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Leveraging IS in the complexity of healthcare: a combined NCA- and PLS-SEM analysis on the effects of co-evolutionary IS-alignment

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LEVERAGING IS IN THE COMPLEXITY OF HEALTHCARE: A COMBINED NCA- AND PLS-SEM ANALYSIS ON THE EFFECTS OF CO-EVOLUTIONARY IS-ALIGNMENT

Research Paper

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Abstract

Several studies have advocated for the value of co-evolutionary approaches to business-IT alignment in healthcare settings because they would be better suited to deal with complexity. However, empirical evidence supporting this premise is scarce and mainly based on qualitative works. We address this research gap by performing a survey among 85 Dutch healthcare organizations, looking into the effects of co-evolutionary information systems alignment (COISA) on organizational performance and the role of dynamic capabilities in this value path. We combine Necessary Condition Analysis and Partial Least Squares Modeling to see which aspects are indispensable and help further develop dynamic capabilities and performance. Our results confirm that COISA indeed positively influences healthcare organizations' organizational performance through dynamic capabilities. Furthermore, we demonstrate that alignment motivation and interconnections between heterogeneous IS stakeholders are indispensable, and show the seemingly higher importance of the operational and orchestrational alignment competencies and the sensing dimension of dynamic capabilities.

Keywords: Co-evolutionary Information Systems Alignment, Dynamic Capabilities, Organizational Performance, Healthcare, NCA, PLS-SEM

1 Introduction

Healthcare is facing more complexity than ever before because of the rising number of stakeholders through the shift to healthcare provision in ecosystems, and through societal developments including the COVID-19 pandemic and consistent healthcare personnel shortages (Korneta et al., 2021; Mohrman & Shani, 2014; Sutherland et al., 2020). Healthcare organizations do not only have to deal with these challenges, but they are expected to innovate and implement advanced information systems (IS) to improve their quality of care, cost efficiency and responsiveness amidst these complex developments further. These IS are expected to provide organizations with the ability to exchange information on an ecosystem level, to provide physicians and nurses with advanced decision support, and to give patients more autonomy in their healthcare trajectories (Faber et al., 2017; Sneha & Straub, 2017).

To successfully leverage the potential benefits of these IS, healthcare organizations have to continuously bring and keep Information Technology (IT) in line with strategies, goals, and needs of the healthcare organization and its stakeholders. In the extant literature, this effort is also referred to as business-IT

alignment (BITA) (Luftman & Kempaiah, 2007). The importance of BITA in a turbulent environment has, for example, become clearly visible in the added value of applying telehealth during the COVID-19 pandemic (Monaghesh & Hajizadeh, 2020). Apart from the quickly changing conditions in healthcare, another factor that further increases the challenge of BITA in healthcare specifically is the pluralistic nature of this particular sector (Llamzon et al., 2021). Specifically, the healthcare ecosystem consists of many different intra- and extraorganizational actors with different goals, knowledge, power levels, and practices. This makes effective alignment in digitalization efforts even more complex, increasing the need for more insight and better approaches to address this problem.

Recent qualitative studies carried out in the context of Electronic Medical Records implementations in hospitals have shown that a complex adaptive systems (CAS)-based, co-evolutionary approach to BITA could be helpful for hospitals to effectively deal with the abovementioned complexity in the pursuit of alignment of EMR (Walraven et al., 2019, 2020). The authors explain that this stance comes from the principle of requisite complexity, based on Ashby's law of requisite complexity (*"[…] only variety can destroy variety"*) (Ashby, 1956, p. 207). This principle states that *"[…] in order to remain viable, a system needs to generate the same degree of internal complexity as the external complexity it faces in its environment"* (Benbya & McKelvey, 2006, p. 290). In other words, the authors of these studies imply that healthcare organizations should be better prepared to deal with their environment's complexity and perform better overall in these conditions, by applying CAS principles in their alignment capabilities.

However, research on this topic has been limited to conceptual and qualitative studies, and empirical work has not gone beyond EMR or hospital contexts. Therefore, there is a call for more empirical research to investigate the promise that CAS-based alignment capabilities actually help healthcare institutions on an organizational level to thrive in complex conditions (Zhang, Chen, & Lyytinen, 2019; Zhang, Chen, Lyytinen, et al., 2019).

This paper aims to address this issue by examining the effects of co-evolutionary information systems alignment (COISA) on organizational performance in healthcare settings. In this effort, we take a dynamic-capabilities perspective on organizational performance. Dynamic capabilities comprise a framework from strategic management literature (Helfat et al., 2009; Teece, 2007; Teece et al., 1997), addressing how organizational performance and competitive advantage can be improved. It is specifically suited for highly turbulent environments and looks into *"[…] the capacity of an organization to purposefully create, extend, or modify its resource base"* (Helfat et al., 2009) as a basis for organizational performance. This seems a fitting approach given its explicit focus on dealing with turbulence and complexity. Based on the above, our research questions are as follows:

RQ1: *To what extent does co-evolutionary IS alignment influence organizational performance in healthcare?*

RQ2: *What is the particular role of Dynamic Capabilities in the value path?*

In the remainder of this paper, we will first elaborate on the theoretical foundations of COISA and dynamic capabilities. Then we introduce our conceptual research model and hypotheses. Following, we explain the used methodology, which includes a quantitative dataset analyzed through Partial Least Squares Structural Equation Modeling (PLS-SEM) and Necessary Condition Analysis (NCA) (*"… a research approach and data analysis method that is based on the logic that factors can be necessary but not sufficient for an outcome to occur"* (Dul, 2019, p. 1)). Combining these analysis techniques is relatively new, but relevant, as Richter et al. (2020) argued. Finally, we elaborate on our results and their implications, followed by a discussion of our study's limitations and suggestions for future research.

2 Theoretical background

2.1 Co-evolutionary approaches to business-IT alignment

Co-evolutionary approaches to business-IT alignment view alignment as an emergent, continuously changing phenomenon arising from the co-evolutionary dynamics between business- and IS-components of organizations (Amarilli et al., 2016; Benbya & McKelvey, 2006; Walraven et al., 2018).

Early work on this topic underlines the viewpoint that alignment is a two-way street because the business does not only influence IT but also the other way around (e.g., Cecez-Kecmanovic & Kay, 2001). More recent work builds upon the notion of organizations as CAS, where alignment emerges from continuous socio-technical co-evolutionary interactions among actors and technologies in organizations (Allen & Varga, 2006; Kim & Kaplan, 2006; Walraven et al., 2018). This CAS perspective is argued to be specifically useful in complex conditions, because of the earlier mentioned principle of requisite complexity (Benbya & McKelvey, 2006). Some of these studies applying CAS principles on alignment focus on describing alignment's microfoundations conceptually (e.g., Allen & Varga, 2006; Benbya & McKelvey, 2006). Other works limit their application of CAS-principles to a specific level of alignment, e.g., strategic alignment (Baker et al., 2011; Liang et al., 2017; Tanriverdi et al., 2010; Yeow et al., 2017). However, as argued by Walraven et al. (2018, p. 5) in their structured literature review (SLR) of co-evolutionary alignment studies, based on the multi-level approach taken by Benbya & McKelvey (2006): *"[…] to fully grasp COISA, taking a CAS perspective on organizations advocates a holistic perspective of alignment, while acknowledging its foundation of individual interactions"*.

In line with this viewpoint, these authors further developed the conceptualization of COISA in this particular SLR (Walraven et al., 2018). To do so, they identified the business processes where co-evolutionary alignment interactions take place in practice. These processes include 1) strategy formulation and 2) strategy implementation in the strategic alignment context; 3) IT usage and 4) IT implementation in the operational alignment context and 5) enterprise architecture management (EAM) bridging the two contexts (Walraven et al., 2018).

This perspective has been empirically tested and refined through its application to hospital EMR implementations using three case studies and several expert focus groups (Walraven et al., 2019, 2020). As a result, the alignment processes were empirically verified, and several factors were identified that promote *effective* co-evolutionary interactions in pursuit of alignment, including alignment motivation (*why do we do this in the first place?*), stakeholder involvement (*who should we involve to ensure efficacy of alignment interactions?*), interconnections (*By which means do we interact on making decisions on these topics among IS stakeholders to ensure the efficacy of alignment interactions?*) and alignment decisions (*Which alignment-related decisions among IS stakeholders improve the efficacy of future alignment interactions?*).

Based on these empirical studies, the same authors have developed a COISA scale suited for quantitative works according to well-known scale development standards where they conceptualize COISA as a whole as an organizational capability (Walraven et al., 2021). We choose to apply this particular conceptualization of COISA because of its theoretical foundations in CAS (Walraven et al., 2018), its earlier empirical application in healthcare settings (Walraven et al., 2019, 2020) and the fact that its operationalization for quantitative studies has been developed already through rigorous standards (Walraven et al., 2021) In the next paragraph, we will further elaborate on this particular conceptualization.

2.2 Co-evolutionary Information Systems Alignment

We conceptualize COISA based on the work by Walraven et al. (2021). These authors define COISA as follows: *"[…] an organizational capability defined as continuously exercised alignment competencies, characterized by co-evolutionary interactions between heterogeneous IS stakeholders, in pursuit of a common interpretation and implementation of what it means to apply IT in an appropriate and timely way"* (Walraven et al., 2021, p. 6017). Specifically, the conceptualization consists of three alignment competencies, enabled by two facilitators (Figure 1).

The three alignment competencies in this conceptual model are directly derived from the earlier mentioned alignment processes (Walraven et al., 2018, 2019). Specifically, the strategic alignment competency comprises strategy formulation and strategy implementation processes; the operational alignment competency comprises IT usage and IT implementation processes and the orchestrational alignment competency comprises the enterprise architecture management process and co-evolutionay interactions between operational and strategic alignment processes.

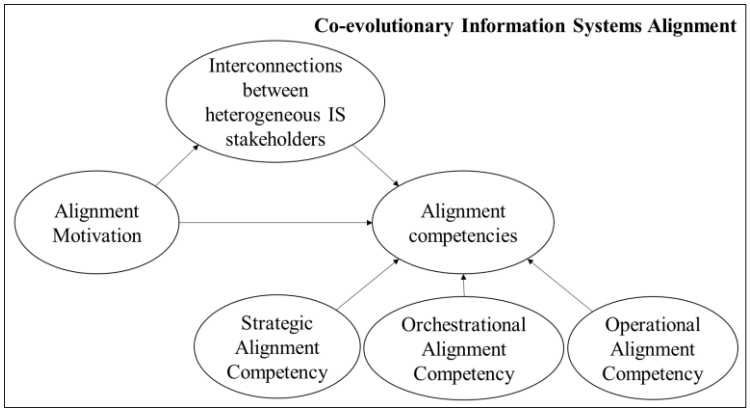

Figure 1 Conceptual model of COISA (Walraven et al., 2021)

The facilitators in this model are synthesized from the enabling factors (Walraven et al., 2020). Specifically, alignment motivation is taken directly from the findings of Walraven et al. (2020); interconnections between heterogeneous IS stakeholders is a construct that is synthesized from the enabling factors interconnections and stakeholder involvement; and the enabler alignment decisions has been deliberately left out of the measurement scale, as explained by Walraven et al. (2021, p. 6019): *"[…] the specific decisions improving future alignment interactions are very much context-dependent and do not directly give insight in the alignment interactions themselves"*. The definitions of the different concepts comprising the resulting model are summarized in table 1.

Concept	**Definition**
Alignment motivation	*"The degree to which IS stakeholders are motivated to actively engage in co-evolutionary (two-way) alignment interactions within and between alignment competencies (e.g., through intrinsic motivation, deadlines, legislations, support by Executive Management, being held responsible"* (Walraven et al., 2021, p. 6021)
Interconnections between heterogeneous IS stakeholders	*"The degree to which heterogeneous IS stakeholders have means to engage in coevolutionary alignment interactions within and between alignment processes through formal governance structures, informal networks, and supporting platforms."* (Walraven et al., 2021, p. 6020)
Strategic Alignment Competency	"*An organization's ability to formulate strategic goals, and articulate strategic plans and structures to implement these goals in relation to IS, while monitoring relevance and topicality of these plans, goals, and structures, in line with frequencies of internal and external changes.*" (Walraven et al., 2021, p. 6020)
Orchestrational Alignment Competency	*"An organization's ability to maintain the coherence of their architecture, through architectural practices such as the definition and application of architectural principles and standards, while monitoring relevance and topicality of these architectural practices, in line with frequencies of strategic and operational changes."* (Walraven et al., 2021, p. 6020)
Operational Alignment Competency	*"An organization's ability to collaboratively use IT solutions effectively in daily operations, and to implement and optimize IT solutions in operational settings in line with end-users' needs, while monitoring and leveraging improvement possibilities during IT usage, implementions, and operations."* (Walraven et al., 2021, p. 6020)

Table 1 Definitions of concepts comprising COISA

2.3 Dynamic capabilities

The Dynamic Capabilities framework is a leading framework in the management literature that describes how firms can achieve and maintain a competitive advantage in turbulent and complex environments (Teece et al., 1997). The framework builds upon the resource-based view of the firm, which argues that

a firm's competitive advantage emerges from its resources, competencies and capabilities, based on the idea that these internal assets are valuable, rare, inimitable and non-substitutable (Teece, 2007; Wade & Hulland, 2004; Wójcik, 2015). The dynamic capabilities framework adds to this perspective by focusing on a firm's capacity to extend, modify and reconfigure these internal assets in line with the complex environment of the organization at hand (Helfat et al., 2009; Pavlou & El Sawy, 2011). Generally, the microfoundations of dynamic capabilities are described in terms of three routines that organizations should have in place to be successful in complex conditions, i.e., (1) Sensing their environment, (2) Seizing opportunities, and (3) Reconfiguring assets (Teece, 2007). Dynamic capabilities are explicitly meant to enable organizations to perform better in complex circumstances. Their applicability to the public sector and thus healthcare has been demonstrated (Piening, 2013, p. 218): *"Like for-profit firms, PSOs* [Public Sector Organizations] *function as a collection of resources and organizational routines aimed at fulfilling policy initiatives and providing services […] both types of organizations modify their operational routines in pursuit of improved effectiveness".* Therefore, we choose to adopt the dynamic capabilities framework to empirically investigate the premise that COISA as a CAS-based alignment capability enables organizations to perform better in complex circumstances.

2.4 Hypotheses development

In line with our research question, we position the COISA capability as our independent variable and investigate its impact on organizational performance through the mediation of dynamic capabilities. The resulting conceptual model is pictured below in Figure 2:

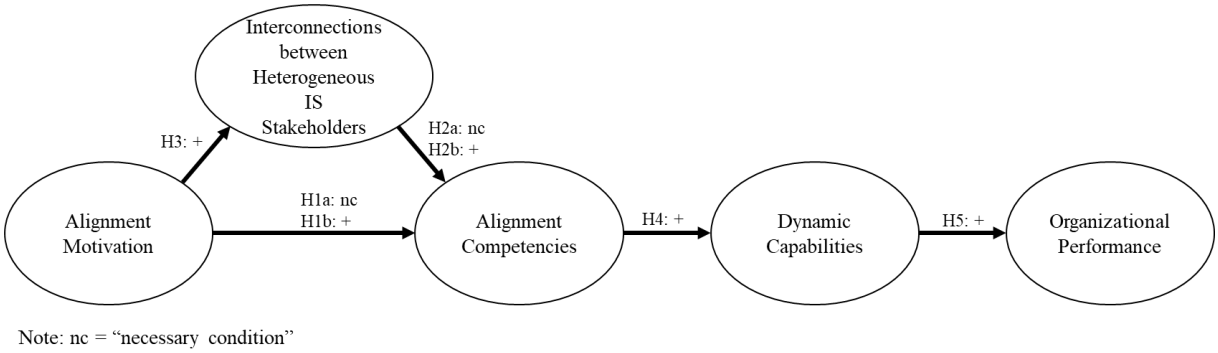

Figure 2 Research model and hypotheses

The first three hypotheses are an inherent part of our COISA conceptualization, i.e., the presumed *necessity* of alignment motivation and interconnections between heterogeneous IS stakeholders for the manifestation of alignment competencies (H1a and H2a), and the positive influence of these constructs on alignment competencies and of alignment motivation on interconnections between heterogeneous stakeholders (H1b, H2b and H3).

In their study on understanding IT business value, Cao et al. (2016) introduce the concept of systemic capabilities as *"[…] the emergent systems abilities generated at the systems level from the synergistic interrelations between IT and other systems elements within an organization*". This definition resonates with COISA in that these authors conceptualize organizations as systems. In doing so, they look at their capabilities (such as the COISA capability) as being shaped by the *synergistic* interrelations among its elements, such as IT components and employees. The elements comprising the systemic capability of COISA comprise for a large part human actors, as is clear from its description in section 2.2. Given this characteristic and the explicit goal of achieving and maintaining synergy, the human actors as part of the system must be motivated to engage in alignment competencies in a constructive manner actively. This is demonstrated by the study by Walraven et al. (2020) in the context of Electronic Medical Records implementations, and supported by several strands of CAS-informed research on alignment and organizational decision-making (e.g., Kaminska-Labbé et al. (2008)). In these research strands, this

concept of alignment motivation is often referred to as adaptive tension. Benbya & McKelvey (2006) in their work argue why this adaptive tension is an indispensable driver of alignment competencies: *"[…] IS/Business coevolution is instigated by adaptive tension imposing on interactions among overlapping sets of individual and group perspectives. Furthermore, as the broader environment and the intersecting 'worlds' continue to change (slowly or rapidly), adaptive tension increases: changes that the system has to address if it is to remain effective become evident, as do tensions calling for aligning IS to changing organizational needs"* (Benbya & McKelvey, 2006, p. 290). This idea is confirmed by Weeger and Ulrich (2016, p. 5), who demonstrate the positive impact of relational motivation, i.e. "*[…] the willingness of the actors to define and act on collective goals"* on the outcomes of health IS systems implementations, implying well-functioning alignment competencies.

Hence, we hypothesize:
H1a: Alignment motivation is a necessary condition for alignment competencies

H1b: Alignment motivation has a positive impact on alignment competencies

Furthermore, of course, interrelations need to be there in the first place before they can be characterized as being synergistic. This is confirmed by several studies on alignment in healthcare settings, underlining the importance of domain sharing across stakeholder groups in the development of an alignment capability (Sha et al., 2011; Weeger et al., 2015). These insights bring us to our first and second hypotheses:

H2a: Interconnections between heterogeneous IS stakeholders are a necessary condition for alignment competencies
H2b: Interconnections between heterogeneous IS stakeholders have a positive impact on alignment competencies

Moreover, we argue that when alignment motivation is in place, chances are higher that interconnections between heterogeneous IS stakeholders are in place. Namely, when stakeholders are motivated to engage in co-evolutionary alignment interactions, they also have a motivation to set up formal communication structures to enable these dialogues, to use existing or set up new informal networks or to implement supporting platforms to do so (Walraven et al., 2021). Hence, we hypothesize:

H3: Alignment motivation has a positive impact on interconnections between heterogeneous IS stakeholders

Several strands of research may inform the hypothesized relationships between alignment competencies as part of the COISA capability, dynamic capabilities, and organizational performance. Firstly, several IS scholars have found that dynamic capabilities generally and in healthcare specifically can be IT-enabled (Mikalef et al., 2021; Pavlou, 2000; Van de Wetering & Versendaal, 2021), in the sense that having specific IT assets in-house may enable an organization to better deal with complex and turbulent environments. In the same line of thought, we argue that having a COISA capability in place may also enable general dynamic capabilities, given the nature of the COISA capability. After all, COISA aims to have effective processes in place to continuously exercise alignment competencies, in pursuit of a common interpretation, but, more importantly, implementation of what it means to apply IT appropriately (Walraven et al., 2020). Thus, having an effective COISA capability suggests having aligned IT, which in turn can enable dynamic capabilities (Mikalef et al., 2021; Pavlou, 2000; Singh et al., 2011). This viewpoint also resonates with the concept of intra-organizational social alignment as introduced in the context of healthcare service innovation by Marsan et al. (2017)

Furthermore, several studies suggest that dynamic capabilities are built upon other capabilities, as, for example, stated by Felin et al. (2012, p. 1355): *"The logic that dynamic capabilities operate on other capabilities indicates that capabilities evolve within a hierarchy."* We propose that this is also the case by looking at the relationship between the COISA capability and an organization's more general dynamic capabilities. Specifically, COISA can be conceptualized as a hybrid capability, i.e., a combination of an operational and a dynamic capability, as introduced by Helfat and Winter (2011). Namely, the alignment competencies are specifically measured in relation to the rate of change in operational, strategic, and external contexts and the rate of opportunities in operational settings, as

Walraven et al. (2021) explained. However, the most important difference between COISA and more general dynamic capabilities is that general dynamic capabilities focus on the challenge to adequately sense and respond to environmental complexity by reconfiguring internal resources in a broad sense, while COISA focuses only on the continuous pursuit of IS alignment in a specific organizational context, given these complex conditions. Thus, the COISA capability's focus is on adequate responses to change, comparable to general dynamic capabilities (Helfat et al., 2009), just focused on a specific theme, i.e., information systems. Therefore, the experience in building and developing a COISA capability may help in developing broader dynamic capabilities due to organizational learning (Zollo & Winter, 2002). Hence, we hypothesize:

H4: Alignment competencies have a positive impact on dynamic capabilities

The premise of dynamic capabilities is that they help organizations improve their performance in turbulent and complex conditions (Mikalef et al., 2021). Since the healthcare sector is characterized by a complex, turbulent environment, it is unsurprising that several studies have indeed found evidence for the proposition that dynamic capabilities help in promoting organizational performance in this particular sector (e.g., Singh, Mathiassen, Stachura, & Astapova (2011)). Hence, we propose:

H5: Dynamic capabilities have a positive impact on healthcare organizations' performance

3 Methodology

We conducted a survey among 85 medium- to large healthcare organizations in the Netherlands to assess our hypotheses. We targeted strategic IT-decision makers in healthcare organizations by personally approaching them via LinkedIn. Furthermore, we aimed for organizations with a minimum of 100 FTE to adequately reflect the organizational pluralism discussed in our introduction. Following, we performed a mixed analysis technique, using both PLS-SEM (Hair et al., 2019) and NCA (Dul, 2019). We use NCA, because of the nature of hypotheses 1a and 2a: in the conceptualization of COISA, both Alignment Motivation and Interconnections between Heterogeneous IS Stakeholders are viewed as necessary, but not sufficient conditions for effective alignment competencies. This is the reason that COISA is conceptualized as a structural model, to begin with: without these enabling facilitators in place, there cannot be effective alignment competencies, and thus one cannot speak of an effective COISA capability in the organization (Walraven et al., 2021). The other hypotheses (H1b, H2b, H3, H4, and H5) are of a different, more commonly applied nature, i.e., they assume a certain correlation between concepts, but do not assume independent variables to be indispensable for the manifestation of the dependent variables. For these hypotheses, we use PLS-SEM (Hair Jr et al., 2016, 2018).

3.1 Operationalization of constructs

In our operationalization of COISA, we adopted the scale as developed by Walraven et al. (2021), measured using a 7-point Likert scale. In this scale, alignment competencies are conceptualized as a second-order formative-reflective construct, and alignment motivation and interconnections between heterogeneous IS stakeholders are first-order reflective constructs. An important note on the Likert scales used for the three different first-order alignment competencies is that they are context-dependent, in line with their theoretical CAS foundation: for the strategic alignment competency, the scale goes from (1) *never*, to (4) *somewhat in line with frequencies of internal and external changes* to (7) *completely in line with frequencies of internal and external changes* (7). For the orchestrational alignment competency, the scale goes from (1) *never* to (4) *somewhat in line with frequencies of strategic and operational changes* to (7) *completely in line with frequencies of strategic and operational changes*. Finally, for the operational alignment competency, the scale goes from (1) *never* to (4) *to the degree that we leverage some opportunities for improvement* to (7) *to the degree that we leverage (almost) all opportunities for improvement*. The full scale descriptions can be found in the work by Walraven et al. (2021).

To further operationalize dynamic capabilities in our current study, we use an adapted version of the scale developed by Van de Wetering (2019a, 2019b; 2021). We choose to use this operationalization

because it reflects recent insights on dynamic capabilities and is developed using acknowledged procedures. This particular scale is developed in the context of Enterprise Architecture-related capabilities and captures three routines, including (1) Sensing of opportunities (SENS), (2) Mobilizing resources (MOB) and (3) Transforming resources (TRANS). These routines resonate with routines by Teece (2007). We adapted the scale by Van de Wetering (2019a, 2019b; 2021) to fit our research goals by removing the specific focus on Enterprise Architecture from the items, leaving a more general operationalization of dynamic capabilities, which is still relevant and operationalized based on state-of-the-art literature on dynamic capabilities. This scale considers a formative-reflective second-order construct. The items used in this particular study are listed in Table 2.

Question		*Please indicate the degree to which your organization is competent in…*
Construct items		**Description**
SENS	SENS1	Identifying new business opportunities or potential business threats
	SENS2	Reviewing organizational services and product development efforts regularly to ensure that they are in line with what our key (internal and external) stakeholders want
	SENS3	Evaluating the effect of changes in existing and new products or services on the organization
	SENS4	Devoting sufficient time to enhancing our current business processes
MOB	MOB1	Evaluating, prioritizing and selecting potential solutions when we sense business opportunities or potential business threats
	MOB2	Mobilizing business, and IT resources to draft a potential solution when we sense business opportunities or potential business threats
	MOB3	Drawing up plans to carry out a potential solution when we sense business opportunities or potential threats
	MOB4	Reviewing and updating our organizational practices in line with renowned business and IT best practices when we sense business opportunities or potential business threats
TRANS	TRANS1	Reconfiguring business processes and the technology landscape to come up with new or adjusted assets
	TRANS2	Enabling flexible adaptation of human resources, processes, or the technology landscape
	TRANS3	Creating new or substantially changed ways of achieving our targets and objectives
	TRANS4	Adjusting for and responding to unexpected changes

Table 2 Operationalization of Dynamic Capabilities

To conceptualize organizational performance, we sought a scale that is suitable in a healthcare context, considering both financial and quality aspects with no particular focus on competition (Grosskopf & Valdmanis, 1987). Thus, we adopted the formative scale developed by Pee & Kankanhalli (2009), in line with these criteria. Table 3 summarizes these items, which were measured using a 7-point Likert scale.

Item	**Description**
PERFPUB1	Over the past two years, the cost of providing services by our organization has reduced significantly
PERFPUB2	Over the past two years, our income and/or budget allocated to our organization has significantly increased
PERFPUB3	Over the past two years, our organization's responsiveness to citizens' and businesses' requests has significantly improved
PERFPUB4	Over the past two years, the quality of our services has significantly improved

Table 3 Operationalization of Organizational Performance

4 Results

4.1 Sample description

Our final sample consists of 85 data points, consisting of different healthcare organizations, with sizes between 100-499 FTE and more than 5000 FTE (Table 4). Our study targeted strategic IT-decision makers.

Industry	N	**Organization size**	N	**Respondent position**	N
Hospital	42	100-499 FTE	8	CIO	11
Mental healthcare	14	500-999 FTE	5	CMIO	5
Healthcare (not specified)	13	1000-4999 FTE	50	CNIO	4
Elderly care	7	5000+ FTE	22	Enterprise Architect	3
Disabled care	6			Information Architect	11
Primary healthcare	1			Information Manager	6
Rehabilitation	1			IT director	4
Public Health	1			IT manager	16
				Other (e.g. CIO advisor, Business consultant)	25
Total	85	**Total**	85	**Total**	85

Table 4 Sample characteristics

4.2 Model fit, CMB and reliability and validity of reflective constructs

First, we assessed the goodness-of-fit of our model using the SRMR index. The results of this analysis showed that the SRMR value (0.075) is below the recommended threshold of 0.08 (Hair Jr et al., 2018). We thus deem the goodness of fit of our model as adequate. Next, we assessed Common Method Bias (CMB) using a full collinearity test (Kock, 2015). This test showed that all inner VIF values are well below the threshold of 3.3 (Kock & Lynn, 2012) (the highest being 1.7), giving us enough confidence that CMB is not an issue in our data set. Then, we assessed the reliability, convergent and discriminant validity of the reflective first-order constructs, including Alignment Motivation, Interconnections, and the Operational, Orchestrational and Strategic Alignment Competency. The results showed adequate reliability (Cronbach's alpha>0.7; Composite reliability>0.6 (Hair Jr et al., 2016)) and convergent and discriminant validity (AVE>0.5; Outer loading > cross-loadings with other constructs (Hair Jr et al., 2016)) (Table 5).

	Construct	**1**	**2**	**3**	**4**	**5**
1	Alignment Motivation	**0.882**				
2	Interconnections	0.405	**0.801**			
3	Operational Alignment Competency	0.553	0.642	**0.849**		
4	Orchestrational Alignment Competency	0.323	0.531	0.585	**0.898**	
5	Strategic Alignment Competency	0.367	0.525	0.683	0.737	**0.845**
	AVE	0.778	0.641	0.721	0.806	0.714
	Cronbach's alpha	0.905	0.814	0.871	0.919	0.865
	Composite Reliability	0.933	0.877	0.912	0.943	0.909

Table 5. Assessment of reliability, convergent and discriminant validity of reflective constructs. In bold on the diagonal are the outer-loadings, in comparison to cross-loadings.

4.3 Assessment of formative constructs

We assessed the formative constructs' reliability and validity, including the Organizational Performance construct, the second-order construct Alignment competencies consisting of the first-order dimensions Operational Alignment Competency, Orchestrational Alignment Competency and Strategic Alignment Competency and finally, the second-order construct Dynamic Capabilities, consisting of the first-order Sensing, Mobilizing and Transforming dimensions (Table 6). Note that the first-order dimensions of alignment competencies and dynamic capabilities themselves are measured reflectively and that their analyses concerning reliability and validity are discussed in paragraph 4.2. There were no collinearity issues, following the recommendations of Hair et al. (2016), indicating that VIF values should be <5.

Construct	Formative dimensions	Weight	Sig.	Loading	VIF
Alignment Competencies ***(second-order)***	OP	0.675	0.000	0.950	1.925
	ORCH	0.280	0.048	0.795	2.250
	STR	0.164	0.277	0.831	2.769
Dynamic Capabilities ***(second-order)***	SENS	0.463	0.027	0.957	4.209
	MOB	0.310	0.125	0.924	3.814
	TRANS	0.309	0.075	0.875	2.370
Organizational Performance ***(first-order)***	PERFPUB1 (cost)	0.271	0.152	0.519	1.139
	PERFPUB2 (income)	0.179	0.472	0.418	1.105
	PERFPUB3 (responsiveness)	0.003	0.991	0.672	1.997
	PERFPUB4 (quality of service)	0.834	0.001	0.938	2.023

Table 6. Formative construct validation

Table 6 shows that the outer weights of the Strategic Alignment Competency dimension as part of the higher-order construct Alignment Competencies is nonsignificant. However, this dimension is important for the higher-order construct's validity. Moreover, the outer loading of the dimension is high (0.831). We chose to not delete this dimension from our analysis given these values, and following the recommendation by Hair et al. (2016, p. 150): *"When an indicator's outer weight is nonsignificant but its outer loading is high (i.e., above 0.5), the indicator should be interpreted as absolutely important but not as relatively important"*. The same issue holds for the dimensions mobilizing and transforming as part of the higher-order Dynamic Capabilities construct. We decided to keep these particular dimensions in our analysis by the same logic. For the Perfomance construct, the cost-, income- and responsiveness indicators had nonsignificant weights. We were able to keep the cost- and responsiveness indicators as they both had high loadings (0.519 and 0.672, respectively). However, this was not the case for the income indicator, which we therefore dropped. We then reran the analysis for the organizational performance construct, which left us with adequate results (Table 7). These results show that only the quality construct has a significant weight, underlining its relative importance for the overall organizational performance compared to cost and responsiveness. However, cost and responsiveness are important as well, as they both have high loadings (0.517 and 0.694).

Construct	Measures	Weight	Sig.	Loading	VIF
Organizational Performance	PERFPUB1 (cost)	0.304	0.107	0.517	1.081
	PERFPUB3 (responsiveness)	0.002	0.996	0.694	1.997
	PERFPUB4 (quality of service)	0.881	0.001	0.955	1.958

Table 7 Second formative construct analysis of Organizational performance

4.4 Hypothesis assessment

We first conducted the PLS-SEM analysis using SmartPLS v 3.3.3 (Ringle et al., 2015) to assess H3-H5 and H1b and H2b This approach is in line with the recommendations on combining NCA and PLS-SEM as outlined by Richter et al. (2020). The results of this PLS-SEM analysis provide support for all of these hypotheses, as summarized in Figure 3. The complete model explains 24,3% of variance for organizational performance (R^2=0.243).

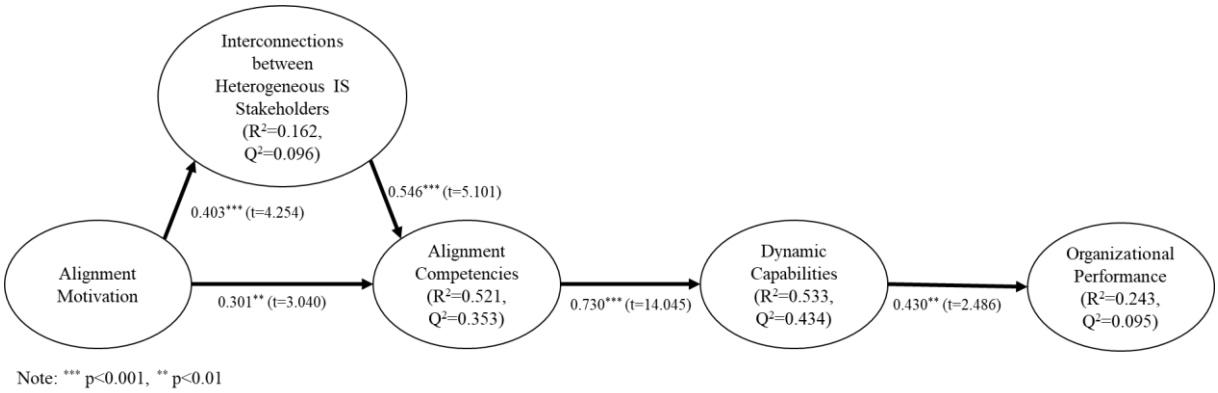

Figure 3. Results of structural model (PLS-SEM analysis)

Subsequently, we conducted a mediation analysis in SmartPLS (Ringle et al., 2015), looking into the direct effect of alignment competencies on organizational performance and its indirect effect through dynamic capabilities. We did this to assess RQ2, i.e., the specific role of Dynamic capabilities in the value path of alignment competencies in relation to performance. The results in Table 8 show that the effect of alignment competencies on organizational performance is fully mediated through dynamic capabilities. Namely, the direct effect is low and insignificant, while the indirect effect through dynamic capabilities is considerably higher and significant.

Direct effect	97,5% confidence interval	*t* Value	p <0.05?	Indirect effect	97,5% confidence interval	*t* Value	p <0.05?
0.082	[-0.266, 0.436]	0.460	No	0.314	[0.056, 0.579]	2.409	Yes

Table 8 Direct and indirect effects of alignment competencies on organizational performance

Lastly, we conducted the NCA to assess H1a and H2a. In doing so, we used R in combination with the NCA software package (Dul, 2021), according to the standards as proposed by Dul (2019). For both Alignment Motivation and Interconnections between Heterogeneous IS Stakeholders, the NCA effect size (CR-FDH) in relation to Alignment Competencies was well above the proposed d=0.1 threshold. Specifically, the effect size of Alignment Motivation is medium and significant (d=0.225, p<0.001) and the effect size of Interconnections is large and significant (d=0.424, p<0.000). Thus, we find support for the hypotheses that both Alignment Motivation and Interconnections between Heterogeneous IS Stakeholders are necessary conditions for Alignment Competencies. This supports our earlier described conceptualization of COISA (alignment competencies, enabled by alignment motivation and interconnections between stakeholders). In summary, on average, an increase in alignment motivation will increase alignment competencies (based on our PLS-SEM analysis). However, a certain level of alignment motivation is necessary for alignment competencies to manifest (based on our NCA analysis). Furthermore, on average, an increase in interconnections between heterogeneous IS stakeholders will increase alignment competencies (based on our PLS-SEM analysis). However, a certain level of interconnections between heterogeneous IS stakeholders is necessary for alignment competencies to manifest (based on our NCA analysis).

5 Discussion and conclusion

Our study supports the premise that a CAS-inspired alignment capability enables healthcare organizations to better deal with external change. We do so, by demonstrating the significant positive impact of alignment competencies on dynamic capabilities and organizational performance using a dataset of 85 Dutch healthcare organizations. After all, adequately responding and quickly changing under complex conditions is the prime objective of dynamic capabilities (Teece, 2007; Teece et al., 1997). Several interesting nuances and specific outcomes arise from our data.

5.1 Theoretical contributions

Our study provides initial quantitative evidence for the value of co-evolutionary approaches to alignment in complex conditions, specifically for healthcare. In doing so, we apply scales that were developed through rigorous procedures and answer the recent call for more empirical studies on business-IT co-evolution (Zhang, Chen, Lyytinen, et al., 2019). Our results confirm the essence of the principle of requisite complexity, as introduced by Benbya & McKelvey (2006), stating that *"[…] in order to remain viable, a system needs to generate the same degree of internal complexity as the external complexity it faces in its environment"* (Benbya & McKelvey, 2006, p. 290). Namely, COISA, as a CAS-based operationalization of BITA, indeed seems to be helpful for healthcare organizations to adequately respond to complex conditions and perform better. Thus, our results advocate for a complex system (A COISA capability) to adequately respond to a complex environment (manifested as effective dynamic capabilities and resulting organizational performance).

Furthermore, we add several nuances and specifics to the thus far quite general knowledge on COISA. Firstly, with our NCA-analysis, we demonstrate that in healthcare, the facilitating conditions of COISA are not only positively influencing healthcare organizations' alignment competencies, but that they are *indispensable* in the manifestation of these alignment competencies: Without interconnections between heterogeneous IS stakeholders and alignment motivation, there can be no alignment competencies. This confirms and further strengthens the findings of Walraven et al. (2020), who identified these facilitators in a qualitative study on effective EMR alignment. Moreover, we find several nuances in how alignment competencies and dynamic capabilities are important in the manifestation of overall organizational performance. Specifically, our results considering the formative construct analysis imply that the operational and orchestrational alignment competencies are relatively more important than the strategic alignment competency in a healthcare context. This finding specifies the framework's relevance further in comparison to earlier works on COISA in a healthcare setting (Walraven et al., 2019, 2020). It is difficult to assess what causes this finding from the data, but future research could look further into these outcomes to find possible explanations. Lastly, the same analysis implies that the sensing capability as part of dynamic capabilities seems to be relatively more important than mobilizing- and transforming capabilities. The most evident explanation for this finding would be that without knowing which opportunities exist (i.e., without *sensing* the environment for improvement opportunities), it is difficult to know which resources to mobilize and transform to respond to the opportunities at hand. Interestingly, this finding has not been reported in other contexts that looked into dynamic capabilities using a quantitative approach (Van de Wetering et al., 2021), suggesting that this may be unique for the Dutch healthcare sector. This could also be an interesting avenue to be explored for future research.

5.2 Practical implications

Healthcare practitioners can use our results to help build their organization's alignment competencies and in doing so, help them perform better in complex conditions. Specifically, the dynamic capabilities enabled by alignment competencies demonstrate to positively influence organizational performance as a composite construct consisting of income, responsiveness and quality of service. It should be noted that in this composite, the quality of service is relatively the most important. Hence, our study suggests that alignment competencies help healthcare organizations to more adequately respond to complex conditions such as the plethora of stakeholder perspectives in healthcare and unexpected events such as

the COVID-19 crisis. Namely, through the development of alignment competencies, healthcare organizations improve their dynamic capabilities, enabling organizations to better deal with complex and quickly changing conditions. Furthermore, our NCA results suggest that in this effort of creating alignment competencies, building interconnections between different IS stakeholders while simultaneously leveraging the motivation of these stakeholders to engage in alignment competencies are indispensable and should be prioritized. As described in earlier work, these interconnections manifest as (1) formal governance structures, (2) existing informal networks, (3) newly created informal networks and (4) supporting tooling (Walraven et al., 2020). Alignment motivation can be intrinsic to stakeholders, advocating for their involvement in the building of alignment competencies, but it can also be provided externally, for example by management explicitly prioritizing alignment efforts, by legislations, or by appointing specific personnel with alignment as their primary task (e.g. information managers) (Walraven et al., 2020). Furthermore, our results suggest that the operational alignment competency should especially get attention in building alignment competencies, given its relative importance compared to the orchestrational and strategic alignment competencies. Lastly, for the general dynamic capabilities that can be promoted through the development of alignment competencies, it seems that the sensing capability should get specific attention given its relative importance compared to the mobilizing- and transforming capabilities.

5.3 Limitations and research agenda

Although our study provides substantial contributions to theory on co-evolutionary alignment approaches and for healthcare practitioners to further shape their alignment competencies, it is not without limitations. Firstly, our dataset was limited to the Dutch healthcare sector, making it difficult to generalize its outcomes to different cultural or geographical contexts and industries. It would be interesting to see whether the findings hold in these different settings. Furthermore, as explained above, we found several specific nuances that we could not fully explain based on this quantitative dataset. Specifically, the explanations behind the seeming importance of the operational alignment competency and of the sensing capability remain vague and should be further examined. Additional quantitative studies could examine whether the nonsignificant weights combined with high loadings is a recurring issue in these constructs. Moreover, it would be a valuable addition to include potential other factors influencing organizational performance as control variables and to use configurational analysis approaches to get a more comprehensive understanding of the relationships between COISA, dynamic capabilities and organizational performance. Furthermore, qualitative approaches combining case studies, expert focus groups and observations could possibly give more in-depth insight in possible explanations behind these relationships.

Furthermore, an important limitation of this current study is that one could question whether it is valid to measure organizational performance as a traditional, relatively static construct, in relation to the clearly more dynamic COISA- and dynamic capabilities constructs. This is especially relevant when considering organizational performance from a punctuated equilibrium perspective, which is not uncommon in works taking a CAS-perspective on organizations (e.g., Sabherwal et al., 2001). This premise implies that organizational performance always goes up and down and that sometimes a “dip” in organizational performance is necessary for the organziation’s performance in the long run. In other words, when you measure low organizational performance at a specific point in time, this does not necessarily mean that the organization performs low overall. Our work, in part, addresses this issue by including the dynamic capabilities construct in our survey, but it would be interesting to further address this idea in future studies. For example, a longitudinal approach looking into the effects of COISA in the long run, measuring the constructs at different points in time, may give some insights in the implications from this perspective.

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