN and SSHF. In all cases, the interviewees were nurses and were primarily selected based on work experience at the ward as well as experience with the use of EPR. We aimed to get a mixed group of participants, both in terms of age and experience, to gain insight into several aspects and user stories.

Typically, an interview guide was used as an issued checklist that required more elaboration. However, the questions were open-ended to encourage the interviewees to explain and elaborate using their own words. Moreover, all interviews were carried out in the interviewee's working environment and often close to a computer so that they could show and explain how they used the system.

Participant observation was another important data source that was used in addition to interviews. The focus of the observation study was on how nurses communicate and coordinate work tasks. We mainly shadowed nurses during day and evening shifts with special attention to how they used the electronic care plan, including standardized terminologies, in interdisciplinary meetings, handover meetings and documentation of clinical work. In addition, we have had access to anonymized log data from the EPR system, which show the frequency of use of NANDA and NIC, and how the use of classifications brings meaning to local practice.

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The next part of the fieldwork was the process of recommending a new standard in nursing. This part of data collection included interviews, official documents and reports. For example, national and professional visions and guidelines have provided us with historical insights into the standardization process. The interviews were conducted shortly after the recommendation from the NNA was published where we interviewed key personnel who had practical influence in the process of developing a common national terminology. Our strategy was to interview considerable numbers of people as soon as possible after the recommendation, in order to obtain first impressions and evolving thoughts about the process. We have interviewed participants from the Terminology Board (2 participants), key representatives from the government (2), a large user group (1), , the vendor (1), and a representative of the publisher of NANDA and NIC in Norway (1), all semi- structured and as described in table 1 under the label "Recommendation process". In general, all the interviewees had significant roles in either the recommendation or as initiators for the use of NIC and NANDA in Norway. The first and the second author conducted five of the interviews together, dividing the last three between them.

During the fieldwork, researchers have made analytical notes, which have been systematized in categories (for instance on different opinions on the usability of NANDA versus ICNP in healthcare) and transcribed. Further, all interviews were audio-recorded and subsequently transcribed. Along with reports from the EPR system and official documents, field notes and transcribed data from interviews formed the basis for the case description and further analysis. The interviewees were informed about the further process, the transcription of audio-recorded data, and their possibility to read the transcribed content. One of the interviewees chose to read the transcript and make some clarifications.

3.3 Data analysis

Data collection and analysis have 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). We have aimed to obtain a historical and contextual understanding of the use of standardized terminologies in nursing, which in turn are used to gain rich insight into the process of recommending a new standard.

The analysis has been carried out in two stages. The first was the analysis of data from the various care settings that were collected separately by the first and second authors. The next step was analysing the historical development of the use of standardized terminologies in Norway. In addition to interview data from key personnel, we used official reports 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 were discussed, leading to further focus in the next interview, and so on. Subsequently, data from the three care settings were analysed in relation to the historical development of nursing terminologies. The analysis was a process back and forth between the different cases in order to gain a better understanding of the whole progress. 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 are often taken for granted (Forsythe 1999).

Our previous knowledge of information infrastructures and standardization as well as our previous experience was the starting point of the analysis. The study is also part of a longitudinal research project on the use of electronic documentation in nursing based on field-data collected by the third author in a period 2003-2005. In addition, two of the authors have experience as nurses, 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 bias, but are the necessary starting point of our understanding (Klein and Myers 1999, p. 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.

Throughout the study, 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 were considered in terms of their sensitivity for possible bias (Klein and Myers 1999).

4 Case

4.1 Setting the stage

We will now describe the historical development, adoption and diffusion of standardized nursing terminology (i.e., NANDA and NIC) in Norway. We then illustrate the use of these terminologies at three different care settings. Finally, we describe the decision-making process towards the recommendation of the ICNP as a reference terminology in the Norwegian nursing community. Key milestones are presented in Table 2.

4.2 Implementing NIC and NANDA in Norwegian hospitals (2001-2005)

In line with increased international and national attention to the use of standards as a means to achieve seamless integration in EPR, the design and development of a nursing module started in Norway in 2001. This was a collaborative effort between the NNA, DIPS ASA, which is the largest vendor of EPR systems in Norway, and users at a hospital ward. It was primarily impor-

1998	NNA translates the alpha version of ICNP
2001	NNA translates the beta version of ICNP The drafting committee behind NANDA and NIC is formed, comprising DIPS ASA (EPR vendor), Diakonhjemmet Hospital, the University College in Oslo, and later the NNA Translation of NANDA and NIC. Cooperation between NNA and DIPS ASA
February 2002 - June 2003	Pilot project at Diakonhjemmet Hospital, and Førde Hospital, care plans and NANDA and NIC
Early 2005	Publication of the first translated version of NANDA and NIC directed by DIPS ASA
November 2005	DIPS ASA withdraws from the drafting committee. NNA undertakes the responsibility for NANDA and NIC
2005	Implementation of the nursing plan, including the use of NANDA and NIC in Norwegian hospitals
2007	NNA starts translating the 1.0 version of ICNP The translated version of NIC is published
2008	The Terminology Board is established
2009	NNA recommend ICNP version 1.0 and 1.1 and newer versions as a nationally agreed terminology.
2009 - 2010	DIPS ASA and the collaboration user group continue to work on NANDA and NIC

Table 2. Key milestones related to the spread of nursing classifications in Norwegian hospitals

tant for the NNA that nursing care was reflected in the nursing module and was in accordance with professional and political requirements for documentation in the EPR.

> "The information in the EPR must be structured and standardized to a larger extent than in paper-based solution in order to utilize the potential benefits of technology for information management. Terminology, classifications and codes are means to standardize the information and contribute to quality assurance of statistics, documentation, financing, and electronic interaction" (NNA, p. 34, 2002)

For the vendor, the nursing module represented an extension of the EPR portfolio, because nurses constituted a major user group that produced and used a large amount of information and documentation in everyday work. Based on initial collaboration between NNA, the University College of Oslo, and DIPS ASA, it was decided to proceed with a pilot testing of the international terminologies NANDA and NIC. A nursing consultant from the vendor recalls:

> "We chose to adopt NIC and NANDA because they were superior in global coverage at that time and scientifically they had shown to be more usable in practical work".

At that time, NANDA had 178 nursing diagnoses and patient conditions, with characteristics and definitions. Currently there are 206 NANDA diagnoses (NANDA-1 2007). Established in the early 1970s by NANDA international, the classification system brought about a major change in the nursing profession by establishing nursing-specific diagnoses. 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 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). 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 intervention codes for the patients involved. Such a nursing module is typically part of a larger EPR system.

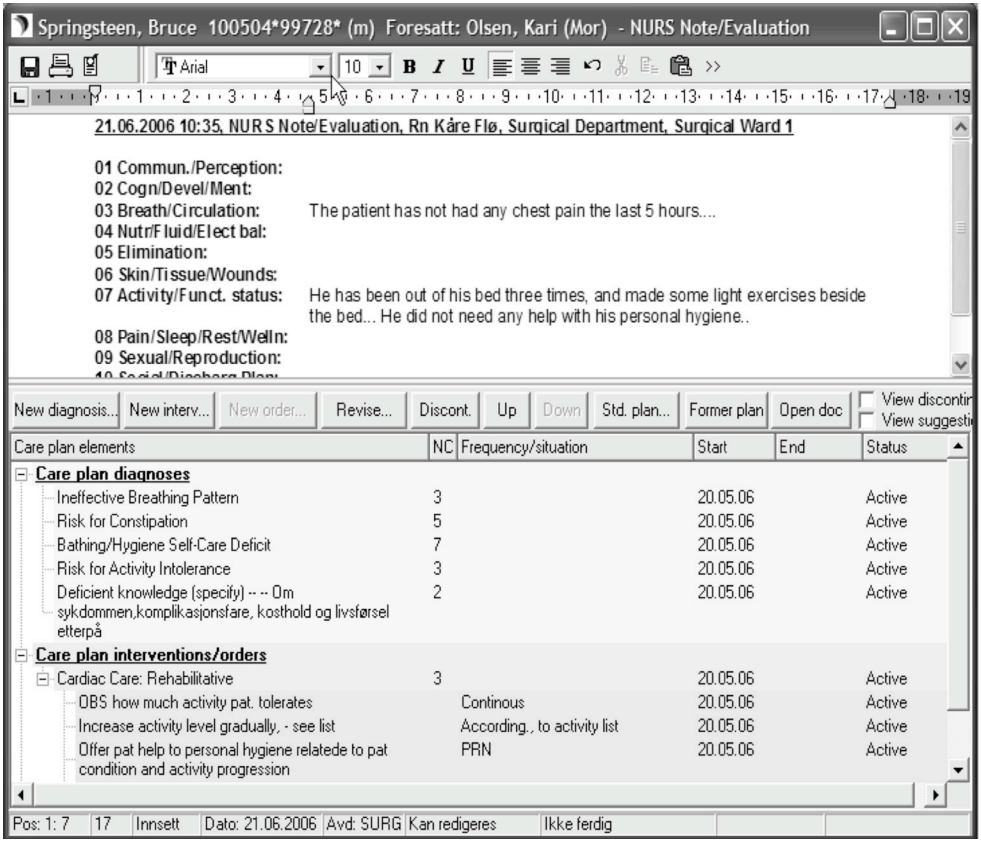

Figure 1. The nursing plan contains an overview of nurse-related diagnoses (Care plan diagnosis) for a particular patient group combined with associated interventions (Care plan interventions/orders).

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A pilot project started in 2001, where the initial goal was to investigate the usefulness of NANDA/NIC classifications in daily nursing work as compared with free text. The hospitals selected for the pilot programme, Diakonhjemmet and Førde Hospital, were drawn from the on-going implementation of the DIPS EPR and the new content of the nursing module was offered to several of the new users. After piloting the system for over a year, the NNA concluded that the trials with NIC and NANDA showed promising results and that future use should be monitored in order to gain knowledge about usability for nationwide implementation. Similarly, the vendor regarded the pilot as successful, and a nursing module that included NIC and NANDA was offered to hospitals on a commercial basis. The implementation started with the pilot projects in 2003, and escalated in terms of both the number of health regions and hospitals involved and the number of standards adopted in the following years.

Development and maintenance of NANDA and NIC is a collaborative process within the international nursing community. Classifications of NANDA build on evidence-based practice and are updated every second year through the submission of new concepts that are reviewed, verified, and presented at the NANDA International Conference and published by the NANDA International organization. In these forums, Norwegian key personnel have also contributed to the development of NANDA at top international levels. One of the employees at Oslo University College has been a member of the NANDA International board for several years, and has participated regularly in the NANDA meeting activities in the United States. In this way, the employee has served as a link between the global NANDA organization and the local Norwegian setting.

The latest version from the year 2009 contains 206 diagnoses, of which nine are revised from the previous edition from 2007. Similarly, the NIC classification system is continuously updated with 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 (Bulechec et al. 2008).

As mentioned earlier, NANDA and NIC were translated into Norwegian in 2001 as a joint project between the vendor and the NNA. Since then, the responsibility for translation has been left to the Akribe publishing house, which is owned by the NNA. So far there has been one Norwegian release of NANDA in 2003 and NIC in 2006, both in book editions as well as electronic versions for use in EPR systems. Moreover, the use and updating of classifications in the EPR system is governed by licence agreements that are organized by the vendor and paid for by each user hospital. For the hospitals, the licence costs are substantial and are currently estimated at approximately 400 thousand Norwegian kroner.

4.3 Some use experiences of NANDA/NIC from three hospitals (2005-2011)

Since the Norwegian release of NANDA and NIC in 2003, several hospitals have implemented classifications as an integral part of the nursing module. Implementation and adoption have taken place in local nursing communities, embedded in strategies at hospitals to integrate nursing documentation in the EPR as well as regional and national cooperation to enhance diffusion of structured documentation in nursing.

At the psychogeriatric ward at the University Hospital of Northern Norway, the motivation for implementing NANDA/NIC was based on the need to improve the content and language of nursing documentation. The management of the ward regarded the use of classifications and electronic care plans as a means to provide a language for describing both planned and performed care in their everyday work practice. As a strategy for the implementation at the ward, it was decided that using terminologies would be mandatory to give the users the opportunity to become familiar with the use of NANDA and NIC. Despite some initial scepticism and reluctance, experiences during the first year showed that the care plans were used in daily practice and that classifications were used extensively. During this period, nursing documentation had become a central part of the interaction among the staff, as is illustrated by a quote from a nurse:

"It is great to use the care plan as a basis for discussing the individual patient."

The continuous focus on classifications and care plans involved an increased awareness of the language used in nursing documentation. However, in line with increased knowledge of classifications, they also experienced limitations and shortcomings of NANDA and NIC in the context of local practice and needs. In cooperation with each other, they gradually began to develop their own terms to compensate for shortcomings in the system. They used NANDA and NIC for support, but if they did not find appropriate terms, they started to choose their own concepts, as illustrated in the quote below.

> "I think it is okay to work with classifications because it is easier to change something that already exists than to reinvent the wheel. If I find a classification that does not completely fit the situation of the patient, it is still easy to use the classification as a starting point. " (Nurse)

Increasingly, key users experienced a growing use of local terms instead of, or as a supplement to NANDA. An internal evaluation confirmed this trend. For further identification of the terms that were used instead of NANDA, 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 (see Meum et al. 2011). For example, there is a NANDA diagnosis called "Imbalance Nutrition: Less than body requirements". This is an example of a quite broad diagnosis and they have become more familiar to using "Impaired appetite". Another example is how they make adjustments to maintain correlation between diagnoses and interventions in the care plan. For example, there is a NIC classification called "Wound Care". A corresponding NANDA diagnosis is "Impaired Skin Integrity". However, the term "Wound" is often used because it is more specific and facilitates a link to the NIC classification. Eventually, the most commonly local terms have been made available in the electronic care plan, that is, become local standards as a supplement to NANDA. This illustrates how some adaptation and localization of NANDA and NIC has been deeply embedded in practice.

While some wards, such as the psychogeriatric ward at the University Hospital of Northern Norway, have had strong local anchoring in implementing NANDA/NIC, other hospitals have pursued a more strategic management-oriented approach. Several hospitals in Norway have had a general plan for the implementation of classifications and electronic care plans. Most

hospitals in Norway use the same EPR vendor and thus the same nursing module. For example, AHUS and SSHF have each had an in-house strategy based on preparing standard care plans, to facilitate the use of care plans and classifications. The implementations at these hospitals were organized in groups of super users representing different departments and specialities. The various super user groups were responsible for preparing standard care plans within their area of expertise. Key users in each group developed standard plans for the most common illness trajectories. These plans were authorized by the professional leadership and made available in the electronic nursing module. A number of plans were developed by and for each specialty. For example, the cardiology ward at AHUS developed a standard plan called "Angina Pectoris", listing the most common nursing diagnoses and interventions for anxiety, insufficient knowledge about the disease, and acute pain. Overall, the cardiology ward has made 17 standard plans and a total of 406 for the entire hospital. Clicking on the menu option "standard plan" in the action bar displayed a list of all the standard plans prepared by the hospital. It was thus easy to choose a relevant plan and select a predefined nursing diagnosis and intervention (Figure 2). Thus, NANDA and NIC have been adapted to the local context and have become embedded in the nursing documentation at these hospitals.

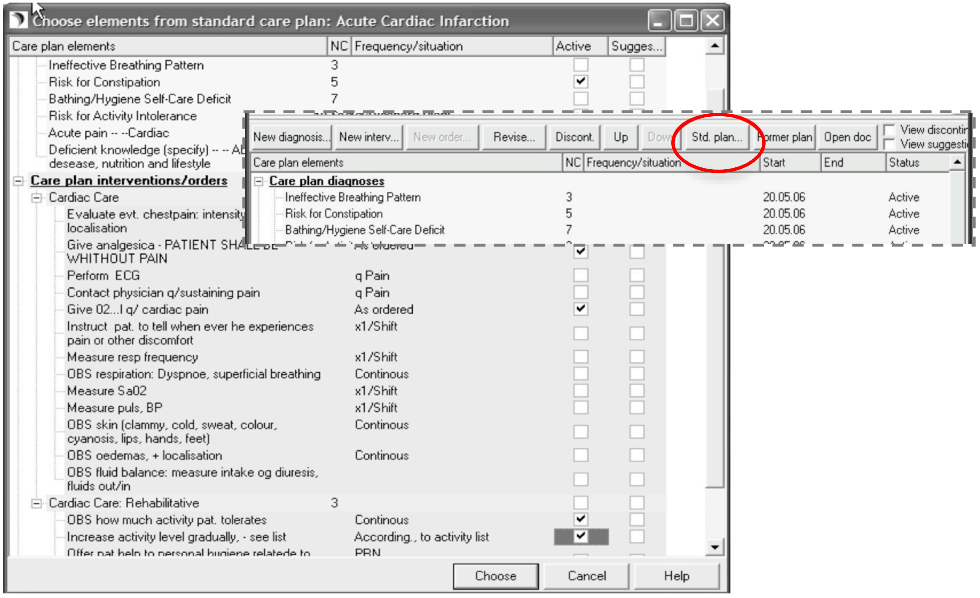

Figure 2. The ordinary care plan to the left and the standardized plan to the right.

The initiative to prepare standardized care plans came from a board of experts appointed by the management at AHUS to enable shared use of terms in nursing practice and to facilitate the use of care plans in daily practice. Nursing specialists from different clinical specialities were engaged to create the content of the standardized plans, especially which NIC interventions matched each NANDA diagnosis. The plans are in continuous development, which is governed

by selected nurses. Moreover, updating and further development of the standardized plans is a continuous process maintained by super-users within domain-specific areas (for example cardiology, neurology and so on. The standardized care plan is extensively used in this department. Patients staying for more than 24 hours typically have a care plan, which is often standardized. Figure 2 illustrates both the ordinary and the standardized plan.

Similarly, the surgical ward at SSHF mainly uses standard plans. Consequently, NANDA and NIC are widely used as an embedded part of these guidelines. A frequency report from the EPR system showed that NANDA and NIC accounted for approximately 97% of all nursing diagnoses and interventions used in the care plans in 2009 and 2010.

With increasing use of NIC and NANDA in Norwegian healthcare, a pressing need arose to establish larger user groups on regional levels to coordinate common efforts, both to serve as quality assurance and to increase the efficiency of hospital work. To accomplish this, a large Norwegian health region, the South-Eastern region, established the Electronic Documentation in Hospitals (EDS) group. In this way, local initiatives were integrated with those on a regional level. The EDS hospitals have appointed representatives to put forward and support the needs of their own users, with a common goal of developing relevant solutions for the region. Common to these hospitals is a consistent and well-organized use of care plans. The cooperation includes a well-organized initiative to create common standardized care plans.

In general, the deployment and use of care plans, and different approaches to standardizing nursing documentation by applying NIC and NANDA, are still growing in Norway. The vendor estimates that 50 % of all the nurses in secondary healthcare now use NIC and NANDA, which amounts to approximately 25,000 users of their nursing module nation-wide. Regarding the use of standardized plans, general numbers derived from the local IT department covering all clinical departments at AHUS clearly indicate a relatively stable use of standardized plans. A cross-section of the numbers indicates that some 30 % of the patients at the hospital have standardized plans.

4.4 Interconnecting different information infrastructures - towards ICNP (2008 - >)

Although NANDA/NIC was widely introduced in hospitals in the period from 2005-2010, there were increasing concerns in NNA that these terminologies could not address all the challenges facing the healthcare system. The Norwegian Directorate of Health had recently requested more process-oriented systems that could follow the patient between the different layers of healthcare (Samspill 2.0 2008) where different terminologies were in use (for instance, Sabaclass in primary care). There was also a pressing need to integrate nursing terminologies with other terminologies in various EPR modules, most notably SNOMED-CT, an essential part of the medical chart. The medical chart contains information about clinical parameters such as blood pressure, medication, fluid balance and various medical procedures, which is also very important for nursing practice.

NANDA/NIC appeared to lack these integrative capabilities, while ICNP was considered more flexible in this regard (KITH 2009, p. 41). KITH reported that ICNP could be used to

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integrate nursing-specific information with SNOMED-CT. The KITH report concluded that the only nursing terminology system able to connect to clinical variables was ICNP.

ICNP has been developed by the International Council of Nursing (ICN) in 133 nursing organizations worldwide, and the beta version has been translated into 20 languages. 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 (ICD-10). 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, 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. In comparison, NANDA has two possibilities to describe "pain": acute or chronic. This must be specified further by using free text in three dimensions (etiological, problem, and symptoms).

The translation of ICNP version 1.0 started early in 2007. Since then, NNA has started translating the newest versions of ICNP, which have standardized sentences in catalogues that are divided between clinical specialities. This ICNP version is comparable to the standardized plans prepared using NIC and NANDA. Initial components, consisting of coded words subjected to the catalogues of the seven-axis system, and the new version of ICNP is available electronically. ICN has further developed a translation tool for several languages, including Norwegian, that eases the translation process, but the software required for practical use is still unavailable in Norway.

In 2008, the Directorate of Health commissioned NNA to outline a strategy for the use of nursing terminologies in Norway. Based on this, the NNA established a terminology board, which was given the operational assignment. Given that nursing is embedded in all levels in the healthcare domain, the selection of participants for the board had to be comprehensive, as a NNA special consultant recalls:

> "Putting together the Terminology Board took much time, and it was very exciting work to find the right persons to attend. We were very engaged in finding participants from all regions, from university colleges, universities, municipalities and hospitals. So, this was a

real puzzle! We ended up with ten people and one observer from the Norwegian Centre for Informatics in Health and Social Care (KITH) "

In this regard, representatives from the EDS group and the EPR vendor were omitted from participation in the board, as such participation was considered to bias the work in the board.

In 2009, the Terminology Board recommended implementation of ICNP in nursing practice, particularly given its key role as a reference terminology. However, there were also other arguments in play related to how well ICNP could describe the problems for the individual patient and how well it would function in particular domains:

"Theoretically, NANDA is very static, it is not able to change anything, and it is not possible to put "risk" in front of NANDA. You can for instance insert free text in front of NANDA, but you cannot code it, or expand the code. In contrast you have an opportunity to do this with ICNP using the seven axis model (…) this really represents individuality of the patient (…) I also consider NIC and NANDA as very hospital-oriented (Director of the board of recommendation)."

In this process, the board chose to compare different terminologies, which included ICNP among others, SNOMED-CT, NIC, and NANDA:

Terminology	*ICNP*	*SNOMED-CT*	*NIC*	*NANDA*
Score	31	28	13	9

Table 3: The criteria listed from 1-9: 1. Complete coverage. 2. Possibility for further development, participation, and ownership. 3. Patient involvement. 4. Synonyms. 5. Syntax and grammar. 6. Unique codes. 7. Definitions. 8. Unique identifiers. 9. Hierarchies and inheritance.

The criteria used are drawn from a former known model that is used in scientific work to compare the usability of different terminologies (Bakken et al. 1998). Based on this, as seen in Table I, ICNP scored highest, and was therefore chosen. The newsletter in February 2009 was distributed in the Norwegian healthcare sector by the NNA. The conclusion was based on the abilities to achieve a common language, data comparison functions, improved research, and better communication. In terms of the criteria, both NIC and NANDA have been compared with ICNP and SNOMED-CT; see Table 1. Since "complete coverage" was the only important criterion, the NIC and NANDA stakeholders and users had problems in understanding the meaning of the comparison.

"My point regarding the criteria used is that they should differ between the recommendation of a reference terminology and one practical applicable terminology as NANDA/NIC for making care plans in an EPR system. When they chose criteria for reference terminologies, ICNP will automatically be the highest ranked. (Vendor consultant)"

There have been increasing concerns among the stakeholders currently involved in NANDA and NIC, such as the user groups, the vendor, and the initiators of NIC/NANDA. Statements collected throughout our field experience indicated that the recommendation (from a NIC/NANDA user perspective) was not based on knowledge about how NIC/NANDA was used in practice, but on theoretical assumptions and direct theoretical comparison between the terminologies.

Further, and in the same line of thought, the user community questioned the ability to extract statistical data from ICNP on the number of concepts used at one ward over a given period. The issue that created most of the tension was whether the translation of NIC/NANDA would be supported by the NNA in the future. It became clear that the publishing house Akribe and the NNA would not use more resources on the translation. As one of the leaders of a large user group said:

> "When we got the final conclusion from the NNA, that NIC/NANDA would not be maintained (no new translations) because of the costs related to it, it became even more confusing what would happened to NIC/NANDA in the future? Do we start all over again or is the focus on mapping? (Leader, EDS group)."

Another major concern was that the latest version of ICNP was never seen in practical use at the time of the recommendation. Even if the Terminology board argued that promising results had been produced from projects in several European countries, the vendor was reluctant to integrate ICNP into their EPR, or how and for what costs. The vendor for their part argued that there was a lack of practical knowledge about ICNP as well as a lack of knowledge on how to create sensible sentences out of the seven-axis system. A further criticism was that "sentences" that included a significant number of codes without any definition of what they denoted were almost impossible to use in clinical reasoning.

> "The system for putting together codes from the focus axis and the assessment axis to formulate nursing diagnosis are pictured too randomly. My point is that far more complex rules must be developed to avoid the generation of meaningless concepts (University College teacher). "

Hence, according to the users, the problem with pre-defined sentences will be the same with ICNP as with NIC and NANDA.

This is partly supported by a statement from the director of the board:

> "There is good decision support in NANDA with titles and a definition, and you have all the relevant characteristics that the diagnoses are related to"

5 Discussion

We have structured our discussion as follows: First, we present the slowly evolving character of large-scale terminology-based information infrastructures. Second, we discuss the challenges of integrating different infrastructures that are continuously changing. Third, we discuss how

a gateway (in information infrastructure terms) transforms from a relatively neutral mapping device into a system that presents itself as a competitor to the existing systems.

5.1 The slowly evolving process of establishing an information infrastructure

A national, large-scale ICT system is never built all at once, but is a slow, evolving process that is founded among different actors and user groups. Some of the key issues in our case study are the evolving nature of classifications and the mutual interrelation between technical and social elements. Adoption and use of standardized terminologies are not just a "plug and play" solution, but a dynamic interplay between technological components, humans, organizations, institutions, and so on (Hanseth 2001). Similar studies have pointed out the challenges of implementing large-scale information systems (Rolland and Monteiro 2002; Hanseth et al. 2010; Aanestad et al. 2011) and the co-constructive capability of standardization (Timmermanns et al. 1997; Ellingsen et al. 2007). Yet very few have taken a longitudinal approach and illustrated the 'cultivation' of classification systems empirically.

A strategic aim of adopting standardized terminologies is sharing and comparing information within and across domain-specific and organizational boundaries (Coenen et al. 2001). However, as our empirical data show, this is not just a technical and static accomplishment. It is rather an on-going process of change, constituted in the dynamic interrelation between new technologies and local, highly professional work practice. In spite of different approaches to the use of NANDA and NIC in the three different care settings, our empirical data demonstrate how NANDA and NIC affect and are affected by local knowledge and practice (Wears et al. 2005).

At the psychogeriatric ward at UNN, implementation of NANDA and NIC was triggered by local motivation to enable more accurate and consistent documentation of planned and performed nursing. Overall, the users at the ward experienced improved documentation of nursing after implementation of the new system. The use of terminologies enabled a more consistent and shared language for describing nursing and for supporting coordination of the care process among the care team. To a growing extent, however, the nursing diagnoses were not selected from the NANDA list in the system, but were adjusted and modified as locally developed concepts. What is interesting in this case is the similarity between NANDA/NIC and local classifications. This progress has gradually evolved in which increased knowledge of NANDA resulted in increased awareness of using the language to describe nursing, which in turn led to increased development of local nursing diagnoses. In this way, NANDA contributed to sound clinical judgement and knowledge development, and thus represented a professional vision of nursing (Goodwin 1994). This was reflected in the way that the users searched the NANDA list, and then modified the NANDA classifications according to the actual situation. Another example was how nurses changed NANDA diagnoses slightly to establish a link between the diagnosis and intervention in the care plan, as a way of generating coherence in the care plan. On the one hand there was a need for local adjustment to compensate for shortcomings in NANDA and specifying to the situated practice. On the other hand, many of the local terms were affected by NANDA as was illustrated in the mapping that was carried out. The transformation and

development of local classifications required negotiation between universal standards and local nursing conventions and we consider this kind of 'tinkering' as a prerequisite for the standard to function in practice (Timmermans et al. 1997). This illustrates the dynamic growth and 'cultivation' of classifications required to achieve interconnection with the work-oriented information infrastructure, i.e., the installed base (Ciborra 2002). However, this standardization process has led to some cost and efforts (Rolland and Monteiro 2002). The local classifications were regarded as free-text terms in the computerized system and were not integrated in the electronic nursing module. To make these terms available in the documentation process, they were collected in a paper-based list. Later, some users had the idea of adding the list of terms as a standard plan in the nursing module. Thus, they have managed to embed local knowledge in the nursing module and regard the local list as useful support in daily documentation. If we consider only the frequency of use of NANDA and NIC, we find a gradual decline over the past years. Yet if we consider the local investment in classification, we find that locally developed classifications were more or less consistent with NANDA, i.e., 95% of all nursing diagnoses were consistent with NANDA.

The empirical data from AHUS and SSHF also demonstrate the co-construction capability of standardization in relation to local practice, although with a different strategic approach. In these cases, the implementation was motivated by the hospital-wide ambitions of a shared system for documenting nursing care. Considerable effort has been invested in developing standardized care plans as a means to enable a common standardized language and to facilitate the use of care plans. Using these templates represents standards in a double sense. First, standardized terminologies are embedded in these plans, since key users at the ward have aimed at using NANDA and NIC when preparing the standard plans. Second, they may be characterized as procedure standards; this "creates a synergy between staff members' embodied expertise and the tool's coordinating activity, in which expertise and coordination mutually reinforce each other" (Timmermans et al. 2003, p. 78). As illustrated at SSHF, NANDA and NIC cover about 97% of nursing diagnoses and interventions in the care plans. Accordingly, the widespread use of standardized care plans grew and evolved through extension and improvements of what already existed; they were not developed from scratch (Hanseth 2001). Since the first pilot implementation in 2002, NANDA and NIC have grown in scale and scope. These classifications have become co-constructed in many places, both locally and hospital wide, and become a large-scale information infrastructure. Moreover, the infrastructure is increasingly heterogeneous as the number of technological components; user communities, procedures and so on are included. Accordingly, the dynamic capability to the adopted infrastructure leads to self-reinforcing path dependency, which means that past events will have major impacts on future development Hanseth 2001; Edwards et al. 2007).

This point is particularly interesting with regard to the recommendation by the NNA on the use of ICNP as a new terminology. Based on the lessons learned from NANDA and NIC, it is likely that the implementation and adoption of ICNP will evolve and "grow" in a similar fashion. Despite the assertion that ICNP is a more flexible terminology that can be mapped to local synonyms, it is still a large-scale terminology system that also needs to evolve to meet the ever-changing needs of multiple users and stakeholders.

5.2 Integrating evolving information infrastructures

Several studies have emphasized how gateways may be used to integrate different information infrastructures (Edvards et al. 2009; Hanseth 2001; Edwards et al. 2007). However, surprisingly few have elaborated on the *work* that is implicated in a gateway technology. Our case enables us to take a longitudinal perspective on integration where the evolving character of information infrastructures is of particular interest as it sheds light on the long-term maintenance work of an integrated IS portfolio. The focus on the work also serves to challenge the promotion of integration as 'easy' in the medical informatics literature (Hardiker et al. 2000; Hardiker et al. 2006; Kim and Coenen 2011).

As a reference terminology, ICNP is particularly designed for integration of different terminologies used in heterogeneous practices. In this regard, Hardiker (2011) argues that the compositional nature and multiple hierarchy of ICNP make it well suited to support the development of local terminologies and to facilitate cross-mapping between terminologies. This may well be true from a purely technical viewpoint. However, our data indicate that the integration task is far from straightforward and is rather of a deeply socio-technical character.

First, we have previously pointed to how the slowly evolving way in which NANDA/NIC have been embedded in practice has entailed a great deal of work. Through this process, NANDA and local practice have constituted each other, transforming the system into local variants of NANDA. It is not obvious how integration mechanisms (i.e., ICNP) should deal with these locally developed terms made to replace the NANDA diagnosis. It appears that this must be done as a manual task conducted by some health personnel when such mapping is needed. At some point, other strategies might be put in play. For instance, other studies have indicated that we might need some additional social classification in combination with core terminologies as a "semantic glue" to replicate the role of local knowledge and communication in large-scale, multidisciplinary and distributed collaboration (Ure and Proctor 2009). Thus, we need mapping mechanisms that facilitate the dynamic, evolving and socially constructed nature of nursing terminologies.

Second, looking at the evolving dynamics of terminologies from a different perspective—not from local practice, but from the evolution of terminologies per se—it is evident that the terminologies are continuously changed and revised due to suggestions and consensus-making processes from the international community using it. For instance, NANDA is revised every second year. This presupposes some strategy on how to maintain the integrated concepts. Related to this, Wade and Rosenbloom (2009, p. 493) argue that "there needs to be a predictable way of updating and maintaining these mapped concepts along with new versions of the terminology." While we certainly agree with this, we believe that our case has illustrated that 'predictability' in how terminologies are used is far from something that can be counted on as a given and practical intervention of ensuring well-functioning integration between the integrated terminologies is something to be expected for each revision of the terminology.

Third, as our case in the ICNP section has shown, both representatives from the vendor and key personnel in the Norwegian NANDA community argue that relying solely on a combination of ICNP codes is not sufficient for use in clinical reasoning. According to them, many of the combinations of codes need to be defined and given a meaning as a concept.

> "I have seen on the web site that there are some catalogues. What I miss is how to get to the catalogues, how to define the terms and what characteristics they have" (Vendor, consultant)

Given that a combination of INCP codes needs to be defined or given a particular meaning, this also needs to be addressed in integrated terminologies—i.e., the particular meaning for a particular combination of codes also needs to be integrated. This is of course far more complex than simply integrating individual ICNP codes, because apparently similar terms may have slightly different interpretations, causing confusion in a well-functioning integration.

All of the above-mentioned factors challenge the role of ICNP as a gateway solution for maintaining seamless integration, i.e., interconnecting the layers in the new information infrastructure. This emphasizes that the use of gateways is not purely technological, but a socio-technical negotiation process. The evolving character needs to be taken into account in the integration efforts, pointing out that integration cannot be done once and for all, but needs to be worked on and maintained as long as the terminologies are in use.

5.3 A gateway as a competitor

While the neutrality of technology has frequently been challenged in the IS literature (see, for instance, Hanseth and Monteiro 1996; Bowker and Star 1999; Sahay et al. 2009), the similar role of the gateway has seldom been examined in detail. The reference technology ICNP appears to map between different terminologies in a relatively unproblematic way. In this section, however, we analyse how ICNP changes role during the recommendation process in such a way that it becomes an influential technology shaping actions of the stakeholders involved.

Given our case on how ICNP was presented to Norwegian healthcare, it is particularly interesting to examine more closely how such terminologies are promoted, how they are received among existing users, and what consequences this may have for existing terminologies and practices. In the process of recommending ICNP, this was elucidated by the fact that several people—from the NIC/NANDA user environments such as hospitals, the vendor, and a university college—interpreted this as an attempt to replace NANDA and NIC with ICNP rather than establishing integration between existing terminologies.

The problems started when the participants of the Terminology Board were selected. The NNA did not want the participants to be biased towards existing terminology systems and existing technologies. Instead, the selection process of participants was intended to ensure a neutral process within the group. However, this meant that the vendor of nursing plans and its associated users (the EDS group) were excluded from participation, as they were regarded as biased towards the existing terminology systems, NANDA and NIC. Surprisingly, however, the Terminology Board did not realize that its strategy—based on the assumption of neutral selection of participants—increased the tensions between those who promoted NANDA/NIC and those promoting ICNP. This clearly took the focus away from ICNP as a neutral mapping device. In particular, the omission of users from the board increased the growing uncertainty among the NIC/NANDA group.

The confusion escalated with ambiguous statements from board members. For instance, the decision to *compare* the different terminologies suggested that one terminology was better than the other, and that the loser could therefore be replaced. Similarly, as our case illustrates, the chair of the board stated that NIC/NANDA was too "hospital oriented" and not suitable for primary care. In addition, ICNP could be changed in a more dynamic way that would represent the patient's situation better.

On the one hand, the board members stated that Norwegian healthcare would include different terminologies, but only one reference terminology as a base. On the other hand, they stated that it was expensive to operate with more than one terminology; when ICNP had been installed, no other terminology was needed. Another issue was maintenance of the existing terminologies NIC and NANDA. In particular, the large vocabulary of NIC was essential in this regard. The leader of the EDS group viewed this as the best indicator of the future NNA strategy as a replacement strategy rather than a mapping strategy:

> "The NNA has confirmed that they will not translate NIC and NANDA, or as they said pursue it in the future and that this was financially motivated"

From the outset, many NIC/NANDA users were positive to the initiative from NNA and saw potential in the recommendation of a reference terminology. Still, they thought that NNA and the board should have differentiated between the recommendation of a reference model and other models used in practice, such as NIC/NANDA. The argument was simple: neither NIC nor NANDA would be adequate as a reference terminology, so the comparison was superfluous, only making things more difficult for the future activities of the NNA.

The controversy between NANDA/NIC and ICNP also came to the forefront on the international level in the process of adapting ICNP to the market. This adaptation has partly been achieved through development and partly through the selection and combination of components from related terminologies. For instance, the use of standardized catalogues was known from NIC and NANDA and pursued by ICNP in their newest version. Initially, the ICN contacted the NANDA board to discuss the possibility of obtaining access to NANDA for mapping NANDA to ICNP. This was positively received by the NANDA board, as it could encourage integration of NANDA and NIC with other systems, making their reach even wider:

> "The first intention from the ICN, to map the systems, was taken as positive by the board, as the mapping between our systems denotes a further spread of our system" (NANDA board member).

Nonetheless, the NANDA board increasingly felt that instead of creating mappings, ICNP was refined by a "direct copying of diagnoses", resulting in a more strained relationship between the two organizations.

ICNP was initially regarded as an inclusive gateway, but NANDA came to perceive ICNP as a competitor, which might capture a large part of the market for nursing terminologies. Ironically, this apprehension is not unfamiliar to the ICN community itself. One of the key actors working with ICNP was travelling around campaigning for the new terminology, and commented at a conference that if you had ICNP, you did not need NANDA and NIC (comment from teacher at the University college of Oslo). Although this was a casual remark, for the

NANDA community it signalled a mode of thinking that has become a source of controversy. This controversy challenged the foundation and principles of a gateway as neutral technology.

Finally, as stated in the first and second discussion aspects of this paper, the slowly evolving process of establishing an information infrastructure—and the integration between them—is hugely complex. This may serve as an argument for replacement per se. However, it remains to be seen what will happen when ICNP is introduced in real-life work settings.

6 Conclusion

This paper offers a new perspective on large-scale terminology-based information infrastructure. The strategic aim of implementing standardized terminologies is to share and compare information within and across domain-specific and organizational boundaries. However, this is not just a technical and static accomplishment, but an on-going process of change that is constituted in the dynamic interrelation between new technologies in local and highly professional work practice. We see scientific work on mapping of technologies from the medical informatics literature as stereotyped and as too technologically oriented. Our focus has been on relational perspectives—a more all-encompassing, real-life oriented approach to the integration and use of terminologies. Viewed as an information infrastructure, this is seen as a socio-technical negotiation process focused on the dynamics between the actors involved. Heterogeneous hospital practices require sharper focus on trade-offs, domain-specific boundaries, and maintenance of existing infrastructure. The three cases demonstrate the co-construction capability of standardization in relation to local practice, and the work implicated in gateway technology in a longitudinal perspective. Further, the dynamic capability of the adopted infrastructure leads to self-reinforcing path dependency, which means that past events will have large impacts on future development.

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