THE ORGANIZATIONAL RIPPLE EFFECT OF IT ARCHITECTURE IN HEALTHCARE

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Research

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Abstract

This study elucidates the organizational ripple effect of a large-scale technology-based healthcare enterprise development. It addresses the interplay between organizational information technology (IT) architecture and IT governance and the mediating role of inter-organizational interdependencies and coordination mechanisms. The research questions are; what ripple effect does IT architecture create in healthcare organizations, and how? What mechanisms are being used to manage them?

We take a coordination perspective to conceptualize formal and informal mechanisms for implementing the IT architecture integration mandate, and propose an analytical framework to develop our argument. Our empirical evidence is a large networked healthcare organization engaged in an IT mega-program aimed at improving clinical services through integration and standardization facilitated by an enterprise architecture practice.

Based on our findings and building on coordination theory, we contribute to the enterprise architecture literature by providing analysis of coordination and governance challenges in enterprise architecture work. The findings demonstrate that IT architecture integration and standardization in complex organizational settings augment organizational coordination efforts by increasing socio-technical interdependencies which necessitate coordination-oriented hybrid governance mechanisms. Large and complex organizations involved in IT-based organizational transformation need to consider: i) socio-technical interdependencies and the ensuing coordination ripple effect of their IT architecture choices and ii) address mechanisms for lateral coordination as part of their enterprise architecture and IT governance processes if socio-technical interdependencies are to be managed adequately.

Keywords: Enterprise Architecture, Coordination Theory, IT Architecture, IT Governance.
1 Introduction

Building a modern and reliable ICT infrastructure to digitize and integrate health information systems has been an elusive goal of the healthcare sector (Avison and Young, 2007; Bygstad and Hanseth, 2015). This objective has received great priority, recognized as a prerequisite for quality and effective healthcare services. The health sector in most modern countries is characterized by fragmented organizational units and IT solutions, constituting a costly hindrance for patient oriented care, and governments and the European Union have initiated large programs to improve on the situation (EU Commission, 2011).

However, unlike other sectors, healthcare presents a unique governance and coordination challenge predominantly due to its complexity and fragment organizational structure. Healthcare involves a highly interorganizational network of national, regional and municipal institutions, hospitals, clinics, community health centres, and home care services (Virkanen et al., 2014). The data and information that supports healthcare services is extensive and is utilized by one of the most varied and co-dependent activities and actors (Hussain et al., 2009). Delivery of healthcare services unlike other sectors demands high integration, personalized services and requires a multidisciplinary team which makes governance and coordination around IS implementation much more complex (Cucciniello et al., 2015; Avison & Young, 2007).

Healthcare also presents institutional tensions across organizational boundaries; departments; and domain areas (Menon et al., 2000). Across organizations and departments, there are conflicting objectives and preferences across sub-national divisions or regions, organizations, units and user levels which shapes the existing arrangements of coordination found in healthcare (Cucciniello et al., 2015). Coordination is a key focus of analysis because of the high degree of division of labour and specialization in healthcare which are grounds for the coordination challenge in IS implementation. Additionally, healthcare presents a strategic context characterized by high complexity and IS implementation in such a context requires a balancing act of diverse strategic objectives including quality of care, efficiency, and cost effectiveness while grappling with technology issues of usability and interoperability (Lau et al., 2011).

Across domains, IT governance and architecture grapple with different entities: business (i.e. administration, corporate management, finance), clinical and IT (Menon et al., 2000). Whereas most other sectors predominantly deal with business-IT dynamics. The clinical domain is governed by medical directors and is itself complex consisting of many semi-autonomous subdivisions each carrying out specialized tasks that are interdependent, in which output for one is input for another. The inclusion of the clinical domain to the business-IT dynamic is a critical one to IT governance arrangements because it adds a layer of essential decision rights, input rights and accountability rights. Additionally, the healthcare sector is highly regulated by government (Menon et al., 2000). Overall, managing the complexity that emerges from the heterogeneity of strategic aims, systems, data, stakeholders, and their interdependencies presents a coordination and governance challenge (Chisholm, 1989). These tensions have been a key factor to the long history of IS failure in healthcare (Heeks et. al., 1999; Kierkegaard, 2014) and a reason why healthcare lags behind other sectors in IS adoption (Menon et al., 2000).

Thus far, the “enterprise-type” model of IT governance has largely been adopted in healthcare with limited success (Avison and Young, 2007; Kierkegaard, 2014). Even in countries with high levels of eHealth adoption nationally, there are interoperability challenges stemming from the interorganizational governance structures adopted (Kierkegaard, 2014). These have historically been addressed through radical government reorganization directed towards formal consolidation and integration (Chisholm, 1989). Accordingly, across many countries, national and regional level efforts for IT architecture consolidation have involved structural reforms which facilitate the establishment of centralized IT governance configurations (Avison and Young, 2007; Bygstad and Hanseth, 2015; EU Commis-
sion, 2011; Kierkegaard, 2014). Additionally, many organizations have attempted to deal with the ensuing complexity by adopting industry-recognized practices such as enterprise architecture (EA).

The key aims of EA is to provide a unified view of the organization which includes the technical and business components in order to foster alignment of process, applications and data (Bradley et al., 2012). EA is defined as “the organizing logic for business process and IT infrastructure, reflecting the integration and standardization requirements of the company’s operating model” (Ross et al., 2006). EA is also an approach to managing the socio-technical ripple effect of change in system components of the enterprise (Ross et al., 2006). The phenomenon of ripple effect was first introduced by Haney (1972) in the context of software development. Ripple effect in architecture based software development refers to components and their relationships where any modification to components many produce effect on other components (Anwar et al., 2012). As a result, modifications introduced in a system include making changes at different levels, i.e., source code, software design, and software architecture (Anwar et al., 2012). However, we investigate the ripple effect of IT architecture on the organization by analysing interdependencies and how these are managed through coordination mechanisms. Although, EA work grapples with the socio-technical nature of IT-enabled organizational change, we know little about the coordination and governance challenges associated with EA (Espinosa et al., 2010). Only a few studies have investigated coordination in EA (Abraham et al., 2012; Espinosa et al., 2010; Pulkkinen et al., 2007). However, these studies fail to account for the governance construct in studying coordination in EA. The study is guided by the following research questions:

- What ripple effect does IT architecture create in healthcare organizations, and how?
- What mechanisms are being used to manage them?

## 2 Theoretical Development

### 2.1 Coordination Theory

Coordination theory provides the theoretical foundation for the research. Coordination theory suggests identifying and studying common interdependencies and related coordination mechanism across organizational settings (Malone and Crowston, 1990). Coordination theory presents insight into group work and how interdependencies between tasks and resources among different group members are coordinated (Espinosa et al., 2010). “Coordination is a function of the interdependence of the parts of an organizational system” (Chisholm, 1989, p.3). A fundamental objective of coordination is to manage various interdependencies (Malone and Crowston, 1990; Pennings; 1974). The extant coordination literature cites two broad strategies for coordinating interdependencies: (1) organizing tasks to minimize interdependencies and (2) managing existing interdependencies (Srikanth and Puranam, 2011). Variations of these two coordination strategies include: plan vs. feedback (Tushman and Nadler, 1978), modular vs. integral design (Sanchez and Mahoney, 1996); and loose vs. tight coupling (Orton and Weick, 1990). Coordination theory has predominantly focused on how coordination mechanisms manage interdependencies. However, the dynamics between interdependencies and coordination mechanisms and how these mechanisms emerge and relate to each other has not been adequately explored.

Since the interest of this study is at a higher level of abstraction (i.e. coordination across programs, units and organizations), we focus on inter-organizational coordination. Inter-organizational coordination can take on different perspectives depending on whether coordination is viewed as a process or a structure of relationships (Alexander, 1993). In this study, we espouse a perspective of coordination as both process and structure (Alexander, 1993).

Coordination theory has four benefits to this research: (1) it enables the analysis of the subdivision of overall goals of the organizational IT architecture into actions which helps us conceptualize interdependencies; (2) it enables the investigation of the delegation of actions into projects, sub-projects or other organizational subdivision which helps us assess the relationship between interdependencies and
coordination mechanisms; (3) it enables the examination of how decision-rights are distributed between the various actors in the organizational subdivisions to accomplish the overall IT architecture goal which helps us analyse the dynamics between governance structure and coordination mechanisms; and (4) it provides a way to study the emergence of new organizational processes and forms which helps elucidate the effect of emergent coordination mechanisms on the distribution of decision rights.

2.1.1 Interdependencies and coordination mechanisms

Coordination aims to address the problem of interdependence (Crowston, 1994). We conceptualize interdependencies in terms of: tasks, roles, technology, and data (Penning, 1974; Thompson, 1967). A key source of interdependency among technical subsystems is an organization’s IT architecture, which refers to the “arrangement through which various software applications and subsystems are interlinked” (Tiwana and Konsynski, 2010, p. 290). A commonly recognized organizational IT architecture is consolidation, which aims to integrate, create order and instil control in a fragmented IT ecosystem. It involves implementing a single solution for the various organizational functions, harmonizing the problems across healthcare functions, and tight-coupled integration of system components (Hanseth et al., 2006).

Managing these interdependencies in a large inter-organizational network requires coordination mechanisms (Alexander, 1993). Coordination mechanisms link diverse stakeholders through deliberately orchestrated communications through formal roles, groups, process or via informal exchanges (Alexander, 1993). Mechanisms for coordination depend on “other necessary group functions, such as decision making, communications and development of shared understanding and collective sense making” (Crowston et al, 2006, p.7). The extant coordination literature presents a broad typology of coordination mechanisms. These include: formal, structural, mechanistic, lateral, feedback, informal and relational coordination mechanisms (Galbraith, 1973; Alexander, 1993; Chisholm, 1989; Balaji and Brown, 2014; Van de Ven et al., 1976).

2.1.2 Linking logic of governance and coordination

Large-scale organizational reform initiatives in the public sector that are directed towards integration and consolidation have often been characterized by governance reforms involving reshuffling and combining agencies and redistributing decision rights (Chisholm, 1989). In line with this, the IT governance literature has often focused on the distribution of authority and responsibility for each class of decisions across different organizational levels (Weill and Ross, 2004). In this regard, the control perspective of governance has received much focus (Weill and Ross, 2004). However, a key facet of governance is coordination (Sabherwal, 2003). “Coordination focuses on managing interdependencies…control focuses on improving performance relative to a certain goal” (Sabherwal, 2003, p. 155). Tiwana and Konsynski (2010) present this distinction in two classes of decision rights: (1) those that define what objectives a unit should achieve (IT specification decision rights) and (2) those that define how it should be accomplished (IT implementation decision rights).

Coordination and governance are intertwined functions that continually inform and influence each other (Bevir, 2009). Coordination can be both a driving force of governance and one of the objectives of governance (Bevir, 2009; Schneider, 2004). In complex organizational settings, control oriented governance structures alone may be insufficient for establishing linkages among key stakeholders for three main reasons. First, business-level objectives may be in conflict with enterprise-wide objectives (Ross et al., 2006). Second, many IS activities require joint consideration of business and IS issues (Zmud, 1988), and lastly, informal constructs such as trust are necessary for cross-unit partnering (Henderson, 1990). Therefore, coordination becomes necessary for corporate management to link intra-organizational stakeholders. A relevant link between coordination and governance is the mechanisms of governance (Bevir, 2009). For example, a common mechanism; hierarchy, is thought of both as a governance mechanism (Bevir, 2011; Pierre & Petters, 2000) and a coordination mechanism
(Bouckaert, Peters and Verhoest, 2010). As a result, governance mechanisms can carry out control functions and also perform coordination roles by acting as coordination mechanisms (Bevir, 2009; Crowston et al, 2006). Therefore, coordination is one function of governance and conversely, governance can be constructed by the various forms of coordination (Bevir, 2009; Schneider, 2004). We explore this dynamic further in this study.

3 Case and Method

In order to investigate the research questions, a case study approach was chosen, since the study aimed at an in-depth understanding of a complex issue in context, for developing theoretical insights (George and Bennett, 2005). The key selection criteria were: (i) an ambitious eHealth initiative based on EA and centralized governance, and (ii) a large, networked organization with high organizational and technical diversity.

3.1 Case

The case study is of a large IT program of the South-Eastern Norway Regional Health Authority (Helse Sør-Øst - HSØ). The HSØ was the result of the structural reform of the Norwegian healthcare sector in 2001, which restructured the governance of all hospitals in Norway to be owned and managed by the government. As a result, all Norwegian hospitals belong to one of four regional health authorities. HSØ serves around half of the Norwegian population, and consists of 10 hospitals, including the largest hospital in the country, Oslo University Hospital.

Prior to the regional amalgamation, each hospital had its own portfolio of electronic medical records, lab, radiology, and various clinical and administrative systems. In 2012, HSØ set out a 5-7 year program called Digital Renewal with a budget of 5 billion NOK (around 625 million Euros). The aim of the program was to consolidate and standardize clinical work processes, technology and content across the region so that patient information would be available across disciplines and health facilities. Digital Renewal consists of four programs including: (1) Regional Clinical Solution (electronic patient record, lab systems and radiology systems); (2) ICT support for research; (3) Infrastructure Modernization and: (4) corporate governance. Each program has a portfolio of projects. In HSØ, the IT operation was centralized through an organizational unit called Sykehuspartner (SP). Within SP, a sub-unit called Integration Factory was also established to handle all technical integrations.

3.1.1 HSØ - IT architecture consolidation

At HSØ, the overarching organizational IT architecture was directed towards integrating and standardizing IT applications across the region’s hospitals. This mandate was driven by problems of fragmentation and duplication of systems across hospitals. Hospitals in HSØ had adopted approximately 4000 different systems, about half of which contain patient data. One enterprise architect stated: “we aim to standardize and clean up the mess of IT purchases over 20 years”. These efforts include: (1) standardizing electronic patient journal (EPJ) and other clinical systems; (2) consolidating to one shared solution radiology systems for x-ray, MR and CT; (3) consolidation to one shared lab system; (4) enabling electronic message exchange on patient management among hospitals and, to an extent, with primary care; (5) consolidation to a shared ERP system and data warehouse; and (6) shared IT platform and data centre across the region.

The IT architecture integration is operationalized through BizTalk middleware; an enterprise service bus technology. The integration of 53 systems, registers, and services with the EPJ take place through the BizTalk platform. Local and central BizTalk platform are used to allow internal communication among applications within each hospital and external communication with other hospitals and external stakeholders. In all, 275 integrations were implemented with the EPJ solution at Oslo University Hospital.
3.1.2 HSØ - IT governance centralization

HSØ’s governance structure is hierarchical and centralized in line with the amalgamation of hospitals into centrally governed regions. The HSØ Board defines what objectives each program should achieve and drives the mandate. The programs receive their IT mandate and budget from the Digital Renewal Board under the auspices of the Program Office. The Digital Renewal Board is accountable to a director group and ultimately the HSØ Board. The organization exhibits characteristics of rigidity and control due to limited feedback and mutual adjustment capacity and its single centre of authority.

Operationally, how objectives are accomplished (IT implementation decision-rights) is consistent with organizations whose information processing and decision making is implemented by specialized programs. There are three programs that have their own program boards. Each program board is accountable to a Program Office, which monitors the implementation of the mandate. Progress and risk analysis is reported monthly to the Board. In addition, external audits are regularly conducted.

3.2 Data Collection

Data was collected from two sources. First, semi-structured interviews were conducted with key informants at different levels of the organizational hierarchy. As a sampling strategy, a selective sampling technique called purposive sampling in combination with snowball sampling was used (Jackson and Verberg, 2007). In total, ten participants were interviewed from different units within the organization; the South-Eastern Norway Regional Health Authority (HSØ), Sykehuspartner (IT function of HSØ), Integration Factory, and Oslo University Hospital (OUS). Second, data was collected from a number of regional and program level technical and strategic documents including project directives, status reports, presentations and high-level IT architecture figures. Document analysis was used to inform the interview guide and to corroborate interview data.

3.3 Data Analysis

The data analysis phase was based on qualitative analysis methods of Miles and Huberman (1994) consisting of three stages: data reduction, repackaging data, and pattern identification and explanatory proposition. First, data reduction was carried out by focusing and organizing raw data compiled from transcripts and document reviews. This involved two steps: identifying and coding components (i.e. social and technical components) and displaying components and related data. Interdependencies were then coded by first identifying where one activity produces a resource required by another. We started with data, which is a key shared resource in HSØ. Drawing upon a high level dataflow architecture diagram that specifies the integration of 53 systems through the BizTalk platform, we were able to trace data and technology interdependencies across key organizational units. Correlated task/role interdependencies were then coded by identifying processes that bring together stakeholders through deliberately orchestrated interaction via formal roles, groups, or via informal exchanges. We then grouped interdependencies by drawing on the EA principles of layers and segments (Ross et al., 2006). EA consists of four common layers that represent the various views of the architecture: business, data, application, and technology layers. These layers are common across various EA frameworks such as the Federal EA Framework (FEAF), The Open Group (TOGAF) and the Zachman Framework. Segments refer to subdivisions of the organization which could be business units, functions, domains, programs, projects or other divisions. Analysing interdependencies across and within segments and layers was used to elucidate social and technical interdependencies (Espinosa et al., 2010).

Second, the repackaging phase of data analysis involved identifying and analysing the key mechanisms among candidate coordination mechanisms by assessing the explanatory power of each (Bygstad & Munkvold, 2011). This last phase of analysis involved developing explanations and conclusion by synthesizing and integrating themes into one explanatory framework. We primarily focused on identifying coordination mechanisms at both the operational and management levels of inter-organization systems. We used the identified interdependencies to examine associated coordination
mechanisms from three perspectives. First, how coordination mechanisms help manage these interdependencies. Second, if and how the emergence and development of these coordination mechanisms is shaped by IT architecture choices and the consequent interdependencies. Third, what role existing governance structures play in shaping coordination mechanisms. Finally, we build on this analysis to elucidate whether the emergence of coordination mechanisms give rise to organizational forms that shape the distribution of decision-rights.

4 Findings

4.1 Socio-technical Interdependencies

We identified a number of socio-technical interdependencies using EA layers and segments (Figure 2). These included interdependencies among the EA layers within each program segment (e.g. lab program) and across program segments (e.g. clinical solution and lab programs). The EA layers and segments were useful for identifying interdependencies among programs which worked with functional units (e.g. lab, clinical programs). We classified these into: (1) technical interdependencies (linkage of application/technology components); and (2) data interdependencies (shared data across applications and business processes). Therefore numerous combinations of technical/data interdependencies exist (e.g. data-data within and across segments, data-application within and across segments). However, these programs also had interdependencies with operational units (e.g. Integration Factory, EA). These were identified as interdependencies across segments (e.g. lab program and Integration Factory). We classified these into: (1) task interdependencies (the flow of work between actors/business processes); and (2) role interdependencies (responsibility and decision-making rights within the enterprise).

Given the challenge of identifying the full gamut of complex interdependencies in such a complex enterprise context, we present examples of interdependencies. The clinical domain presents diverse technical and data interdependencies. There are about 46 specializations across the thirteen hospital units within HSØ, each specialization with its own set of business process, technology, and data requirements. There are also differences among these EA layers in the same specialization across different hospitals that would have to be consolidated. Additionally, technical and data interdependencies exist across 53 different applications which are integrated with the new EPJ through 275 individual integrations (i.e. application-application and data-data interdependencies) through the BizTalk integration solution.

We also identified task and role interdependencies among programs and specialized units and sub-projects. These are cross-cutting units that work with various programs and projects. One such specialized unit is the Integration Factory. With more than 20 specialized developers, the unit works with individual projects to handle all BizTalk configurations to ensure the mapping and routing of messages from disparate applications to the EPJ. This creates task/role interdependencies between projects and Integration Factory. Additionally, the various segments collaborate with various vendors to carry out configurations and consolidation of data and standards between new and legacy systems.

Lastly, the various segments collaborate with the overall EA function, which overlooks project-level decisions that have implications on other programs and organizational functions. HSØ has an outlined target or ‘to-be’ architecture which is built upon a common set of standardized security, platform and infrastructure services. The Architecture and Design Group is mandated to ensure compliance with the strategy and the target architecture architects.
4.2 Coordination Mechanisms

Managing the multiplicity of interdependencies among the various components in healthcare enterprises is an arduous task. A key challenge confronting the enterprise architecting work of HSØ is establishing coordination processes to ensure effective management of interdependencies. Three types of coordination mechanisms were identified: (1) structural coordination mechanisms; (2) lateral coordination mechanisms; and (3) informal coordination mechanisms.

4.2.1 Structural coordination mechanisms

Structural coordination mechanisms at HSØ consist of formal and planned coordination mechanisms that aim to foster well-coordinated work processes. HSØ’s structural coordination mechanisms are designed to ensure high level strategic goals and decisions are escalated down to operational levels and that operational level bottlenecks are escalated up to top-management. They are synonymous with formal organizational arrangements and traditional hierarchy of vertically integrated organizations. The aim of structural coordination mechanisms at HSØ is to ensure coordination by managing interdependencies across formal organizational settings along the hierarchy of organizational units. Coordination takes place between departmentalized and grouped organization units that exist at different levels of HSØ’s organizational hierarchy (e.g. boards, steering groups, program control office, projects, sub-projects). In this arrangement, the mechanisms for coordination involved top-down communication and unilateral management and decision-making.

This mechanism takes place predominately through programmed meetings giving participants the opportunity to discuss strategic tasks and facilitate coordination of interdependent work processes and clarify conditions of uncertainty. Such coordination is done by program or plan using artefacts, schedules, formalized rules, policies and procedures in order to minimize frequent communication.

*Lead Organization - HSØ*

A key high-level structural coordination mechanism is the lead organization itself. The lead organization is “the arrangement in which one organization is charged with, or assumes, the responsibility for coordinating the activities of all the relevant organizations in the inter-organizational network” (Alexander, 1993, p. 337). HSØ as the lead organization consists a board and steering committee that carry out high level coordination tasks. HSØ also has responsibility for driving the regional strategic man-
date and budget allocation to various inter-organizational systems and is therefore different from a coordinating unit (discussed below). HSØ as a high-level coordinating mechanism works in combination with other coordination mechanisms to implement HSØ’s mandate.

**EA Function as Coordinating Unit**

The EA function at HSØ is identified as a coordinating unit because of its primary coordination role of managing various technical, data and business process interdependencies and the implementation of decisions that affect interrelated inter-organizational units. It has its own organizational identity with its own set of architects. Although the EA function is recognized as an autonomous organizational unit on HSØ’s organizational chart, it operates across many inter-organizational systems. However, the EA function does not have specific “line” functions and therefore does not implement any of the tasks it is charged with coordinating. Additionally, the EA’s representation and influence at the regional board level on strategic decision-making is limited in part due to the organization’s early stage of EA maturity. As a result, its value to high-level management has been challenged by executives, largely because it has not been beneficial in informing strategic decisions. However, the benefit of EA as a coordinating unit could be evident in addressing a key challenge identified by an executive, who states: “where we struggle in terms of our governance model is reconciling decisions made at the high-level and at the program-level”.

Thus far, most of EA’s influence has been at the program-level, in fostering lateral coordination which gives it traction at the operational level.

**4.2.2 Lateral coordination mechanisms**

Lateral coordination mechanisms were found to take place across segment boundaries. They included HSØ’s formal organizational arrangements that manage cross-functional interdependencies and ensure cross-program coherence. Although formally recognized, these mechanisms were not part of the formal organizational structure but emerged later to address unanticipated and emergent interdependencies. They facilitate collaboration among participants in different functional units whose task activities have residual interdependency. The benefit of EA work was especially evident in its role in fostering such lateral coordination. We identified three lateral coordination mechanisms: (1) Architecture Board; (2) Architecture Design Group; and (3) Architects.

**Architecture Board**

The Architecture Board at HSØ is an extension of the EA function and is located at the program level. It is made up of various stakeholders including: clinical representative, program leads, enterprise architect, and IT function lead (i.e. Integration Factory). The Architecture Board carries out management and coordination across the Digital Renewal Program. Compliance to architecture guidelines are also carried out by the Board, which handles exceptions. The task of the Board also includes communicating architectural decisions to the various stakeholders in a way that is accessible and understandable. Ultimately the board aims to ensure standardization and coordination among the regional programs and specialized organization functions (e.g. Sykehuspartner) so that operational architectural decisions align with the region’s overall IT architecture mandate. Decisions are channelled to the Architecture Board by another lateral coordination mechanism: the Architecture Design Group.

**Architecture Design Group**

The Architecture Design Group is a multi-disciplinary group where IT architects and clinicians work together on cross-project issues to ensure consistency in the total architecture and the clinical solution. This lateral coordination mechanism aims to foster better coordination in order to facilitate reuse of investments in IT services and infrastructure across hospitals. Unlike the Architecture Board, it works with various projects and managers to adopt guidelines around business process descriptions, data and coding systems, product requirements, integration and technology standards, and security. The group
is also part of the EA function that is building the EA documentation and repository of the enterprise. The group works alongside the Architecture Board by escalating relevant decisions.

**Architects as Coordinators**

Architects play an important coordinating role across programs and domains. Architects are similar to boundary spanners or cross-functional liaisons, who are individuals who integrate the work of various people (Galbraith, 1973). They have the sole or main responsibility of carrying out coordination across inter-organizational systems at HSØ, such as programs or projects. They are distributed throughout the enterprise including HSØ, SP, OUS, and various projects. Architects embedded within projects work closely with project teams to flag and provide input on decisions that affect other projects and ensure the escalation of cross-boundary issues to the Architecture Design Group. Architects also play the role of cross-domain liaisons by working with the business and IT domains in their respective projects. The coordination role of architects is utilized in combination with other coordination mechanisms.

The effectiveness of architects in this coordinating role was found to be dependent on two factors. First, this boundary-spanning role requires multi-disciplinary knowledge. The healthcare context especially demands business/clinical domain knowledge and experience combined with IT skills. However, most architects seem to be technically oriented. Nevertheless, the business analysis function is being addressed through multidisciplinary teams in the Architecture and Design Group and Architecture Board. Secondly, architects seem to have limited authority within projects, diminishing their effectiveness in this coordinating role.

### 4.2.3 Informal coordination mechanisms

Informal coordination mechanisms were also identified at HSØ for fostering collaboration within and across functional boundaries to achieve task integration when work was interdependent, uncertain and time constrained. Informal coordination mechanisms were carried out through informal channels of communication including: informal meetings. Informal coordination mechanisms such as meetings seem to be especially high in this proactive enterprise development context.

The IT architecture consolidation mandate across 10 hospitals and their respective departments involving a large number of stakeholders is bound to create a conflict of interest. One informant stated: “each of these parties have different interests that creates a political storm”. Coordination to drive organizational change in this context requires communication, shared value and trust. Accordingly, informal coordination mechanisms were dependent on the informal constructs of trust, frequent communication, timely and accurate communication, and shared values. One architect stated that: “If the organization does not have trust in me as an enterprise architect no matter how factual what I say is, it won’t be relevant. Establishing trust is extremely important”. Again on communication: “key to operationalizing this integrated projects is communication... however, there are challenges with being able to communicate clearly and regularly”.

The physical colocation of various operational units such as the Integration Factory is also a deliberate effort to foster informal coordination and problem solving by enabling information processing, interpersonal contact and informal channels of communication. However, OUS hospital stakeholders also voiced concerns that loosing many of their IT staff to Sykehuspartner, who were knowledgeable of their hospital and with whom they had strong collaborative relationships, was a setback.

## 5 Analysis

### 5.1 IT Architecture Consolidation and Interdependencies

The case study shows that IT architecture consolidation efforts have enhanced the emergence of various inter-organizational interdependencies. The IT architecture standardization and integration decision has required the tight coupling of not only technical components but also organizational structures
creating a more complex inter-organization arrangement. This has resulted in a greater need for cross-boundary coordination between projects, programs, and operational units such as Infrastructure, Converting, and Integration Factory. The IT architecture consolidation choice has also produced larger number of interdependencies across business, data, applications and technology layers between various hospitals, hospital departments/specializations, and functional units. As the Digital Renewal Program expands from OUS to the other hospitals in the region, system components, organizational units/departments, and stakeholders will also increase. Along with it, interdependencies will likely surge demanding greater coordination effort and cost since complex interdependencies require greater coordination effort (Tushman and Nadler, 1978).

5.2 Interdependencies and Coordination Mechanisms

Numerous interdependencies and the various coordination mechanisms designed to manage them have been identified at HSØ. Ultimately, it may not be possible to anticipate and manage all residual interdependencies due to the emergent nature of such complex systems (Alexander, 1993). As a result, the coordination mechanisms have two attributes based on the nature of the interdependencies they attempt to manage: (1) anticipatory and (2) adaptive. First, anticipatory forms of coordination attempt to manage known interdependencies, which require programmed coordination based on planning. Here, various structural coordination mechanisms have been put in place by the region to manage expected interdependencies. The lead organization (i.e. HSØ) was identified as a central coordinating structure for carrying out high level coordination by pushing strategic mandate down the formalized coordination mechanisms (i.e. boards, steering group, program office etc.). However, centrally programmed coordinating mechanisms may only be adequate under conditions where the task environment and its interdependencies are known and unchanging. These predominantly structural coordination mechanisms allow minimal feedback and mutual adjustment. Therefore, although these centralized and vertical coordinating mechanisms have the formal authority to make decisions, the technical capacity to make them may be hindered because they neglect technical information input for effective decision-making.

Second, adaptive coordination deals with situations marked by variability and emerging interdependencies, which requires coordination based on monitoring, feedback and mutual adjustment. At the operational level, the complexity and scope of interdependencies is greater. Therefore, more coordination mechanisms exist in order to manage larger number of task and resource interdependencies. These interdependencies are characterized by emergence and variability. Therefore, new and unanticipated interdependencies trigger the development of new or adapted forms of formal and informal coordination mechanisms. Compliance through architects embedded in projects, the Architecture Board and the Architecture Design Group are examples of new inter-organizational coordination mechanisms that were initiated late (Early 2015) in the program to manage emerging cross-program interdependencies. Unlike centralized coordination, these coordination mechanisms are more apt to deal with emerging interdependencies (Chisholm, 1989).

5.3 Coordination Mechanisms and IT Governance Forms

New organizational coordination mechanisms lead to the development of new organizational forms (Crowston, 1994; Malone and Crowston, 1994). One type of organizational forms is inter-organizational groups (Alexander, 1993). These inter-organizational groups may take the form of a board, task force, working group, or steering committee (Alexander, 1993). Inter-organizational forms may be assigned decision-making rights and therefore may act as a governance mechanism. They are decentralized ways for facilitating IT governance centralization by being the governance mechanisms through which IT decisions are made and monitored at the line functions. This is where the scope and complexity of decisions grows beyond the limits of simple hierarchical control. In our study, two types of inter-organizational group or lateral coordination mechanisms were identified which came to existence through routinization over time of working groups that were intended to address emerging tech-
nical and data interdependencies. Although these organizational forms do not have a staff of their own, an office location or budget, they do have some authority. For instance, the Architecture Board positioned within the Clinical Solution program has the mandate to make decisions that affect various stakeholders. Therefore, the Architecture Board has emerged as a new governance mechanism that makes IT implementation decisions at the program level.

Emerging coordination mechanisms such as the Architecture Board are legitimized and given decision-making rights at the program level by existing governance structures (IT specification decision rights). Conversely, the need for overt coordination efforts in an organizational setting with multiple components led to changes in governance structures and processes. We see the intertwined role of coordination and governance mechanisms where cross-boundary units (e.g., Architecture Group) carry out dual functions of coordination and governance at the operational level (IT implementation decision-rights).

Overall, our finding show that a purely centralized IT governance structure is inadequate for highly complex and interdependent organizations that aim for an integrated IT architecture at the system development and implementation phase due to their high demand for coordination. At HSÖ, due to the centralized IT governance arrangement, there was a lack of decision-rights and input-rights for specific decision domains, particularly for clinical decisions. For instance, the lack of decision-making regarding lab formats and protocols which should have been made at a higher level to ensure consensus and standardization across hospitals had to be made by a hospital lab working group due to the absence of technical input for decisions at higher levels. The standardization and redesign of clinical business processes have also been difficult to address in the Digital Renewal program and has been largely driven by functional groups in each project.

6 Discussion

Our theoretical emphasis was on how the interplay of organizational IT architecture influences inter-organizational coordination and IT governance arrangements and processes. We propose a conceptual framework which shows that organizational IT architecture consolidation: (1) enhances the need for new coordination mechanisms by increasing residual interdependencies and (2) influences the emergence of new coordination mechanisms that drive coordination-oriented governance approaches that facilitate IT implementation decision-rights (Figure 1). Our findings also show that interdependencies and coordination mechanisms play a key mediating role in the evolution of centralized IT governance towards a hybrid governance configuration that facilitates IT implementation decision-rights.
Based on the empirical findings, we present three contributions to the IT governance and EA literature. The first contribution is an explanation of how IT architecture consolidation produces organizational ripple effect by enhancing interdependencies which require the intensified need for inter-organizational coordination. Our results show that coordination mechanisms are important variables that mediate the implementation of IT architecture integration. Three types of coordination mechanisms were identified by linking them with each category of interdependencies, namely, structural, later and informal coordination mechanisms. Moreover, the ripple effect extends to the emergence of coordination-oriented IT governance arrangements and mechanisms at the line function.

Secondly, healthcare organizations that opt for consolidated IT architecture design choices can govern interdependencies in two main ways: coordination by managing existing interdependencies on ongoing basis by implementing coordination-oriented governance approaches and by organizing technical and organizational components in ways that reduces their interdependency. Ultimately, the association between technological and organizational IT components should be considered together. The extensive coordination effort required to manage the complex set of emerging interdependencies puts into question whether these ongoing organizational costs that are necessary to sustain an integrated IT architecture outweigh its benefits. Therefore, IT architecture choices towards integration should be considered in relation to their organizational ripple effect.

Moreover, an important underdeveloped area in EA is how organizations and managers transforming their IT architecture can leverage on EA to determine what the appropriate size and scope of components (both technical and organizational) should be in order to minimize interdependencies and ensuing inter-organizational coordination efforts. Determining what constitutes an appropriate componentization of a complex system requires detailed knowledge about the process and its surrounding activities in order to recognize interdependencies. Henderson and Clarke (1990) refer to this as ‘architectural knowledge’. The EA repository is a way to develop such enterprise-wide architectural knowledge. However, in the large-scale, complex and dynamic organizations, compiling such architectural knowledge of all interdependencies is difficult if not impossible. For one, residual and emerging interdependencies are difficult to account for in advance (Srikanth and Puranam, 2011). As a result, without such knowledge, these interdependencies have to be managed on ongoing basis through continuous mutual adjustment and feedback (Srikanth and Puranam, 2011). This highlights the importance of social and informal constructs in EA work.
Thirdly and in line with the previous point, we extend the EA literature by highlighting the coordination complexity that organizations face in implementing their IT architecture. We start to fill this gap by showing that coordination mechanisms do not just link the management, business unit and project levels as Ross and colleagues (2006) put forward but that lateral and informal coordination mechanisms are necessary at each level.

Future research could consider what constitutes appropriate components in healthcare organizations and how decision-makers should partition components so as to minimize complexity and coordination efforts. Additionally, this research has focused on one factor of coordination: interdependency. However, both task uncertainty and size are factors of coordination that should be explored (Van de Ven, et al., 1976).

7 Conclusion

The study has highlighted the ripple effect of organizational IT architecture on governance and inter-organizational coordination complexity. The findings show that the coordination mechanisms of IT architecture consolidation, often afterthoughts, are not trivial and require special attention by management. IT architecture consolidation in complex organizational settings augments organizational coordination efforts by increasing socio-technical interdependencies which necessitate coordination-oriented hybrid governance mechanisms. Since the main goal of EA is to support business processes, coordination is a key aspect of EA work that translate technical benefits into business processes improvements. Therefore, both EA research and practice need to provide greater granularity on how EA facilitates coordination in complex organizations carrying out technology-based transformation.
References


