

## Enterprise Architecture in Hospitals: Resolving Incongruence Issues

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### Abstract

*Enterprise Architecture allows addressing technologies and processes in a holistic way and mirrors choices related to process standardization and data integration. It has the potential to address long-standing problems in health information systems related to fragmented IT portfolios, immature IT infrastructures, and silo-structured organizing. Nevertheless, uptake of Enterprise Architecture in hospitals has been slow. To understand the issues related to this slow uptake we have undertaken an interview study with architects and managers. The issues identified reveal a level of incongruence between healthcare as a domain and the practice of EA. Specifically, by analyzing the experiences of architects and managers we identified four different areas of such incongruence that create the need to reconcile a) Bottom-up vs. Top-down Planning b) Clinical vs. Systems' Knowledge, c) Local vs. Global Arrangements and d) Patient Safety vs. Patient Privacy. Building on prior related research we propose ways for resolving the incongruence issues identified.*

### Keywords:

Architecture; Health Information Systems; Qualitative Research

### Introduction

An organization's Enterprise Architecture (EA) describes in a hierarchical way its processes, the data and applications that support these processes, and all related information and communication technology (ICT) arrangements [3]. Practitioners and researchers have advocated EA as a systematic approach for designing, planning, and implementing process and technology changes [5; 21]. The EA approach addresses technologies and processes in a holistic way and mirrors choices related to standardization and integration [17]. During the last two decades, hospitals started EA initiatives aiming to address long-standing problems in health information systems related to fragmented IT portfolios, immature IT infrastructures, and silo-structured organizing.

Norway has formally adopted EA as a strategic tool for hospital information systems and processes [14]. Nearly all hospitals in the country are public and organized as health trusts that can include several local hospitals. The trusts are allocated to four independent regional health authorities under the jurisdiction of the Ministry of Health and Care Services. The strategic coordination, prioritization, and consolidation of key ICT issues across the regions are performed by a separate organizational entity dedicated to healthcare ICT called the

National ICT (NICT). Four regional health authorities is jointly owned by NICT. The Norwegian government has issued several white papers that describe how ICT shall be used to achieve health policy objectives and deliver more effective and efficient services, with emphasis on quality and patient security [9]. Two of the most important white papers that guide the development of eHealth services are "The Healthcare Coordination Reform" (2009) and "One Citizen – One Record" (2012). The first one addresses issues related to collaboration, while the second one, sets the targets for the evolution of healthcare services [2; 8].

Norwegian hospitals are supported by complex information infrastructures that evolved over many years. The earliest use of electronic documentation of patient information in health services dates back to the 1970s while the first implementations of applications for entire hospital coverage started in the 1980s [7; 16]. With the adoption of EA, structured, comprehensive and aligned blueprints for current and future states of hospital systems and processes can be developed. Furthermore, EA can provide guidance for implementing processes and technology changes to operationalize strategies. Nevertheless, despite the potential benefits and the state mandate for introducing EA, there have been significant delays and challenges.

To gain insights about EA introduction in Norwegian hospitals, we performed interviews with key actors at the local, regional and national level across the hospital sector. Prior research has shown that the introduction of EA is far from straightforward and pointed to the importance of a favourable organizational culture [1; 15; 23]. Intrigued by this previous research finding, we specifically investigated the following research question: *are there inherent issues related to incongruence between healthcare as a domain and the practice of EA?*

The rest of the paper is structured as follows. First, we describe the empirical setting and explain our research method. Second, we provide the results. Third, we discuss the results and drawing from prior related research we propose ways for resolving the incongruence issues identified. We conclude the paper by pointing to the contributions and limitations of our research.

### Methods

#### Data collection

Semi-structured interviews were conducted with Enterprise Architects and Managers involved in the introduction of EA in Norwegian hospitals at the local, regional, and national level. In total 17 interviews were performed between November 2016

and August 2017 (Table 1). All the informants interviewed had at least two years of experience in their current position. At the national level, most of the interviewees had been working since NICT started (2.5 years ago) while all were experienced before joining NICT. At the regional level, the enterprise architects had been employed for an average of about 5 years, and the managers for about 7 years. At the local level, the enterprise architects had been employed for an average of 10 years and the managers for 8 years on average. Interview questions explored the experiences of participants. The interviews included topics on how EA was used, the role of enterprise architects, and issues about national coordination and collaboration in eHealth. All interviews were audio recorded and transcribed.

Table 1—Interviews Performed

Level	Informants	# interviews
National	5 Enterprise Architects	5
Regional	4 Enterprise Architects and 2 Managers	7
Local	2 Enterprise Architects and 3 Managers	5

In Figure 1 we present the overall structure of the hospital sector in Norway (as described in the introduction) marking the specific units where interviews have been performed.

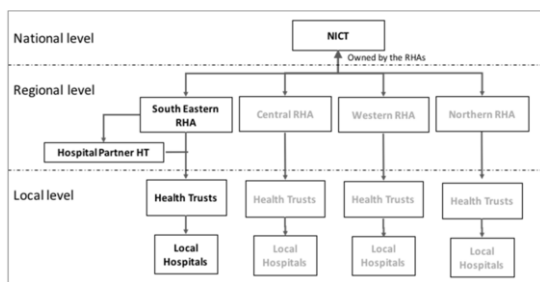


Figure 1—Overview of the Norwegian Hospital Sector (units covered by interviews are marked in bold)

## Analysis

An iterative approach was followed for the data analysis. The coding followed the principles of first- and second-cycle coding [13]. The first cycle was done in NVivo where all anonymized transcripts were entered. The transcripts were further analysed and grouped into Excel forms. In the second cycle, the data were discussed, organized, and compared in an iterative process to identify emerging patterns. This initial analysis yielded a wide range of challenges, some related to the technological landscape, the financing mechanisms in place, the different logics of actors involved and the governance arrangements. Furthermore, we also encountered issues related to inherent healthcare characteristics that complexify the introduction of EA. Drawing from these initial findings, and building on previous research that points to the significance of idiosyncratic characteristics (such as culture) for the introduction of EA, we focused our analysis on issues related to incongruence between healthcare as a domain and the EA practice.

## Results

We identified four key themes related to healthcare characteristics that create friction in the introduction of EA. In the paragraphs that follow we present the findings from the interviews organized according to these key themes.

### Clinical vs Systems Knowledge

Several informants expressed concerns related to the instances where core hospital processes need to be redefined. In such instances, systems' knowledge encounters medical knowledge. One of the architects wondered about the role of systems experts since they "do not treat patients". Another architect said, "administrative tasks can be standardized, but for clinical ones we cannot suggest the best way". One of the managers pointed to the singularity of healthcare domain related to the key role of the medical staff for setting the norms for patient care irrespectively of hierarchical positioning: "the tax director does not understand that the health director cannot decide". Another architect pointed to issues of distributed control in the domain "you have so many strong doctors ... you have strong departmental directors...there are many little kings". Overall, hospitals unlike other large-scale organizations such as banks or public administrative services where EA has been successfully introduced, are characterized by strong professional practices that have a decisive role in process and systems optimization.

### Local vs Global Arrangements

One of the architects lucidly expressed a key challenge with EA work: "they want their local systems, not regional ICT services". The health trusts want autonomy to meet local needs and there is a power struggle with the regional authorities. The regional authorities do own the health trusts, but they do not treat patients directly, so they do not experience day-to-day operational challenges. A manager explained that health trusts are similar to individual companies; they do not really have a "mother-daughter" relationship within the overall healthcare structure. One of the enterprise architects said, "a model that ensures both standardization and taking care of local wishes may be beneficial". Another architect pointed to concrete differences between two major hospitals: "hospital A is much more IT mature than B, doctors and many nurses are involved in the IT department, they are much closer to the users". A manager explained that although the needs may be similar in different regions there are different cultures across hospitals and these cultural differences matter.

### Bottom-up vs Top-down Planning

EA is a plan-driven approach, however, holistic planning of ICT within healthcare can be especially challenging as explained by one of the architects interviewed "the biggest challenge is to maintain local understanding...it should be taken from patients to clinicians and upwards not top-down". Another architect explained that it is important to follow a bottom-up approach because clinicians often have good solutions to their own problems. Nevertheless, one of the managers pointed to the importance of top-down approaches that allow better coordination, the manager pointed to the need for a stronger central role "everybody wants new systems,

*nobody wants to change*". Balancing bottom-up with top-down planning has proven to be challenging for the EA initiatives.

### Patient Safety vs Patient Privacy

An architect pointed to the need to consider data flows not only in terms of security and privacy but also in terms of patient safety. The standard regulations and procedures for systems analysis and risk containment are addressing issues related to data security and patient privacy but not issues of patient safety. Architects are not experts in issues related to patient safety. Another architect explained how important it is to make available patient data when patients move from region to region, but this is not straightforward to implement. A manager pointed also to the need for data exchanges between primary care and hospitals. Overall, the visions for data integration are bringing up unresolved issues related to balancing patient safety and privacy.

Table 2 provides an overview of the results, mapping the four key themes identified to key EA features that are challenged by the singularities of the healthcare domain. Specifically, the practice of EA is plan-driven and oriented towards process standardisation, and data integration and these characteristics relate to friction experienced when introducing EA in healthcare.

Table 2– Incongruence Themes Identified

EA characteristics	Healthcare characteristics	Incongruence themes identified
Plan-driven	National strategies but also pivotal bottom-up initiatives	Bottom-up vs Top-down Planning
Process standardisation	Processes inscribe clinical knowledge Local variation	Clinical vs Systems' Knowledge Local vs Global Arrangements
Data integration	Sensitive but also mission-critical data	Patient Safety vs Patient Privacy

## Discussion

The issues identified reveal a level of incongruence between healthcare as a domain and the practice of EA. The friction themes identified, can be related to prior research findings in Health Informatics. Healthcare is "work regarded as unusually complex, uncertain, and of great social importance." To ensure the best possible outcomes under these difficult circumstances, "the strategy pursued is to couple capability with discretion in one responsible actor and place him or her as close as possible to the problem situation ... legitimate control over the nature and quality of professional practice is vested in the professional staff, not in the administration" [18]. Prior research [20] has identified that in healthcare universality is always "local universality" in the sense that it "always rests on real-time work and emerges from localized processes of negotiations and pre-existing institutional, infrastructural, and material relations". Furthermore, along the same line of thought, researchers [4] have conceptualized the distinction between conjoint and context-dependent design negotiations showing how in successful standardization processes stakeholders define and

agree on boundary factors (elements that are meaningful across borders) while creating possibilities for local reconfigurations.

Prior research has also pointed to the fact that frequently, advancements in healthcare come out of practice-driven initiatives without a predetermined strategy and without the initial support of management; a novelty in healthcare usually entails extensive work over lengthy periods of time by different participants [10; 11; 19]. An approach that balances between bottom-up and top-down approaches for the evolution of Health IT Systems has been proposed in the literature [6]. The approach is labelled "middle-out" and is described as a situation where governments provide incentives and support that encourage clinical providers to acquire systems that are technically or functionally compliant, and to pursue innovations that keep their systems compliant over time. Such an approach entails specifying commonly agreed compliance requirements.

Ensuring data security and privacy while catering for patient safety is one of the big challenges when it comes to streamlining data flow and pursuing data integration in healthcare. A possible way to address this challenge is by enabling a more active role for the patients. A patient-centric logic not only spans the whole spectrum of patients' needs from preventive healthcare, to treatments and long-term care but also presumes a more active role for the patients themselves. Patients can contribute through information sharing, self-service, and assisting healthcare staff acting as resource integrators [12]. To do this, they need to be able to access, manipulate and contribute data. Moreover, they need to stay informed about who is accessing their data and be able to manage access. Enabling patients to control data flows entails ensuring the clarity, user-friendliness, and transparency of patient-oriented data handling solutions.

Overall, healthcare is a safety-critical domain that requires everyday coping with uncertainty. Patients can have unique combinations of conditions and this explains the acknowledged need for medical discretion. Reliability in healthcare is not only the outcome of protocols and formal procedures but also, of an acquired capacity to perform even though working conditions fluctuate and are not always known in advance. This capacity frequently found in high-reliability settings is a mix of risk anticipation and containment encapsulated in the term "mindfulness" [22]. Mindfulness is analysed to: a) preoccupation with failure; healthcare practitioners are concerned with success as much as with failure – Hippocrates' Oath "do no harm", b) reluctance to simplify; simplifications are avoided, c) sensitivity to operations; attention is given to process dependability under diverse circumstances, d) commitment to resilience; healthcare professionals need to be able to recover from mishaps and cope with surprises pursuing alternative means to goals, and paying attention both to error prevention and containment, and e) deference to expertise; the need for a wide array of specialisms is acknowledged and respected. EA initiatives need to retain and possibly further enhance mindfulness in the domain.

### Implications for Practice

The findings suggest that in order to advance with EA in hospitals, it is important to resolve key issues related to the characteristics of EA and the singularities of the domain. There is limited prior research on the domain-specific characteristics

that hinder the introduction of EA in healthcare. This is work that we have begun to undertake. The table that follows (Table 3) is building upon prior related research to propose a set of resolutions for the incongruence themes identified. These proposed resolutions can guide practitioners involved in the introduction of EA in hospital settings.

Table 3– Resolutions for Incongruence Themes Identified  
Directions for Mindful EA Initiatives

Incongruence Themes	Proposed Resolutions	Brief Description
Bottom-up vs Top-down Planning	Middle-out	Incentivize clinicians to acquire compliant systems (based on common requirements).
Clinical vs Systems' Knowledge Local vs Global Arrangements	Configurable solutions catering for both standardisation and local needs	Technology accommodating clinical discretion and local variation.
Patient Safety vs Patient Privacy	Stronger patient role – patient data access management	Patients can contribute acting as resource integrators.

### Limitations and Strengths

The study has been conducted within Scandinavian healthcare so we cannot judge to what extent the findings reflect friction and tension with the introduction of EA in hospitals in different countries that have different institutional characteristics. However, the issues identified relate to the characteristics of healthcare as a practice in general and are also found in prior research conducted in different countries. A strength of our study is that it links to prior related research to propose concrete resolutions. Furthermore, it provides detailed qualitative data on the experiences of architects and managers involved in the implementation of EA at different levels (local, regional, national) and can provide insights for those that seek to contribute to such initiatives.

### Conclusions

This study suggests that there are inherent issues in the introduction of EA in hospitals that relate to some level of incongruence between EA and the key characteristics of the healthcare domain. Specifically, by analyzing the experiences of architects and managers we identified four different areas of such incongruence that create the need to reconcile a) Bottom-up vs. Top-down Planning b) Clinical vs. Systems' Knowledge, c) Local vs. Global Arrangements and d) Patient Safety vs. Patient Privacy. Our study can be used as a basis for further research towards the development of a measurement instrument to assess trade-offs in the four incongruence areas identified. As these areas relate to the nature of healthcare delivery, prior research has brought insights related to potential resolutions. Although the introduction of EA in hospitals is far from straightforward, working towards resolutions for the specific incongruence themes identified can be a basis for mindful EA initiatives. Mindful EA can be a healthcare-specific EA

approach for systematically designing, planning, and implementing process and technology changes.

### Acknowledgements

We would like to thank the informants that shared their experiences and views. We would also like to thank the anonymous reviewers for their constructive comments that helped us improve our manuscript.

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