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CO-EVOLUTIONARY IS-ALIGNMENT: A COMPLEX ADAPTIVE SYSTEMS PERSPECTIVE

Research full-length paper

Track N°6:Improving Lives with Information Technology (track organized by the OCIS group of the Academy of Management)

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Abstract

Many studies have investigated the effects of information technology (IT) in achieving organizational performance. However, despite substantial IT investments, organizations often fail to improve organizational performance using IT. This failure could be the result of a lack of Business-IT alignment. Recently, scholars and practitioners have adopted a complexity science approach to better address the many interwoven IT, organizational and environmental turbulence challenges. These efforts resulted in the emergence of the complexity-based concept of co-evolutionary IS/IT-alignment (COISA). COISA involves "the series of coevolutionary moves that makes IT aligned over time." However, the notion of COISA remains conceptual, and further operationalization in preparation for more empirical evidence seems appropriate. Therefore, this study aims to provide further clarification on the conceptualization of COISA in turbulent environments. We conducted a structured literature review using a theoretical foundation of Complex Adaptive Systems theory. In this effort, we developed a COISA model composed of five continuous alignment processes characterized by co-evolutionary moves toward alignment, situated in two organizational contexts. This model provides a basis for further empirical research on COISA.

Keywords: Business-IT alignment; Complex Adaptive Systems; Co-evolutionary IS-alignment; Alignment processes

1 Introduction

Many scholars have argued that investments in information technology (IT), along with structural adoption and use, can lead to multi-factorial advantages for organizations (Van de Wetering et al., 2018, Gerow et al., 2014). These benefits include for example more efficient processes, reduction of costs, better deals with business partners, advanced creativity and ideation processes, and augmented reputation (Devaraj and Kohli, 2003, Kearns and Lederer, 2003, Mûller and Ulrich, 2013). Therefore, organizations invest large proportions of their budgets on IT, aiming to improve their overall performance. Despite these substantial investments, organizations in practice often fail to enhance organizational performance using IT. In general, this 'productivity paradox' has been argued to be caused by the lack of fit or alignment between business strategy and internal resources including IT (Brynjolfsson and Hitt, 2000), in other words, the lack of Business-IT alignment (BITA). BITA aims to apply IT in an appropriate and timely way, in harmony with business strategies, goals, and needs (Luftman and Kempaiah, 2007) and has been a significant concern for business executives and IT practitioners for decades (Kahre et al., 2017).

Scholars have investigated BITA for decades, because of its relevance. In their extensive literature research in this field, Chan and Reich (2007) underline the distinction between two different overarching perspectives on alignment. Namely, on the one hand, there is the perspective of alignment as a process *"[…] which requires specific IT management capabilities, encompasses specific actions and reactions and has discernable patterns over time"* (Chan and Reich, 2007). On the other hand, there is the perspective of alignment as a goal or an end state, *"[…] which focuses on the antecedents, measures, and outcomes of alignment"* (Chan and Reich, 2007). However, recent literature points out that existing IS theories, including those addressing BITA, do not sufficiently account for the environmental turbulence and organizational complexity faced by contemporary organizations (Merali and McKelvey, 2006, Merali et al., 2012). These challenges are driven by for example increasing customer demands, changing collaborations and technological development itself (Jansen et al., 2006).

To better address the organizational challenge of environmental turbulence, scholars increasingly adopt complexity theory and related complex adaptive systems (CAS) principles (Merali et al., 2012, Onix et al., 2017). They do so because complexity theory is often pointed out to provide potential solutions to the organizational challenges of complex, highly dynamic environments. For example, Benbya and McKelvey (2006) formulate the law of requisite complexity: *"[…] 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"*, which was based on Ashby's law of requisite variety: "*[…] only variety can destroy variety"* (Ashby, 1956). By these principles, contemporary organizations should exhibit complex characteristics to remain successful in turbulent environments. Herein, maintaining critical complexity is essential, i.e., between the edge of catastrophe (leading to a deterministic system) and the edge of chaos (leading to a chaotic system) (McKelvey, 2002)

By these recent developments, the IS community, too, adopts and uses complexity- and CAS principles as a basis for better suited BITA theories (Onix et al., 2017, Merali et al., 2012). These efforts resulted among others in the emergence of the CAS-based concept of co-evolutionary IS/IT-alignment (COISA) (Amarilli et al., 2017, Benbya and McKelvey, 2006), or the *"[…] series of co-evolutionary moves that makes IS aligned over time"* (Benbya and McKelvey, 2006), emphasizing a two-way evolution of both business and IT domains. Indeed, this view subscribes to the view of alignment as a process as opposed to an end-state. However, the concept of COISA remains vague: Specifically, the unique business processes that incorporate these co-evolutionary moves toward alignment have been left implicit until now. For example, the model by Benbya and McKelvey (2006) distinguishes strategic, operational and individual alignment, while emphasizing co-evolution between business and IT domains taking place. However, these scholars did not explicitly specify the business processes where these dynamics manifest in practice. Moreover, CAS-inspired case studies of alignment (e.g., Amarilli

et al. (2017), Montealegre et al. (2014)) naturally study one or more business processes in practice as their unit(s) of analysis to understand the phenomenon of alignment. However, none of these studies *explicitly* identifies these processes as alignment processes or takes a holistic account of *all* processes that play a role in COISA. In other words, the knowledge we are looking for is available in the existing literature. However, it is left implicit. The lack of an explicit connection between business processes in practice and the notion of alignment as a process makes it difficult to assess COISA empirically, in a holistic fashion. Further operationalization in preparation for more empirical evidence thus seems appropriate.

This current study thus aims to provide further clarification on the conceptualization of COISA for organizations in turbulent environments, drawing from existing CAS-inspired alignment research using a structured literature review (SLR). Given the law of requisite complexity, we argue that taking a CAS perspective on organizations is a promising avenue to better understand and address alignment in turbulent environments. Specifically, we identify business processes in which co-evolutionary alignment activities take place, developing a solid basis for empirical research in this area. In other words, this current paper aims to clarify the unit(s) of analysis that should be taken into account when assessing COISA holistically. Given the above, we formulate the following research question:

RQ: *In which business processes do co-evolutionary alignment activities take place?*

In the remainder of this paper, we will first specify our theoretical framework. Then, we will explain our approach in conducting the SLR, and finally, we will present our findings and conclusions.

2 Theoretical framework

In this research, we utilize the definition of BITA as given by Luftman et al. (1999): *"[…] applying IT in an appropriate and timely way, in harmony with business strategies, goals and needs"*. In line with our CAS perspective, herein BITA is not an end-state because the mentioned strategies, goals and needs are in constant change due to environmental turbulence. Instead, the nature of BITA in turbulent environments can be compared to the higher-level aim of many natural CASs: survival. This aim also needs to be worked on continuously and thus cannot be considered an end-state. COISA extends this notion of BITA by focusing on the co-evolutionary alignment activities, viewing the organization in which these moves manifest as a CAS. Two theoretical building blocks explain this extension, i.e., I). alignment as continuous processes and II). emergent alignment. Table 1 presents a summary of these building blocks and their CAS characteristics. We now elaborate on their theoretical foundation, by first broadly introducing CAS theory, and then explaining the building blocks that form the basis of our conceptualization of COISA.

Theoretical building blocks	Description	Supporting CAS characteristics
Alignment through continuous processes	COISA manifests through continuous alignment processes, involving feedback loops between business domains, IT domains and external actors.	Dynamism; interdependence; co-evolution; adaptation; connectivity; flow; nonlinearity; self-organization
Emergent alignment	COISA is an emergent phenomenon resulting from interactions between individuals in different organizational contexts and should be approached holistically to be thoroughly assessed and understood.	Emergence; aggregation

Table 1. Theoretical building blocks and supporting CAS characteristics

2.1 Complex Adaptive Systems Theory

CAS theory stems from scientific fields of physics and evolutionary biology, and it is part of Systems science, which *"[…] transcends technological problems, reflecting a reorientation that has become necessary in all sciences, from physics and biology to the behavioral and social sciences, emphasizing relationships between parts."* (Hammond, 2003). In other words, systems theory emphasizes interactions between individual, heterogeneous parts, leading to aggregated wholes, where the sum is more than its parts (Hammond, 2003). CAS theory as applied to human systems can be distinguished from general systems theory by the behavior of CASs individual agents, adapting to environmental conditions, based on their perception of reality. Dooley (1997) explains that, in a CAS, *"[…] agents scan the environment and adapt accordingly […], using schema to interpret reality and context, and trigger decisions and actions […], while competing with other agents for resources and information."* Furthermore, Anderson (1999) emphasizes that the essence of taking a CAS perspective on organizations is that *"[…] at any level of analysis, order is an emergent property of individual interactions at a lower level of aggregation"*. These insights can be summarized in several indicators characteristic to CAS, i.e., dynamism; interdependence; adaptation; connectivity; flow; nonlinearity; self-organization; co-evolution; emergence and aggregation (Onix et al., 2017, Holland, 1995, Anderson, 1999).

Given the heterogeneous nature of agents acting within a human CAS, it is crucial to acknowledge the existence of different organizational contexts: Indeed, alignment may be perceived differently in each context. Essentially, an organizational context may be seen as a subsystem of the CAS that is the organization as a whole. As a comparison, we consider a coral reef, an excellent example of a CAS, given its heterogeneous actors (e.g., coral, fish, divers, predators), and co-evolutionary interactions. In this coral reef, there are different "contexts" in place, interacting with each other while all are having their perspective on the CAS as a whole and its parts. Examples of these contexts include the fish living in the coral reef, the coral itself, and tourists diving to observe its beauty. When a larger fish swims into the coral reef, this is terrible news for the small fish's context, since they risk to be eaten. In other words, the introduction of the large fish into the coral reef is not well aligned with the goals and needs of the small fish, i.e., survival. However, for the tourist diver's context, it might be a fantastic event because it might be a beautiful, rare fish. In other words, the large fish being present in the coral reef is very well aligned with the goals and needs of the tourist diver, i.e., spotting as many beautiful and rare creatures as possible. Comparably, organizations have different contexts which all have their view of the organization and how it should go forward. An IT solution can, just like the larger fish swimming into the coral reef, be very well aligned with the goals and needs of one organizational context, but not necessarily with another.

For this current study, we distinguish two organizational contexts which are based on the classic Strategic Alignment Model, namely I) The strategic context and II) The operational context (Henderson and Venkatraman, 1993). After all, it is not self-evident that employees working in the operational context agree with strategic objectives, as becomes clear from existing literature on organizational change management (Rajagopalan and Spreitzer, 1997, Ford et al., 2008). These different perspectives are no different concerning organizationally embedded IT (Aladwani, 2001), potentially leading to alignment being assessed as high within the strategic context, but low within the operational context, or vice versa.

2.2 CAS foundation of COISA

As mentioned earlier in the theoretical framework, we base COISA on two theoretical building blocks, namely I) alignment as continuous processes and II) emergent alignment.

We base our first building block, i.e., alignment as continuous processes, on CAS characteristics of dynamism, interdependence, adaptation, connectivity, flow, nonlinearity, self-organization and co-evolution (Holland, 1995, Onix et al., 2017, Anderson, 1999). These characteristics imply that com-

plex organizations are highly dynamic. This means that the diverse agents (i.e., actors involved in alignment processes, e.g., CIO, IT and business management, software developers, users) within the organization are continually adapting and co-evolving. These continuous adaptations cause changes to occur frequently in both the business and IT domain of the organization, in accordance to changes in other parts of the organization, the environment (Anderson, 1999) or by the very implementation and use of IT (Allen and Varga, 2006, Nan, 2011). Moreover, seemingly small changes in one domain can lead to substantial effects elsewhere in the organization, due to the nonlinearity of CAS behavior (Anderson, 1999). From an executive management perspective, the system self-organizes because many decisions are made locally to enable quick responses to changes.

These inevitable changes and adaptations cause any equilibrium state of alignment to be unstable, giving rise to the need for continuous alignment processes. In these alignment processes, business employees, IT employees and external actors such as customers, software suppliers, or consultants, communicate and collaborate, pursuing alignment. These interactions lead to interdependence, connectivity, and flow between the involved actors and consequently, co-evolution manifests between business employees, IT employees and external actors.

This co-evolution is triggered by events involving organizational embedding of IT, such as I). IT adaptation (e.g., software, hardware, development methods and strategic plans that change), II). business adaptation (e.g., operational processes, products, and strategic plans that change), III). new opportunities that are driven by external actors (e.g., new technologies or partnerships that emerge and evolve) and IV). changing requirements from external actors (e.g., new regulations or customer demands). Note that co-evolution can also manifest *within* the business domain or the IT domain: For example, business employees from different departments might hold differentiated views or ways of working with a specific type of software, and these can co-evolve by interacting or collaborating. The same goes for IT employees, for example when different expertizes collaborate in developing a new IT solution (e.g., a business intelligence developer and a solution architect). Co-evolution between external actors may exist, but this is not within scope since we focus on COISA within organizations. In summary, our first theoretical building block is that COISA manifests as continuous alignment processes, characterized by co-evolution between business employees, IT employees and external actors.

Our second primary theoretical building block, i.e., emergent alignment, is based on CAS characteristics of emergence and aggregation, which emphasize that order is an emergent property of aggregated individual interactions on a lower level (Anderson, 1999). In line with this statement, we argue that alignment in CAS contexts should also be viewed as an emergent phenomenon, acknowledging that alignment is a specific manifestation of order. In the same line of reasoning, alignment is a phenomenon emerging from interactions between actors (e.g., people operating in teams) involved in business processes that pursue BITA in different organizational contexts (Allen and Varga, 2006, Burton-Jones and Gallivan, 2007). Therefore, to fully grasp COISA, taking a CAS viewpoint on organizations advocates a holistic perspective of alignment, while acknowledging its foundation of individual interactions (Benbya and McKelvey, 2006, Amarilli et al., 2016, Anderson, 1999).

To proceed with these statements, we need to identify the business processes that can we can label as co-evolutionary alignment processes in both the strategic and the operational organizational contexts. In doing so, we define alignment processes as business processes where co-evolutionary interactions toward alignment take place between business employees, IT employees and external actors.

3 Methodology

To answer our research question, we conducted a structured literature review (SLR), following the guidelines by Okoli and Schabram (2010). The reason we chose to do an SLR, is because a considerable amount of CAS-founded studies on aligning business with IT has been done in the past decade, both empirically and conceptually. However, as far as our knowledge reaches, no research has been done to explicate the specific business processes underlying these alignment efforts. As mentioned in

our theoretical framework, we view co-evolutionary IS alignment as an emergent phenomenon resulting from interactions between individual business employees, IT employees and external actors from different organizational contexts, jointly pursuing BITA. In correspondence with this perspective, three types of studies can potentially provide answers to our research question. These types of studies include firstly articles focusing on BITA from a CAS perspective; secondly, articles focusing on IT adaptations based on business needs from a CAS perspective; and finally business adaptations as a result of IT adaptations from a CAS perspective. By incorporating these three types of research, this current study aims to give a holistic overview of the business processes in which alignment interactions take place.

3.1 Search protocol

While finding literature relevant to our research question, we limited our scope to articles that were published in the top *basket of eight* IS Journals as acknowledged by AIS (*Senior Scholar's Basket of Journals*, 2011). In doing so, we assured that all articles included in our review were high-quality and peer-reviewed. Additionally, we only included articles published between 2007 and 2017, to get an up-to-date overview of business processes that can be identified as alignment processes. Moreover, we added full research papers that were part of proceedings of AIS-supported conferences from the past three years (2015-2017). After all, the most recent insights in the field cannot yet have been published in top journals, due to the timeline of this research and the subsequent publishing process. We looked for articles using the AIS online library, Google Scholar, and Web of Science to get a broad overview of the available literature. To assure that alignment and CAS were a primary focus of the found articles, we limited our search areas within articles to titles, abstracts and/or keywords whenever possible. Specifically, we searched in titles and abstracts in the AIS online library, and in Web of Science, we limited our search to article topics. As an exception, while using Google Scholar, we *did* search in the full text of the articles, as Google Scholar's search options were too limited to specify search areas within articles further.

3.2 Keywords

The keywords used to find relevant articles revolved around two main topics. These topics are alignment on the one hand and CAS theory on the other hand, given that the main purpose of our SLR is to explicate further the business processes underlying COISA, based on CAS principles. In doing so, we assure that the business processes that we identify indeed contribute to alignment, and show co-evolution and/or interaction between the actors involved. For the topic of CAS, we included the search term "c*omplex adaptive systems,"* as well as search terms relating to complexity science in a more general sense, including "*complexity theory,"* "c*omplexity science"* and "*complex systems."* Furthermore, we included "*co-evolution"* as well as "*co-evolutionary"* to make sure that we include articles that actually use co-evolutionary alignment in their primary terminology.

For the topic of alignment, we used the search terms "*alignment"* and its frequently used synonym *"fit."* However, we realized that using only these keywords might exclude articles focusing on IT-induced organizational change and IT adaptation caused by organizational needs. However, as explained earlier in this chapter, these are in fact very relevant to our research question as they do focus on co-evolution between business domains, IT domains and external actors. Therefore, we also took into account the more general keywords of "*information systems"* and "*information technology."*

We subsequently applied every possible keyword combination, using one keyword from each of the two lists in every query. To optimize replicability of our research, we kept track of a log specifying each of our searches, as well as a list of found articles, with for each article its corresponding search query and source. This log is available on request.

3.3 Quality- and practical screen

Our search efforts led to a total of 245 articles. These articles all fulfilled our quality screen criteria since this was addressed by only including articles published in one of the eight top IS journals or presented at AIS-supported peer-reviewed conferences. We then developed practical screen criteria to filter out the articles that were not relevant to our research question. These practical screen criteria aimed to reassure that the articles included in our final analysis indeed focused on alignment and that they indeed used CAS principles. We decided to screen the articles based on their abstracts since these generally give a good overview of the articles' focus.

Early on in our screening process, we discovered that many of the found articles did not explicitly state in their abstract to use CAS theory but instead mentioned several properties that are characteristic to CAS. Therefore, our practical screen criterion considering CAS as a theoretical basis could be fulfilled in two ways:

- The abstract mentions that it uses CAS theory/principles as a theoretical foundation
- The abstract mentions at least two of the properties that are characteristic to CAS. These properties include aggregation, nonlinearity, flows, diversity, emergence, co-evolution, self-organization, connectivity, interdependence, dynamism, and adaptation. (Anderson, 1999, Onix et al., 2017, Holland, 1995).

We developed the following three statements to decide whether alignment was a main focus or not. Articles had to correspond to one of these statements to fulfill the criterion of focusing on alignment.

- The abstract explicitly mentions focusing on alignment or fit
- The abstract mentions focusing on IT-induced organizational adaptation
- The abstract mentions focusing on organizationally induced IT adaptation

A total of 18 articles were considered to be relevant for our research after applying these practical screen criteria. Later in the process, two additional articles on Enterprise Architecture Management (EAM) from a CAS perspective were added by replacing the keywords considering alignment with "Enterprise Architecture Management." The reason to do so is that EAM did show up in our first sample as an alignment process, however mainly in theoretical and conceptual papers. By doing an additional search, we found two articles that provide additional empirical support for EAM as being a co-evolutionary alignment process (Rolland et al., 2015, Schilling et al., 2017), thus strengthening our results. The total amount of articles that we considered for this study is therefore 20.

3.4 Coding, analysis, and synthesis

We coded the articles with NVivo software, using two complementary coding techniques based on Saldaña (2015), namely in vivo coding and descriptive coding. In vivo coding implies that codes are taken from the text in the qualitative data. We used this technique for articles that explicitly address different alignment processes. The second coding technique we adopted is descriptive coding. The primary purpose of this coding technique is to infer the primary topic of a text passage (Saldaña 2015). We used this technique for studies that provided information on alignment processes, without explicitly naming them. Articles that we analyzed following this procedure included for example case studies on specific IS implementations or organizational transformations. In our analysis, we used a hybrid coding approach: We used open coding to identify the business processes showing co-evolutionary moves toward alignment, but we categorized these codes into the pre-defined strategic and operational contexts. The codes we used in our descriptive coding were taken from the codes that emerged from our in-vivo analysis.

We subsequently synthesized the results of our coding into a conceptual model, integrating the organizational contexts and corresponding alignment processes. In doing so, we only included alignment processes supported by at least one empirical study (i.e., not only by conceptual papers). Alignment processes were labeled as "supported" when at least two articles either used them as a unit of analysis

or if they were described in empirical data. This step ensures that the alignment processes, that we incorporate, actually manifest in practice. By also taking into account conceptual and theoretical papers, we strengthened the theoretical CAS foundation of the final conceptualization.

4 Results

We identified five alignment processes based on our analysis and synthesis of the included studies. Two are part of the strategic context, i.e., I) strategy formulation and II) strategy implementation, one bridges the strategic context and the operational context, i.e., III) Enterprise Architecture Management, and two are part of the operational context, i.e., IV) IT implementation and V) IT usage. Interestingly, we also identified co-evolutionary interactions to take place *between* some of these alignment processes, i.e., between EAM and strategy formulation, between EAM and Strategy implementation, between EAM and IT implementation, between Strategy Formulation and Strategy Implementation, between Strategy Implementation and IT implementation and between IT implementation and IT usage. We visualize the results in Figure 1.

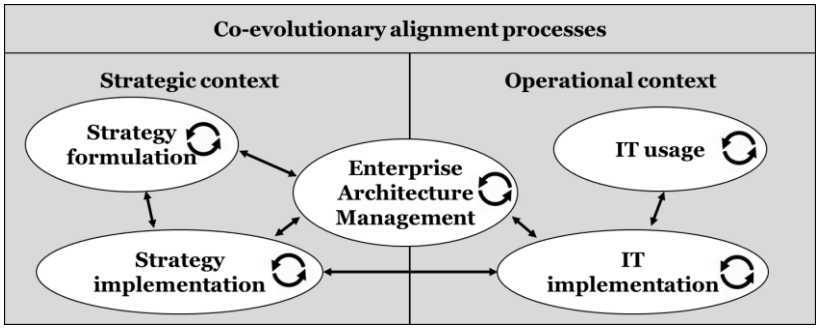

Figure 1: Conceptual model of COISA

This COISA model fits the CAS perspective very well. The model focuses on alignment processes wherein and between which interactions between business actors, IT actors and external actors prevail. Furthermore, these individual interactions lead to emergent alignment in different contexts, i.e., a hallmark of the CAS perspective. Because the goals, needs, and strategies of organizations in turbulent environments change quickly and may differ among the involved actors, so does their alignment with IT. Therefore, the interactions between actors operating in and between alignment processes should be continuous, making the pursuit of emergent alignment an ongoing process.

Appendix A shows an overview of all articles, with for each article the supported alignment processes, and the way in which each alignment process was incorporated in the article at hand. We now elaborate on the main findings.

4.1 Co-evolutionary alignment processes in the strategic context

In the strategic context, we identified two different alignment processes, i.e., Strategy formulation, and Strategy implementation.

The alignment process of *strategy formulation* is supported by Liang et al. (2017), who did a survey study on the relationship between BITA and organizational agility. In doing so, they subscribe to our CAS viewpoint on organizations by acknowledging the emergent and interdependent nature of strategic alignment processes, i.e., Strategy formulation and Strategy implementation. They underline that executive managers (both business- and IT-oriented) are responsible for both processes in strategic alignment efforts. Therefore, they address both in their survey design. Yeow et al. (2017) take the same viewpoint, stressing the importance of responding to environmental turbulence in their explana-

tion of the process of strategy formulation. In doing so, the authors emphasize the emergent nature of strategy and strategic alignment, taking a dynamic capabilities approach to the problem at hand. However, they do not explicitly take the process of strategy formulation into account in their empirical analysis, so support comes mainly from the theoretical discussion. Additionally, Tanriverdi et al. (2010) mention that co-evolutionary development of IS strategy, corporate strategy, and competitive strategy is essential in turbulent environments. In this article, too support comes from the theoretical discussion in the paper. Baker et al. (2011) agree with this viewpoint, reinforcing the importance of co-evolution of business- and IT strategies in highly dynamic conditions. They, however, do focus on the process, thus, in this case, it is the unit of analysis.

The second alignment process, i.e., *strategy implementation*, is also acknowledged by Liang et al. (2017), who, as discussed above, explicitly address both strategy formulation and strategy implementation and thus use it as part of their unit of analysis. Additionally, by acknowledging the interdependent and emergent nature of these processes, the article by Liang et al. (2017) also provides support for co-evolution taking place *between* these processes, as is visible in Figure 1.

Case study findings on strategy implementation in CAS contexts appear to lean on emergent initiatives that are driven by simple, strategically defined axioms. For example, Busquets (2015) focus on *discovery paths*, explaining *"[…] the firm's evolution by sets of variations in the strategic interaction between the organization and technology"* (Busquets, 2015). Their explanation of strategy implementation involves how the strategically defined customer-centricity axiom found its way throughout the studied organization by using customer-centric data. This concrete example of strategic objectives directly influencing IT implementation subsequently provides support for co-evolution taking place between Strategy Implementation and IT implementation, as the use of the customer-centric data took place within IT implementation processes. Comparably, Grisot et al. (2014) describe the evolution of a hospital's information infrastructure, *"[…] characterized by nonlinear evolutionary dynamics"* (Grisot et al., 2014). The instance of strategy implementation described by these scholars addresses how the strategically defined patient-centricity principle was intrinsic to a new initiative from a team at a hospital's IT department. Again, this provides support for both the process of strategy implementation as well as its co-evolution with IT implementation. Montealegre et al. (2014) take a co-evolutionary view on information services development and in doing so, they seem to address strategy implementation as well: They underline that alignment between vision, strategy, governance, and resources *enable* operational alignment processes. Unfortunately, they do not address further how this enabling process of strategy implementation manifests in practice. In other words, they do not provide sufficient support to draw further conclusions on co-evolution taking place between specific alignment processes.

4.2 Co-evolutionary alignment processes in the operational context

We found two alignment processes in the operational context, i.e., IT implementation, and IT usage.

IT implementation refers to all activities that are part of embedding IT within an organization. These include for example quality design and implementation of requirements, but also dimensions such as prioritization, and change management. Additionally, IT implementation can take place both in- or outside of a project context (Wagner et al., 2010). Several articles support this viewpoint:

Two articles discuss IS development as situated socio-technical change, emphasizing its emergent nature (Lyytinen and Newman, 2008, McLeod and Doolin, 2012), based on results from their case study considering the implementation of a reporting tool. Vessey and Ward (2013) address in their conceptual paper among others how to manage IS development projects in co-evolutionary contexts, providing further theoretical support for these projects to show co-evolution. Furthermore, Amarilli et al. (2017) illustrate co-evolutionary dynamics taking place within IT implementations, by doing a multiple case study. Additionally, Grisot et al. (2014) describe in their case study how the project initiated

by a small team from a hospital's IT department went by in defining requirements, taking a learning approach while implementing the system. In doing so, the authors underline the evolutionary, emergent nature of this process. Montealegre et al. (2014) take a co-evolutionary view on information services development in their case study, stressing the importance of modular information services design to enable dynamic adaptation in accordance with environmental turbulence.

Four different articles support the process of IT usage as a co-evolutionary alignment process. Firstly, Allen et al. (2013) describe how unintended changes emerged in the work system of a healthcare environment after implementing two different IT systems through interactions between business employees using the systems. Apart from co-evolution within the IT usage process, the study, additionally, provides support for co-evolution taking place between the IT usage and the IT implementation processes. Wagner et al. (2010) focus on large-scale, off-the-shelf software (Enterprise Systems), specifically on the "*turnaround process by which a troubled project at go-live becomes a working information system"*. Therein, they introduce the notion of negotiated practice, which aims to address emergent misalignments between best practices that are characteristic to off-the-shelf software, and existing practices within the organization. The co-evolutionary interactions that they address in their case study focus mainly on the process of IT usage. However, they also touch upon co-evolution between the IT usage process and the IT implementation process, by discussing changes made to the system based on user feedback, *after* its go-live, providing additional support for co-evolution between these processes. Goh et al. (2011) look at the effects of an implementation of a computerized documentation system in the work system within a hospital setting, from an adaptive structuration theory perspective (characterized by co-evolution and adaptation). They explain changing routines caused by system implementation through three stages: The pre-implementation stage, "*[…] when users form initial symbolic expressions about the new system and plan for the changes to existing routines"*, the transition stage, "*[…] focused on restoring the essential functions of routines"* and the refinement stage, focusing on "*[…] fine-tuning and exploring new capabilities"*. Apart from these empirical papers, Burton-Jones and Gallivan (2007) address IT use conceptually, from a multi-level, agent-based perspective and therein provide additional theoretical support for the alignment process of IT usage.

4.3 Enterprise Architecture Management

The alignment process of *enterprise architecture management* (EAM) bridges the strategic context (addressing questions of 'what' and 'why') with the operational context (addressing questions of 'how') (Ahlemann et al., 2012). Several studies show evidence for EAM to be part of COISA:

Vessey and Ward (2013) view the transition from current to target EAs as co-evolution between business- and IT-domains. They apply adaptive management principles as defined by Vidgen and Wang (2009) to EA maturity stages, aiming to address co-evolutionary alignment throughout the organization instead of only within IS development projects. This supports EAM as a COISA process from a theoretical viewpoint. Schilling et al. (2017) address IS architecture as a socio-technical phenomenon in their survey study, emphasizing that *"[…] IS architecture can be considered as a continuous effort to keep changing organizational aspects aligned with changing technological aspects"* (Schilling et al., 2017). The scholars show that evolutionary change of the architecture itself has a positive relationship to the Architecture outcomes, thus providing solid support for EAM as a co-evolutionary alignment process. Furthermore, they discuss how EAM coevolved with strategy, thus providing support for co-evolution between the processes of EAM and strategy implementation, and between EAM and strategy formulation: *"[…] as part of a strategy for increased global growth and collaboration across locations, a new Information System […] was developed in 2009"* (Schilling et al., 2017). Rolland et al. (2015) show that EAM, or *Enterprise Architecting*, as they call it, is a continuous, evolutionary process that should focus on realizing the transitions from as-is EAs to target EAs. This process should address not only the target state of the architecture but also the current architecture and the path dependencies that come along with decisions made in the past. In their case study, the authors describe

the co-evolution not only within the EAM process but also between the EAM process and the IT implementation process. Finally, Weeger and Ulrich (2016) did a longitudinal case study of co-evolving business- and IT domains. Their primary focus is on misalignment in the activity systems of and between both business and IT domains. The authors stress the role of ITs shift of focus, from local tools to organization-wide optimization (characteristic to EAM), to address these misalignments successfully. This is a clear example of the process of IT implementation coevolving with the process of EAM.

5 Discussion and Conclusion

We identified five different co-evolutionary alignment processes, manifesting in and between the operational and the strategic contexts. These processes include I) Strategy Formulation (strategic context), II) Strategy Implementation (strategic context), III) Enterprise Architecture Management (bridging the strategic and the operational context), IV) IT implementation (operational context) and V) IT usage (operational context). In these processes, business actors, IT actors and external actors communicate and collaborate through co-evolutionary interactions, continuously pursuing alignment. Our study additionally revealed that co-evolution also manifests *between* different alignment processes.

Interestingly, our literature study did not show co-evolutionary interactions between *all* alignment processes, as is visible in Figure 1. Specifically, for the alignment process *IT usage*, our study only showed evidence for co-evolution with the alignment process IT implementation. We found no evidence for direct co-evolution with any of the other alignment processes. The absence of this particular relationship may be explained by the sheer complexity and diversity of IT usage processes, as these occur in every organizational context making use of IT. However, IT usage may simultaneously be the most interesting process to influence the alignment processes in the strategic context, as it *is* the process where outcomes of alignment efforts first emerge. We see good potential for co-evolution between IT usage and strategic co-evolutionary alignment processes in the CAS-based approach of quantified self-interpreted micro-narratives (Snowden, 2011). This potential is clearly explained by Snowden (2011): *"We are dealing in complex systems with human motivations and attitudes, and […] these are best revealed through an understanding of the day-to-day micro-narratives of existence"*. Fitness landscapes can then represent these large-scale collected micro-narratives, allowing actors in strategic COISA processes *"[…] to sense the evolutionary possibilities (and impossibilities) of the present along with risk assessment. It also allows monitoring of the impact of safe-fail experiments, permitting more rapid, effective, and lower-cost interventions."* (Snowden, 2011)

Apart from the process of IT usage, we also found no direct interactions between the alignment processes IT implementation and Strategy formulation. Instead, we only found indirect co-evolution through the processes of Enterprise Architecture Management and Strategy implementation. The relatively small sample of our study may explain this outcome, suggesting that interaction between those processes, in fact, *does* take place in practice. However, it may also indicate that the absence of interactions between some of the processes is in fact quite useful: Indeed, this absence limits the alignment processes' complexity. Therefore, it may just prevent the organization to fall into a state of chaos. Further research should aim to provide clarification on this matter.

Our model is a valuable addition to the existing knowledge base for two reasons: First, our findings consolidate COISA's foundation on CAS theory. They do so, by using theoretically founded building blocks to identify the relevant alignment processes.

Second, our study takes the first step toward operationalizing COISA, by specifying the business processes that should be taken into account when assessing COISA empirically.

This step builds upon existing work on COISA by, e.g., Benbya and McKelvey (2006) and takes a process-view of COISA as a key foundation. Our process perspective does not mean, however, that we dismiss literature approaching alignment as an end-state altogether. Instead, we bring some nuance in

the notion of BITA in turbulent environments specifically. We do so, by subscribing to the definition given by Luftman and Kempaiah (2007), who focus on the goals, needs, and strategies of the business with which IT needs to align. Given environmental turbulence, these goals, needs, and strategies are in constant change. Moreover, most complex organizations have multiple organizational contexts (i.e., strategic and operational) which, as we have argued, are likely to have different or even contradictory goals and needs. These different contexts within one organization add to the challenge of alignment and the constant need for change. The fact of constant change thus gives us reason to conceptualize BITA not as an end-state, but as a general aim of the CAS that is COISA within organizations, comparable to the general aim of survival of many natural CASs (e.g., a coral reef). Both survival and BITA—given environmental turbulence—indeed are aims, but explicitly not end-states, since they may be interpreted differently depending on the organizational context, and are in constant change due to environmental turbulence. In other words, they are not end-states because they need continuous work and effort to be pursued.

Additionally, our model could also have practical relevance as it can be applied as a useful checklist for organizations to identify COISA improvement areas.

Despite the value of our contribution, there are several limitations that future work must seek to address. First, we conceptualize a model of COISA based on an exploratory SLR. Complementary empirical evidence is needed to validate our model and its claims. Moreover, a substantial limitation of our model is that in assessing COISA empirically, it is not enough to merely measure whether an organization applies the identified alignment processes or not. After all, this does not guarantee co-evolutionary moves toward alignment to take place within and between the processes. Thus, the model should be extended with indicators of these co-evolutionary interactions.

Furthermore, future research should expand the scope and reach of COISA and also compare results across industries, contributing to the generalizability of our findings. An interesting direction would be to apply a configurational approach (van de Wetering et al., 2017, Meyer et al., 1993); through which groups and (sub)segments can be analyzed in detail. This approach aligns well the complexity paradigm to capture the complex entanglement of strategic and operational IT and business operations in practice. For example, the model could be adapted for different types of organizations (e.g., public or private sector, small- or large-scale) or different types of IT solutions (e.g., large-scale systems versus small, innovative solutions). The notion of organizational contexts can be a good starting point to do this: By first identifying the specific organizational contexts that should be taken into account in a specific (type of) organization, a more reliable, holistic assessment of the degree of alignment within these organizations can be made. For example, in universities, each faculty might be its own organizational context and might have differentiated views on how IT should be leveraged to support business goals.

Lastly, our model's application to organizations facing turbulent environments is only based on the principle of requisite complexity. To strengthen its applicability in turbulent environments, we will further develop and test the model in the context of hospitals. Namely, almost every environmental aspect that hospitals face (Social, Technological, Economic, Environmental, Political, Legal and Ethical, see also Kew and Stredwick (2017)) evolves in a high pace, making it a very suitable domain for our aims.

To conclude, we further clarified COISA by identifying specific alignment processes in different organizational contexts, therein taking the first steps toward an actionable operationalization of COISA. Our model specifies the conceptualization of COISA for organizations facing environmental turbulence and is designed for further empirical research. By using theoretically founded building blocks, its CAS theory basis is reinforced.

6 Appendix A: Matrix of articles included in SLR

#	Article	Methodology	Alignment process	Integration in article
1	Liang et al. (2017)	Survey	Strategy formulation	Unit of analysis
			Strategy implementation	Unit of analysis
2	Yeow et al. (2017)	Case study	Strategy formulation	Theoretical discussion
3	Tanriverdi et al. (2010)	Research commentary	Strategy formulation	Theoretical discussion
4	Baker et al. (2011)	Conceptual paper	Strategy formulation	Unit of analysis
5	Busquets (2015)	Case study	Strategy implementation	Described as part of case study
			IT implementation	Unit of analysis
6	Grisot et al. (2014)	Case study	Strategy implementation	Described as part of case study
			IT implementation	Unit of analysis
7	Montealegre et al. (2014)	Case study	Strategy implementation	Theoretical discussion
			IT implementation	Theoretical discussion
8	Schilling et al. (2017)	Survey	EAM	Unit of analysis
9	Rolland et al. (2015)	Case study	EAM	Unit of analysis
10	Weeger and Haase (2016)	Case study	EAM	Described as part of case study
11	Vessey and Ward (2013)	Conceptual paper	EAM	Unit of analysis
			IT implementation	Unit of analysis
12	McLeod and Doolin (2012)	Case study	IT implementation	Unit of analysis
13	Lyytinen and Newman (2008)	Theoretical paper	IT implementation	Unit of analysis
14	Allen et al. (2013)	Multiple case study	IT usage	Unit of analysis
15	Wagner et al. (2010)	Case study	IT implementation	Unit of analysis
			IT usage	Unit of analysis
16	Goh et al. (2011)	Case study	IT usage	Unit of analysis
17	Burton-Jones and Gallivan (2007)	Conceptual paper	IT usage	Unit of analysis
18	Nan (2011)	Agent-based modelling	IT usage	Unit of analysis
19	Vidgen and Wang (2009)	Multiple case study	IT implementation	Unit of analysis
20	Amarilli and van den Hooff (2017)	Multiple case study	IT implementation	Unit of analysis

Table 2. Matrix of articles included in SLR

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