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USING A CO-EVOLUTIONARY IS-ALIGNMENT APPROACH TO UNDERSTAND EMR IMPLEMENTATIONS

Research paper

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Abstract

Electronic Medical Records (EMRs) are repositories of electronic medical histories of patients, maintained over time. Hospital operations and EMRs typically become interdependent, due to the inclusion of medical workflow- and administrative process support as core functionalities. Hence, it is profoundly challenging to effectively enable complex, multi-stakeholder clinical processes, enhance patient care, and align EMRs with hospital strategies, goals, and needs. In this study, we build upon co-evolutionary IS-alignment (COISA) theories and argue that current approaches to business-IT alignment in hospitals should be reconceptualised, particularly regarding modern EMR implementations. In this effort, we respond to the call for more empirical research on business-IT co-evolution. We unfold how COISA manifests during EMR implementations using a multiple case study method. This method allows us to get a rich understanding of the complex social phenomena that emerge during EMR implementations. Outcomes show that COISA manifests in all three cases, involving different stakeholder groups, but in different localities and intensities. These findings suggest that COISA is a suitable framework to describe and understand EMR implementations and that different configurations of interaction patterns can lead to comparable results. This understanding enables EMR practitioners to more effectively identify improvement areas in dealing with internal and external complexity.

Keywords: Co-evolutionary IS-alignment (COISA), complexity science, Electronic medical records (EMR), hospitals.

1 Introduction

The effects of digitisation are becoming widespread in modern societies. Technological change takes place at unprecedented speed, and ordinary lives have become part of collaborative and social networks. These impactful developments also hold for the healthcare sector, and hospitals in particular, as the future of medical practice is evolving due to new exponential and digital technologies (Van de Wetering, Versendaal and Walraven, 2018). Also, emerging technologies in mobile health drastically alter healthcare delivery processes and how patient value is delivered across the healthcare ecosystem (Sako, Adibi and Wickramasinghe, 2017). Consequently, patients and governments have high expectations from the hospital's (digital) services (Liang et al., 2017a, Engelen, 2018). This shift in expectations causes hospitals to strategise toward delivering patient-centred care, i.e., care that is both respectful of, and responsive to, individual patients' needs and values¹.

The shift to patient-centred care has a direct impact on the organisation of hospital IT: *"Today, many hospitals are dominated by systems that are organised in isolated silo structures, which are result of IT systems implemented to support specialised clinical needs. Supporting clinical needs is of course functional from the clinician's perspective, but the typical patient follows a path across organisational boundaries and require different IT systems"* (Bygstad and Bergquist, 2018, p. 3170). Consequently, hospital employees who used to work in silos should now intensively collaborate and work integrally (Sherer, Meyerhoefer and Levick, 2017).

This study focuses on implementations of a specific digital technology where the challenge of integrality is evident, i.e., Electronic Medical Records (EMRs). EMRs can be defined as repositories of electronic medical histories of patients, maintained over time (Kohli and Tan, 2016). The newest generations of EMRs provide integrated information and medical records from different specialists and stakeholders, in line with the principle of patient-centred care. Therefore, multiple stakeholders throughout the hospital have to be involved for an extended period of time. Furthermore, hospital operations become interdependent with the EMR due to the inclusion of complex healthcare process support in these EMRs (Van Eekeren and Polman, 2016, p. 13, Raghupathi and Tan, 2008, Sulaiman and Wickramasinghe, 2014). Hence, the EMR is subject to both strategic and operational objectives from many different stakeholders. Therefore, the quest to effectively enable medical processes, enhance patient care, and 'align' EMRs with hospital strategy, goals, and needs, becomes a profound challenge.

This particular process of applying IS/IT in an appropriate and timely way, in line with strategies, goals, and needs is prominently referred to in the literature as Business/IT alignment (BITA) (Luftman and Kempaiah, 2007). However, in a hospital context, strategies, goals, and needs may change quickly due to the rapid changes in the hospitals' networked ecosystem. Additionally, the many relevant internal and external stakeholders may in their turn have their own (possibly conflicting) strategies, goals, and needs (Currie and Guah, 2007, Pouloudi, Currie and Whitley, 2016, Kizito and Kahiigi, 2018).

The extant scholarship on BITA in a healthcare setting typically studies specific groups of stakeholders, e.g., physicians (Gewald and Gewald, 2018) or nurses (Nguyen et al., 2017). Sulaiman and Wickramasinghe (2014) are an exception, addressing multiple stakeholder groups in their single case study on hospital IT (HIT) assimilation. However, these scholars do not clarify possible interrelations with strategic alignment processes and outcomes. Comparably, Weeger, Ohmayer and Gewald (2015) take a process-view on alignment in a healthcare setting. In doing so, they underline the importance of collaboration between business- and IT stakeholders, but only in an operational alignment setting.

We argue that an understanding of the interrelations between different stakeholder perspectives and between strategic and operational alignment processes is critical in the pursuit of better alignment of EMRs with hospitals' strategies, goals, and needs. Namely, such an approach may point toward integral solutions to the challenges of both internal and external complexity in an EMR implementations context. However, there is no current research holistically addressing these interrelations.

¹ We follow the definition of the IOM (Institute of Medicine).

A stream of research that seems promising in this matter addresses the alignment problem from a co-evolutionary IS-alignment (COISA) perspective (Benbya and McKelvey, 2006, Allen and Varga, 2006, Amarilli, van Vliet and Van den Hooff, 2017, Amarilli, van Vliet and Van den Hooff, 2016, Walraven et al., 2018) COISA implies that alignment is a continuous process including two-way interactions between business, IT and external parties and between strategic and operational alignment processes. Therefore, COISA may provide a holistic understanding of interrelations between different stakeholder groups and strategic and operational alignment processes. As argued, this holistic understanding is critical for HIT practitioners to integrally address internal and external complexity in pursuit of better alignment of EMRs with hospitals' strategies, goals, and needs. However, until now, COISA has only scarcely been applied in empirical studies and to the best of our knowledge, never in a healthcare setting. Hence, the objective of this study is twofold: First, we aim to assess the application of COISA to achieve a better understanding of the alignment dynamics in hospitals by applying this theory to EMR implementations. Second, we aim to refine and validate COISA theory for organisations facing complex conditions, such as hospitals. We thus add to the scientific knowledge base on COISA, where empirical research is still sparse and explicitly called for (Zhang et al., 2019). Our research question is as follows: *How does co-evolutionary IS-alignment manifest in EMR implementations?*

We address our research question using a multiple case study method. This method is suitable because we aim to derive a holistic understanding of the complex social phenomenon that is COISA and to elucidate its theoretical model using empirical evidence (Yin, 2018). This study proceeds as follows. First, we elaborate on the theoretical foundations of this study. We will then discuss our research approach, followed by the results. We will end with our contributions and future research opportunities.

2 Theoretical foundation

2.1 Co-evolutionary IS-alignment

To proceed, we first need to outline our conceptualisation of COISA in this current study. COISA research generally presents complexity-based conceptualisations of alignment, which are especially suitable for organisations facing highly turbulent environments and complex internal structures (Benbya and McKelvey, 2006, Allen and Varga, 2006, Amarilli, van Vliet and Van den Hooff, 2017, Amarilli, van Vliet and Van den Hooff, 2016, Walraven et al., 2018). As explained in the introduction, COISA theories emphasise that alignment is a continuous process including two-way interactions between business, IT and external parties and between strategic and operational alignment processes. Furthermore, this school of thought takes a Complex Adaptive Systems (CAS) viewpoint on organisations as a foundation, implying that “[...] at any level of analysis, order is an emergent property of individual interactions at a lower level of aggregation” (Anderson, 1999, p. 219). There are several conceptual models available that explicate the building blocks of COISA and could thus be possible theoretical foundations of our research (Amarilli, van Vliet and Van den Hooff, 2016). However, not all are well-suited for the aims of this current study given the holistic viewpoint we are looking to apply.

Namely, many existing studies addressing co-evolutionary aspects of alignment focus on only one context of alignment, i.e., strategic, operational or individual, and thus do not fit the complex, multi-stakeholder, multi-context challenge of EMR implementations sufficiently. For example, Liang et al. (2017b) emphasise the importance of social alignment involving two-way interactions between CIOs and CEOs on the strategic level in order to achieve emergent coordination of operational aspects. While these authors address the interaction between strategic and operational alignment processes, they do not cover co-evolutionary interactions taking place within the operational context of the organisation, but instead, handle this as a black box. Contrastingly, Allen and Varga (2006) focus on individual co-evolutionary interactions leading to IS-alignment, explaining the mechanisms underlying these processes within individuals. However, these scholars do not embed individual interactions within strategic and operational organisational contexts. Therefore, although valuable, these articles do not provide the holistic viewpoint we are looking for in this current study.

We identified three existing articles that do address both strategic and operational COISA, i.e., our model (Walraven et al., 2018), Benbya and McKelvey (2006), and Amarilli, van Vliet and Van den Hooff (2017). Benbya and McKelvey (2006) distinguish different three levels of alignment, i.e., individual alignment, operational alignment, and strategic alignment. The model aims to provide a different understanding of alignment using co-evolutionary theories. Stakeholders are not explicitly part of the model in itself. However, the authors do underline the importance of stakeholder perspectives in their theoretical explanation, where they emphasise that different stakeholder groups aim to embed their own views in the IS. (Benbya and McKelvey, 2006) Nonetheless, we found the model to have an insufficient degree of operationalisation to enable empirical measurement, as it is difficult to clearly relate the role of these stakeholders to the conceptual model. On the other hand, the model by Amarilli, van Vliet and Van den Hooff (2017) does provide a solid basis for empirical studies. This is well illustrated by the considered article itself, applying the model directly for empirical measurement in a multiple case study of co-evolutionary alignment mechanisms. The building blocks of this model consist of four alignment mechanisms, i.e., 1) the business challenges the personnel to innovate the IS; 2) the social component of the organisation acts on the IS...; 3) ...and adapts to its changes; 4) the business can leverage and take advantage of the IS to be transformed. However, again, no explicit attention is paid to different stakeholders, making the model insufficient for our purposes.

Our model (Walraven et al., 2018), as depicted in Figure 1, builds upon the insights of the aforementioned scholars. The study where this model was first developed consists of a structured literature review (SLR), aiming to unveil the specific business processes in which co-evolutionary alignment activities among business actors, IT actors and external actors take place (Walraven et al., 2018). In this effort, we drew from existing studies addressing business-IT alignment from a Complex Adaptive Systems perspective. The resulting model includes five different alignment processes in two organisational contexts, i.e., strategy formulation and strategy implementation in the strategic context, IT implementation and IT usage in the operational context, and enterprise architecture management (EAM) bridging the two contexts. Additionally, indications for co-evolution *between* some of the alignment processes were found in this SLR.

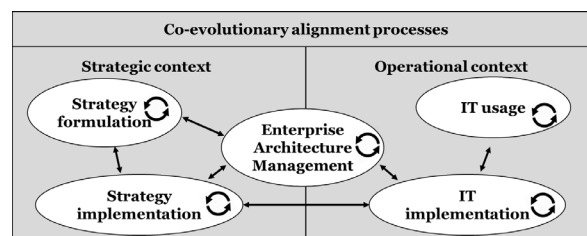


Figure 1. Conceptual model of Co-evolutionary IS alignment

The model explicitly aims to provide an operationalisation for empirical measurement in complex conditions, suiting the goals of this current article very well. Furthermore, the model pays explicit attention to different stakeholder groups by incorporating not just business- and IT-actors, but also external actors playing a role in the alignment processes. Lastly, in our conceptualisation of organisational contexts, we underline differing goals and needs to exist within organisational boundaries, in line with our multiple stakeholder perspective: *“most complex organisations have multiple organisational contexts [...] which, as we have argued, are likely to have different or even contradictory goals and needs. These different contexts within one organisation add to the challenge of alignment and the constant need for change.”* (Walraven et al., 2018). Therefore, we will use this model as our theoretical basis for further empirical analysis.

To further improve structured analysis and to ensure the replicability of our study, we explicated definitions of the indicated alignment processes. To achieve this, we used the article where this model was first developed (Walraven et al., 2018) combined with insights from literature underlying that article. For EAM, some additional sources were added to achieve sufficient refinement for our analysis. Table 1 summarises the working definitions that we applied in this current study.

Alignment process	Working definition
Strategy formulation	The process of defining strategic objectives that the organisation wants to achieve (Liang et al., 2017b, Walraven et al., 2018)
Strategy implementation	The process of setting up and maintaining structures to ensure that strategic objectives are realised in the operational context of the organisation (Liang et al., 2017b, Walraven et al., 2018)
Enterprise Architecture Management	The process of managing an organisation's architecture (Ahlemann, Legner and Schäfczuk, 2012, p. 20)
IT implementation	The process of embedding an IT solution within an organisation (Walraven et al., 2018)
IT usage	The process of employing a system to perform a task (Burton-Jones and Gallivan, 2007, p. 659, Walraven et al., 2018)

Table 1. Working definitions of alignment processes in COISA

Apart from the alignment processes that are central in COISA, we define several guidelines to identify co-evolution taking place within or between these processes. Our model is built upon the foundations of CAS theory, which states that emergent properties, such as alignment, are the result of individual interactions at a lower level of aggregation (Anderson, 1999, Allen and Varga, 2006). Furthermore, extant research has defined COISA as co-evolutionary moves making IT aligned (Benbya and McKelvey, 2006). Thus, co-evolution of these IT-related moves and stakeholders' (support for) strategies, goals and needs should also be assessed at the level of interaction among stakeholders within and between the mentioned alignment processes. Furthermore, the term co-evolution implies a *two-way* interaction (Benbya and McKelvey, 2006). Therefore, we outline co-evolution to take place when in an alignment process, the involved stakeholders and/or technology have a *mutual* influence on IT-related moves, or on stakeholders' (support for) strategies, goals, and needs. Of course, these interactions may cross the boundaries of alignment processes, making co-evolution of stakeholders' (support for) strategies, goals and needs, and IT-related moves also possible *between* different alignment processes.

2.2 Stakeholders in EMR implementations

Because of the importance of involving different stakeholders in EMR implementations, in this current study, we aim to look for relevant stakeholders playing a part in the co-evolutionary interactions within and between the identified alignment processes. Information systems stakeholders can be defined as “*the individuals, groups, organisations, or institutions who can affect or be affected by an information system*” (Pouloudi, Currie and Whitley, 2016). Operationalising this definition to our COISA conceptualisation, we can distinguish at least three different stakeholders as a starting point for our analysis, namely business actors, IT actors and external actors (Walraven et al., 2018). Enriched with the literature on conflicting institutional logics within hospitals (Currie and Guah, 2007, Kizito and Kahiigi, 2018), the list can be further specified by distinguishing management, and medical staff on the business side of the hospital. Palvia, Jacks and Brown (2015) focus on EMR implementations specifically from a stakeholder perspective, distinguishing between vendors and medical providers, adding vendors as a more specific stakeholder in the group of “external actors” indicated in our model (Walraven et al., 2018). Lastly, a group of stakeholders that is particularly important to be included in the group of external actors in an EMR context consists of patients. This provides the following initial list of relevant stakeholders, i.e., the starting point of our analysis: 1) IT actors, 2) Medical staff, 3) Management, 4) EMR vendors, 5) Patients and 5) other external actors. Furthermore, stakeholders are assessed as being involved in an alignment process when they have an executing function within the process.

3 Study design and approach

3.1 Multiple case study approach

In investigating how COISA manifests in EMR implementations, we apply a multiple-case study approach. The multiple case study approach is well-suited for our exploratory study to investigate organisational issues (Benbasat, Goldstein and Mead, 1987) and allows to present rich evidence and a clear statement of theoretical arguments (Eisenhardt and Graebner, 2007). Hence, this approach enables us to explore similarities and differences within and between cases and to gain a better understanding of the phenomena at hand (Baxter and Jack, 2008). As argued by Yin (2018), a multiple case study design should follow a replication logic as applied to experimental research (Barlow and Nock, 2009) instead of a sampling logic as applied to quantitative research. This is very clearly explained by Yin (2018, p. 55): “[...] upon uncovering a significant finding from a single experiment, an ensuing and pressing priority would be to replicate this finding by conducting a second, third, and even more experiments. Some of the replications might attempt to duplicate the exact conditions of the original experiment. Other replications might alter one or two experimental conditions considered challenges to the original finding, to see whether the finding can still be duplicated.”

In this current study, we use literal replications, meaning that all case studies have comparable outcomes, “[...] with the multiple-case inquiry focusing on how and why the exemplary outcomes might have occurred and hoping for literal (or direct) replications of these conditions from case to case” (Yin, 2018, p. 59). In particular, we only include successful EMR implementations in this current study. This approach is comparable to the multiple case study by Olsson et al. (2008), who studied two comparable cases that implemented two-stage offshoring bridge models, aiming to understand similarities and differences between the approach of both case companies.

3.2 Sample selection: EMR implementation cases

To select our case hospitals, we first made a shortlist based on an investigation which hospitals implemented a new EMR between 2015 and 2018 (Van Eekeren and Van Zuilen, 2018). We limited our scope to hospitals in the Netherlands to improve the odds of success in data collection and to minimise possible inter-case cultural differences. We then selected from this shortlist potential cases based on the EMR- and hospital type. We ensured that the implemented EMRs were indeed modern, integrated EMRs providing more functionalities than just patient records (e.g., workflow support, administrative process support). Furthermore, we selected only hospitals that provide complex care as opposed to just basic care, to ensure internal complexity and to improve cross-case comparability. Following, we contacted several consultancy companies specialised in healthcare IT because these organisations were involved in many of the shortlisted EMR implementations. Based on their knowledge of the implemented EMRs and their expectation of hospitals being willing to cooperate in this research, we were able to incorporate three EMR implementations in three different Dutch hospitals in this current study.

3.3 Data collection and analyses

Data collection was done through retrospective interviews with different stakeholder groups. Additionally, we collected project documentation to enable triangulation in our final analysis and to improve construct validity (Yin, 2018).

The interviewees were selected so that we had an optimal representation of each identified stakeholder group, based on the recommendation by Pouloudi, Currie and Whitley (2016). These stakeholder groups include IT, medical, management and external. Furthermore, we aimed to select participants that had a broad overview of the implementation process and the developments therein. We were able to apply this principle because all of the identified implementations had several project leaders and program managers with a background in one of the relevant stakeholder groups in a hospital context. An additional advantage of this second criterion is that we were able to identify interactions between strategic and operational contexts. Namely, the roles of these people are often situated between the strategic and operational levels.

This current study did not capture the patients' perspective because, in all of our case hospitals, there were no representatives of this stakeholder group that fulfilled the criterion of having a broad overview of the EMR implementation. Furthermore, we were able to interview a vendor representative only in Hospital B, because the vendor of the system implemented in Hospital A and C was not willing to cooperate in this study. Table 2 gives an overview of the interviewed roles for each hospital, along with the corresponding stakeholder groups they represent.

Stakeholder group	Case	Hospital A	Hospital B	Hospital C
IT		ICT manager Project leader	ICT architect	Project leader_1 Project leader_2
External		Project leader	Program manager Vendor representative	Program manager Project leader_1 Project leader_2
Management		Project leader	Project leader	Project leader
Medical		Project leader	Information manager	Information manager

Table 2. Interviewed roles for each case hospital

Interview questions were developed based on our two theoretical pillars as outlined in the theoretical framework, i.e., COISA (Walraven et al., 2018) and the stakeholder perspective (Palvia, Jacks and Brown, 2015). All interviews were recorded, fully transcribed and coded in NVivo. Coding of alignment processes was done through thematic analysis (Saldaña, 2009, p. 139), using a deductive approach with pre-defined codes for the COISA processes from our conceptual model. We consecutively applied both deductive and inductive coding to identify stakeholder groups involved in these COISA processes. We used deductive coding when a stakeholder group as identified in our theoretical framework was involved. However, in some instances, we encountered stakeholder groups that did not fit any of the pre-defined stakeholder groups. In other instances, we found that more specific groups within our pre-defined codes should be distinguished. This is where we added codes based on our empirical findings, i.e., an inductive approach. As stated in section 2.2, we deem a stakeholder to be involved when they play an executing role in the alignment process at hand. Furthermore, we coded text passages indicating co-evolution taking place between two or more stakeholder groups within the regarded process. To identify potential influence or co-evolution *between* two alignment processes, we made use of NVivo's functionality of *relations*, enabling us to relate two COISA processes and their corresponding stakeholders with each other. These relations also indicated whether they could be indicated as one- or two-way.

To ensure the reliability of our coding approach, we selected two random interview transcripts, and had these coded both by ourselves and reviewed by an independent researcher. This is comparable to the approach of Anandarajan and Simmers (2005). We retrieved inter-coder agreement of > 90% on these transcripts, providing us with sufficient confidence in our analysis (Boudreau, Gefen and Straub, 2001).

Finally, we cross-checked our findings from the interviews with project documentation for each hospital. For example, we compared formally documented formal program structures with their descriptions given during the interviews

4 Findings

We studied three different hospitals (A, B and C) that recently implemented a new, integrated EMR. Hospital A and C both implemented a system from one vendor, which we will refer to as System 1. Hospital B implemented an EMR from another vendor, which we will refer to as System 2. We characterise both systems as integrated EMRs, including a broad range of functionalities (e.g., workflow support, decision support) apart from just integrated patient records. However, there is an essential difference between the systems: namely, System 1 is highly configurable, leaving many decisions on process design and system configuration to the hospital. System 2, on the other hand, is highly standardised.

Notably, System 2 still has parts to configure and choose from, but to a considerably lesser extent than System 1. The three hospitals provide complex care in addition to standard care, and two of the three hospitals implemented the new EMR parallel to a merger with one or more other hospitals in the region. Table 3 summarises the cases and provides relevant contextual information. In the remainder of this chapter, we will discuss the most notable findings for each of the three cases.

	Hospital A	Hospital B	Hospital C
Size	750-1000 beds	500-750 beds	>1000 beds
No. employees	5000-7500	2500-5000	10000-12500
Simultaneous merger?	Yes	Yes	No
Go-live year	2018	2018	2017
EMR vendor	System 1	System 2	System 1

Table 3. Hospital case overview

4.1 Stakeholder involvement in Hospitals A, B, and C

Table 4 shows the involved stakeholders for each alignment process in Hospital A, B, and C.

Stakeholder	Hospital	COISA process			Strategy formulation			Strategy implementation			EAM			IT Implementation			IT usage		
		A	B	C	A	B	C	A	B	C	A	B	C	A	B	C			
Doctors		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Nurses		■	■		■	■		■	■		■	■		■	■		■	■	
Administrative staff			■			■			■			■			■			■	
Apothecary & Laboratory																			
Finance & Control			■			■			■			■			■			■	
Internal ICT employees																			
Executive management		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Finance management		■	■		■	■		■	■		■	■		■	■		■	■	
IT management		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Middle management		■	■		■	■		■	■		■	■		■	■		■	■	
Program Management				■			■			■			■			■			■
Software vendor					■	■		■	■		■	■		■	■		■	■	
Consultancy			■	■	■	■		■	■		■	■		■	■		■	■	
Patients														■	■	■	■	■	■
Ext. healthcare providers														■	■	■	■	■	■
Ext. project employees																			

Table 4. Stakeholder involvement in alignment processes in each hospital

A few results stand out in this overview. First, representatives from both doctors and nurses played an executing role in almost all processes, in all three hospitals. The only exception is that there were no nurse representatives in the strategy formulation and strategy implementation processes in Hospital C. An important side note to the comprehensive representation of doctors and nurses in alignment processes, is that in EAM, this involvement was mainly visible in the process architecture. Furthermore, in none of the hospitals, patient- or external healthcare provider representatives were involved in strategic alignment processes. However, these stakeholders were involved in IT implementation and IT usage, although this involvement only considered the EMR's portals for these specific stakeholders.

Moreover, Hospital C used many external project employees in IT implementation, compared to Hospital A and B. Lastly, in the IT usage process, in all hospitals, apart from end users, the software vendor was also involved. In all three cases, this involvement entailed on-floor support by employees of the software supplier in the first weeks after go-live, as an addition to in-house trained key users.

4.2 Co-evolution in Hospital A

Hospital A is a merger of two hospitals, whom both had their own EMR. The old EMRs of the formerly separate hospitals were outdated and very complex, making its management and governance near to impossible. Therefore, Hospital A decided to implement a new EMR, aiming to harmonise the processes of both hospitals, while putting more focus on patients. Hospital A chose to implement System 1. Figure 2 depicts our findings in terms of co-evolution in Hospital A.

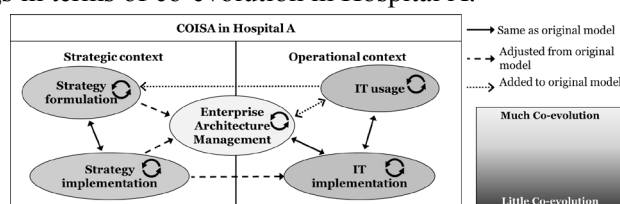


Figure 2. COISA in Hospital A

4.2.1 Co-evolution within Hospital A's alignment processes

We found that Hospital A showed indications for co-evolution in all alignment processes, with a concentration in EAM. This relatively high amount of co-evolution lies in process harmonisation and – definition. Namely, Hospital A created two types of teams for this task. Firstly, they had eight teams working on processes to be harmonised throughout the hospital, including for example medical processes, medication processes, and financial processes. In all of these teams, staff with know-how on the process at hand had an executing role in these teams to come to harmonised processes collaboratively. For example, in the team that considered the medication process, there were two physicians, an apothecary, a nurse, an operational IT employee and several types of assistants, both medical and administrative. These hospital-wide focused teams would then provide guidelines and rules for the second type of teams, i.e., specialism-specific teams. Each of the 34 specialisms had their own team, where also a broad set of role representatives of the specialism at hand was included. Co-evolution was clearest between these specialism-specific teams and hospital-wide teams in the pursuit of adherence to-, or agreed-upon deviation of hospital-wide process guidelines. This was a continuous process during the entire implementation, also providing structures for co-evolution in IT implementation and IT usage processes.

The strategy implementation process in Hospital A showed some indications for co-evolution, although not as frequently as in EAM. The program structure and -approach was a hybrid combination of insights of three crucial stakeholder groups, i.e., the software vendor, internal program management of the hospital, and a consultancy firm. The structure regarding project planning and milestones was derived from the standard approach of the software vendor, while the program organisation structure was developed by internal program management in collaboration with a consultancy firm. The abovementioned process-focused teams came from internal program management: One quote of an external consultant illustrates the influence of the hospital's program management herein: *I had never seen it that way. In the beginning, I had my doubts because I thought, those are many meetings with many different people. But in practice, it works because everyone has their own share and the hospital-wide guidelines provided a basis for discussions.* Furthermore, the internal project manager who, among others, came up with the project structure, explains that some persuasion was needed toward the vendor, too: *“You have to be well-prepared because this vendor works mainly around applications, while we had deliberately set up our end-user teams around processes. In the beginning, this really was a struggle to keep it that way. But we believed in what we were doing: we felt like we knew why we did it that way. But we had to justify ourselves”*

4.2.2 Co-evolution between Hospital A's alignment processes

We found several indicators of co-evolution taking place between Hospital A's alignment processes. First of all, we found co-evolution between strategy formulation and strategy implementation. Strategy formulation was initially done by a committee consisting of executive management, doctors, middle management and IT management, as a basis for the EMR vendor selection. Nurses were represented by a member of middle management who was highly knowledgeable of nursing related processes. However, when the EMR implementation formally started, the newly formed project group did another iteration on the strategic principles, refining them. Nurses also participated in this project group. Because the formation of the project group was part of the strategy implementation process and the strategic principles were slightly adapted, this provides evidence for co-evolution between strategy formulation and strategy implementation processes.

Between strategy implementation and EAM and between strategy implementation and IT implementation, only one-way interactions could be identified, contrary to our original model: Namely, the earlier described project structure that enabled EAM on a processual level, evidently, directly influenced the EAM process. However, from our analysis, we could not identify and extract interactions in EAM that directly influenced strategy implementation. The same goes for IT implementation. Strategy implementation influenced IT implementation, i.e., the program planning and organisational structure applied in IT implementation were, of course, the result of the strategy implementation process. However, in maintaining the structures to implement strategic principles, influence from the strategy implementation process was also clearly visible: Namely, every meeting on the process- and system configurations in IT implementation was started with the core strategic principles to provide guidelines for the decisions to be taken. IT usage influenced strategy formulation, EAM and IT implementation processes, because end users were involved in each of these processes, bringing along their earlier experiences. The other way around, EAM and IT implementation had a direct influence on the IT usage process because these determined the work processes and corresponding system configurations, respectively.

4.3 Co-evolution in Hospital B

The EMR implementation in Hospital B was, like Hospital A, the result of a merger between two separate hospitals, who wanted to join forces and collaborate in providing better healthcare in the region. Hospital B chose to implement System 2. Figure 3 presents an overview of the co-evolution we found within and between the alignment processes during the EMR implementation in Hospital B.

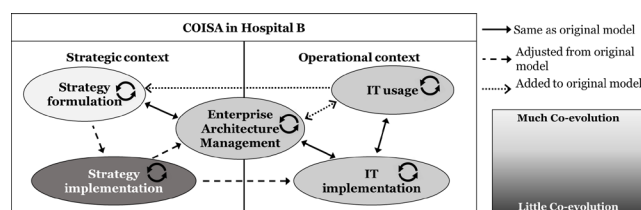


Figure 3. COISA in Hospital B

4.3.1 Co-evolution within Hospital B's alignment processes

The first notable finding is that in Hospital B, we found indications for high levels of co-evolution taking place in strategy formulation. Namely, before the vendor selection, interviews and workshops with many different stakeholder groups were organised by the consultancy company involved in the selection. The insights from these interviews and workshops, combined with market insights and the overall hospital strategy formed the basis of the strategic principles underlying the vendor selection. Thus, in Hospital B, strategy formulation was a co-evolutionary process between executive management, consultancy and medical, administrative and IT staff of Hospital B. The latter three groups were involved in the above-mentioned interviews and workshops.

The strategy implementation process in Hospital B had minimal indications for co-evolution. Namely, the project structure and approach was the standard approach of the vendor of System 2. As explained

by the external program manager: “The approach was proven, they [the software vendor] did this more often, so there was no discussion. It enables us to explain it to the hospital: this is how we will do it”. The only possible indication of co-evolution in the strategy implementation process, is that the program plan was written by the external program manager, with input from several colleague consultants and one IT project manager in Hospital B. Consequently, the expertise and insights from the consultancy company probably directly influenced the final structures forming the basis of strategy implementation.

In the EAM process, there was co-evolution. In the more technical areas, this co-evolution took place between the software vendor and an internal ICT architect. However, co-evolution was more clearly visible on the level of process architecture, where two expert groups, i.e., one consisting of doctors and one consisting of nurses, jointly were responsible for hospital-wide processual decisions. In doing so, the expert groups received input from domains and underlying project groups responsible for department-specific process definition and corresponding IT implementation. The same structures provided the basis for co-evolution taking place in IT implementation. Within the IT usage process, there was co-evolution as well. This co-evolution mainly took place by colleagues training each other and by doing so, improving employees’ system understanding and attitudes toward the new EMR.

4.3.2 Co-evolution between Hospital B’s alignment processes

In Hospital B, EAM and strategy formulation processes showed co-evolution because, on the one hand, the ICT architect was directly involved in strategy formulation, while on the other hand, strategic principles following from the strategy formulation process, provided guidelines for the EAM process. EAM and IT implementation also showed co-evolution: namely, on the one hand, processual decisions stemming from EAM provided guidelines in IT implementation, while IT implementation sometimes influenced EAM, as there were examples where Hospital B would consciously deviate from architectural principles due to other circumstances. Co-evolution between EAM and IT usage took place because IT users were directly involved in the harmonisation and redefinition of organisational processes, which in their turn constrained how the EMR could be used in practice. Comparable mechanisms were at play in the co-evolution between IT usage and IT implementation: IT users were directly involved in IT implementation processes, while the decisions regarding system configurations constrained EMR use in practice.

We also found indications for one-way interactions between processes. For example, IT users had a direct influence on the strategy formulation process. However, our analysis did not show indications of the strategy formulation process directly influencing IT usage. The same holds for strategy formulation and strategy implementation: as far as our knowledge goes, strategic principles were not changed due to interactions in the strategy implementation process. However, strategic principles did provide a basis for strategy implementation, providing evidence for a one-way interaction from strategy formulation to strategy implementation. In the same vein, strategy implementation provided guidelines for EAM and IT implementation, but the other way around, we could not identify any indicators of direct influence.

4.4 Co-evolution in Hospital C

Hospital C is a large hospital that decided to implement a new EMR because their old EMR was end-of-life. The hospital had a rigorous timeline to achieve its goals as the support of their old EMR would end soon. Figure 4 depicts the co-evolution in Hospital C.

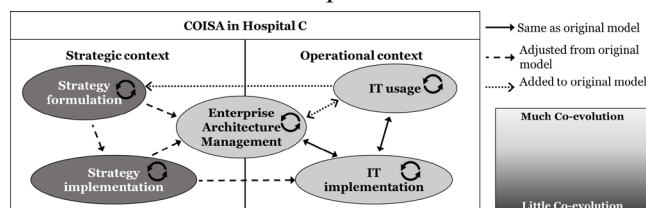


Figure 4. COISA in Hospital C

4.4.1 Co-evolution within Hospital C's alignment processes

The first thing that stands out in Figure 4 is the relatively low levels of co-evolution in strategy formulation and strategy implementation processes. The vision that formed the basis of the EMR implementation was formulated by a group of two doctors, two internal IT project leaders, and the external program manager. Two communication experts supported this group, and the hospital-wide strategy formed the basis of this vision. Results were presented to the board of directors and operational employee representatives. However, these presentations did not change the content of the strategy, so that no co-evolution could be demonstrated there, apart from possible co-evolution within the team responsible for the vision. In the strategy implementation process, there also was minimal co-evolution. The program structure was almost entirely set up by the external program manager, and the software vendor defined the program approach.

For EAM, comparable to Hospital A and B, in the more technical areas, co-evolution would only take place between internal IT employees and the software vendors. Moreover, again, most co-evolution within this particular alignment process could be found on the process level of EAM. Herein, Hospital C had an approach very similar to Hospital A: they appointed three core teams, i.e., one medical core team, one nursing core team, and one administrative core team. These teams were responsible to take decisions on hospital-wide processes. The core teams received input from the project teams, responsible for the configuration of the EMR. Furthermore, there were departmental teams, which were created to decide on specialism-specific system configurations. However, Hospital C had, contrary to Hospital A, no employees entirely dedicated to coordinating these departmental and hospital-wide teams.

In IT implementation, the structures essential for EAM on a process level also ensured co-evolution to manifest between the employees configuring the system and the end-users in the departmental teams and core teams. However, an important side note, in this case, is that this went considerably better for the modules that served only one department, for example, the team responsible for the radiology module of the EMR. Some project teams had to communicate with all 45 specialist departments. Indeed, communication with departmental teams was a more significant challenge for two reasons: Firstly, it simply costs a lot more time to align decisions with 45 departments instead of one or two, and the team did not have enough resources to do this as intensively as they would have wanted. Secondly, as said, there were no people fully dedicated to the coordination among departmental teams, and between departmental and hospital-wide teams.

4.4.2 Co-evolution between Hospital C's alignment processes

We only found co-evolution between alignment processes in the operational context of this hospital. Co-evolution between IT usage and IT implementation occurred because end users were directly consulted and actively influenced decisions considering the configuration of the EMR in the IT implementation process. The other way around, this EMR configuration directly influences the way the EMR is used in practice. Furthermore, co-evolution between IT implementation and EAM occurred in two ways: First, the processual decisions made in the EAM process were reflected in the configurations of the EMR itself, and second, the processual decisions were constrained or enabled by (im)possibilities of the system. Lastly, we found co-evolution between IT usage and EAM, because end users were actively involved in the process redefinition within Hospital C. Between all other alignment processes, we only found one-way interactions: strategy formulation set the guidelines for EAM and strategy implementation, while strategy implementation set up the structures for EAM and IT implementation. Furthermore, there was a one-way interaction from IT usage to strategy formulation because doctors (i.e., end users) were involved in the strategy formulation process and took along their IT usage experience with them.

5 Discussion, conclusion, and limitations

This study shows that our COISA model is suitable to demonstrate and visualise alignment process interactions during EMR implementations and provides an insight into the interrelations between strategic and operational alignment and co-evolution between stakeholders. Following our rigorous analyses, we found that many different stakeholders take part in COISA processes, in both strategic and

operational contexts. Moreover, we found that co-evolution takes place within all processes in all three hospitals. We also found evidence for interrelations between the different alignment processes. However, the degrees of co-evolution and the processes in which co-evolution prevailed differed from case to case.

A commonality across all cases is that the co-evolution within the EAM process especially played a substantial role in aligning the EMR configuration with strategies stemming from the strategy formulation process. The prevailing co-evolution between EAM and IT implementation in each of the hospitals might be a possible explanation for this finding. Another commonality found across all cases is the involvement of medical staff in *all* alignment processes. In all hospitals, doctors and in most cases, nurses, had an executing role in every process. This particular involvement might have contributed to the levels of support among other medical staff in the hospital and thus to successful EMR implementations. These particular outcomes are in line with previous findings on EMR alignment (Weeger, Ohmayer and Gewald, 2015, Gewald and Gewald, 2018, Nguyen et al., 2017).

Furthermore, it is notable that, even though all three case hospitals have patient centrality as one of their strategic principles, patient involvement in alignment processes is not very prominent and limited to discussions on patient portals in IT implementation, where they are represented as end users.

Differences between our case hospitals lie mostly in the locality of co-evolution. For example, in Hospital B, co-evolution seems to be concentrated more in the strategic context, while in Hospital C, this seems to be the case in the operational context. Hospital A falls right in between these hospitals by having its concentration of co-evolution in EAM, right between strategic and operational contexts.

This current study provides several notable contributions. Firstly, using COISA as a theoretical framework, we show that in all three of our cases, different stakeholder perspectives were represented in all alignment processes and interrelations also existed between strategic and operational contexts. In this effort, we provide a new theoretical lens to explain and understand the complex, multi-stakeholder alignment interactions that play a part in EMR implementations.

In particular, this new lens combines insights of interrelations between strategic and operational alignment contexts with interrelations between different stakeholder perspectives. This understanding enables practitioners to target improvement areas in integrally addressing internal and external complexity faced by hospitals, as both perspectives are crucial in the challenge of aligning EMRs with hospitals' strategies, goals, and needs. Furthermore, we refine and empirically validate our COISA model in an EMR implementation context, providing a solid basis for further operationalisation of this theoretical concept. In doing so, we add to the knowledge base of BITA generally and COISA specifically.

Our study has several limitations that should be addressed by further research. Firstly, our study only focuses on EMR implementations and thus does not take into account the interactions that are at play during EMR operations. A more in-depth investigation of COISA during EMR operation builds upon the research by Sulaiman and Wickramasinghe (2014), who identified a gap to exist between HIT implementation- and operations phases. Another limitation of our study is that we used a retrospective interview technique, which might have slightly altered the perceptions of real-life experiences of our respondents. Future research could aim to use a more longitudinal approach, adding observations as a research method to get a more comprehensive view of the studied phenomena. Moreover, we did not take into account the patient perspective in this current study, which would be especially interesting in the operations phase, as this is the phase where patients should be confronted with the EMR's effects and benefits. Lastly, we currently only focused on three cases, which all considered successful implementations. Future research could investigate a more substantial amount of hospital cases, possibly including failed implementations, to validate and compare findings, or even apply a more quantitative approach to get additional insights into the manifestation of COISA in a healthcare setting. Another line of thought that future research could address is to focus on the different enablers and inhibitors of these and other EMR implementations and to discover whether these manifested in our cases and thus could explain the successful go-live, despite or, possibly, thanks to their differences in terms of COISA.

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