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Understanding How Enterprise Architecture Contributes to Organizational Alignment

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Abstract. Alignment is one of the most important benefits that Enterprise Architecture (EA) could bring to organizations. However, it is still unclear what mechanism EA uses to help organizations achieve alignment. Related research is very scattered, making it difficult to accumulate relevant knowledge and experiences, and thus, the more successful EA application is hindered. To address this issue, the present research examines essential requirements of alignment and mechanisms with which underlying EA deliverable models impact organizations. By doing so, we proposed a conceptual framework explaining how EA modeling activities contribute to organizational alignment. We demonstrated the use of this framework with three use cases. The results show that EA could help organizations achieve alignment in quite different ways, and our proposed framework helped us examine and understand the mechanisms. We expect this research could establish an essential common understanding of how EA enables organizational alignment, thereby facilitating academia to move forward in this field.

Keywords: Alignment, Enterprise Architecture, EA, Model Quality.

1 Introduction

Empirical studies showed that Enterprise Architecture (EA) brought various benefits to organizations. However, the application of EA does not always succeed and also faces multiple challenges such as its complexity, heavy workload demand, and poor user acceptance [1]. This motivated researchers to examine the mechanism of how to achieve EA benefits. Among all these benefits, alignment is one of the most important benefits that EA could bring to organizations, directly or indirectly [2]. Some benefits are directly referred to as strategy alignment, business-IT alignment, and partner alignment [2]. Other benefits, such as agility, are thought to be relied on alignment significantly [3]. We limited our focus on organizational alignment (so called alignment in this paper), covering all such relation compliance in an organizational context. To our

knowledge, there is little consensus about how EA brings organizational alignment. Relevant researches are very scattered [4], fragmented, and lacks explanatory theories [5], making it difficult to accumulate relevant knowledge and experience.

This problem motivated the present research. In this research, we examined the nature of organizational alignment requirements, EA primary deliverables, and EA mechanisms to impact organizations. The result shows alignment focuses on the compliance of relations among organizational components. Alignment shall be achieved with a continuous process. The result also shows that EA deliverable models provide the capability to represent and realize the compliance of relations among organizational components through a series of modeling activities. And such activities could be included in the continuous process of aligning.

To understand how different modeling activities contribute to alignment goals, separately and as a whole, we proposed a framework named EA-AIR. In this framework, we decompose the alignment process into parts where different modeling activities contribute to and identify key factors of such activities that impact alignment goals. This article also demonstrates how to use the framework to analyze EA's contributions to organizational alignment with three use cases.

The remainder of the paper is structured as follows. Section 2 introduces relevant background knowledge. Section 3 proposes a conceptual framework based on existing theories. In Section 4, we present three use cases where EA plays different organizational roles. We demonstrate how to use the proposed framework to analyze the mechanism EA contributes to organizational alignment in each case. Then, we discuss how to use this framework to better apply EA for alignment goals in Section 5. Lastly, we conclude the paper in Section 6.

2 Background

This section introduces some background knowledge about organizational alignment and EA. Because EA is generally delivered as (graphical) models, we also present relevant knowledge about different modeling activities and factors that make good models. Based on such knowledge, we summarize possible explanations on why and how EA contributes to alignment achievement.

2.1 Organizational Alignment

Alignment in dictionaries is defined as "the act of aligning or state of being aligned [6]", "arrangement in a straight line or in correct relative positions [7]", and "the proper positioning or state of adjustment of parts (as of a mechanical or electronic device) in relation to each other [6]".

When alignment is used in organizational contexts, it is defined as "the continuous process, involving management and design sub-processes, of consciously and coherently interrelating all components of the business-IT relationship in order to contribute to the organization's performance over time [8]". Typically, organizational alignment

is often referred to but not limited to Strategy Alignment [9, 10], Business-IT Alignment [8, 11, 12], and Partner Alignment [2]. Literally, their focuses differ a little bit on relations that are primarily considered and strive to achieve. For instance, Strategy alignment indicates that organizations' resources shall be appropriately arranged to realize strategies. Business-IT alignment cares about whether business and IT components have supported each other.

To summarize, organizational alignment is in general about the compliance of relations among organization components. It is about a status that needs to be achieved by a continuous process involving a series of activities.

2.2 Enterprise Architecture

EA is generally defined as "The fundamental organization of a system, embodied in its components, their relationships to each other and the environment, and the principles governing its design and evolution [13] ". Here, an enterprise is viewed as a "system" [13].

EA is usually delivered as a set of abstract graphics covering the enterprise's high-level content across areas such as strategy, business, information, and technology. We call these abstractions EA artifacts or EA models as they are usually in graphical forms.

To summarize, EA is usually delivered as a set of graphical artifacts named EA models. Such models could represent organizational components and their relations involved in an alignment goal. They could reflect and influence reality (e.g., realizing the alignment goal) by means of a series of modeling activities.

2.3 Models

Models are generally defined as "explicit **representations** of some portions of reality as perceived by some actor [14]". However, models can also **influence reality** if they are **active** [15]. This means when a model is changed, the way some actors perceive reality (reflected by the model) is also changed. Actors in this context include users and software components.

Model **activation** is the process by which a model affects reality. Model activation involves actors interpreting the model and, to some extent adjusting their behavior accordingly. This process can be automatic, manual, or interactive. We define a model to be **interactive** if it is interactively activated.

An interactive model entails **coevolution** of the model and its domain. The process of updating an interactive model is called **articulation**. The interplay of articulation and activation reflects the mutual constitution of interactive models and the social reality.

Researchers pursued to define what makes a **good model** as it is crucial to influence the reality that the model reflects [16]. In [16], the authors distinguished between goals and means by separating what to achieve in modeling from how to achieve. The notion of feasibility was introduced to make goals more realistic. A framework summarizing model quality goals and means was proposed (hereafter called the SEQUAL framework

[17]). The SEQUAL framework was closely linked to linguistic concepts as it was recognized that modeling is essentially making statements in some language. Its initial version [16] considered three quality levels: syntactic, semantic, and pragmatic quality. The framework was later extended [17] [18] to include more quality aspects such as physical quality and empirical quality. It was also revised [15] to make it more appropriate for active models.

2.4 EA and Organizational Alignment

Based on our understanding of EA (models) and organizational alignment as introduced above, we identified some facts which explained why EA could facilitate organizational alignment.

- Organizational alignment is about the compliance of **relations** among fundamental components of an organization. EA can represent such relations as well as components involved in the relations.
- Organizational alignment often involves statuses of both "**as is**" and "**to-be**." EA can represent such with descriptive and prescriptive models.
- Organizational alignment takes place in **reality**. EA Models can influence reality by facilitating (human and technical) actors to learn new knowledge and take action.
- Organizational alignment is achieved through a **continuous process**. EA model can evolve and continuously interact with reality utilizing articulation and activation. Such modeling activities can be embedded in such an aligning process.
- How well models actually influence reality highly depends on the model **quality**.

Based on these facts, we aim to construct an explanatory theory to systematically understanding mechanisms of EA-enabled alignment.

3 The EA-AIR Conceptual Framework

We define Alignment Insights and Recommendations (AIR) as descriptive and prescriptive information relevant to alignment relations. Such information can be generated from data collected according to the alignment context and converted to knowledge after interpretation of people or tools.

We think EA contributes to organizational alignment, primarily by representing AIR (entailed by developing EA deliverable models) and realizing AIR (entailed by activating EA deliverable models). Therefore, we name the proposed framework as EA-AIR because it helps us decompose the alignment process and examine relevant activity aspects that might impact the EA models delivered.

We pursue using the EA-AIR framework to explain the mechanism of EA-enabled alignment, namely, how different EA activities, separately and as a whole, help organizations achieve alignment goals and *the key influencing factors*.

We describe how we derived the EA-AIR framework and formalize it in this section.

3.1 Deriving the EA-AIR framework

As explained in Section 2, we assume that it is possible to decompose the overall alignment process into parts where different (EA) modeling activities can contribute. We also think it is possible to identify key aspects that impact the quality of delivered (EA) models. By examining the decomposed parts of the alignment process and key aspects of involved modeling activities, we can better analyze, at a smaller granularity, how alignment goals are achieved through EA.

First, we decompose the alignment process into five parts where different modeling activities could contribute. As shown in Table 1, we could observe how various modeling activities, separately and accumulatively, help organizations achieve alignment goals. Notably, in the first three parts (colored in light blue in Table 1), EA activities are primarily leveraged to represent AIR and thus more restricted to (paper or electronic) models themselves. While in the last two parts, EA activities are more about realizing AIR and therefore take place in reality.

Table 1. Mapping EA modeling activities to alignment achieving process.

Alignment process	Alignment Scoping (AS)	Alignment Embodiment (AE)	Alignment Augmentation (AA)	Alignment Realization (AR)	Alignment Maintenance (AM)
(EA) modeling activities	Model conceptualization	Model externalization	Model computation	Model activation	Model evolution

Second, we identify key aspects of modeling activities in each part, which significantly impact the quality of delivered models. This work was done in two steps:

- Step 1: observing which model quality goals [15] can be decided in relevant modeling activities.
- Step 2: identifying aspects (means) that could impact the quality goals according to [15, 17], specializing the aspects considering the alignment context, and compensating with new aspects to activities that are not discussed in [15, 17], according to common knowledge.

Regarding step 1, we cover five main model quality described in [15, 17]: physical quality, syntactic quality, semantic quality, empirical quality, and pragmatic quality. There are more quality aspects described in [15, 17]. We do not include them, namely organization quality, perceived semantic quality, and social quality, for two reasons. First, these three aspects are more about how models fit with the environment (organizations and stakeholders) than models themselves. Second, according to [15], such aspects are unavailable for a formal inspection.

Regarding step 2, *firstly*, we identify some modeling aspects that could contribute to a specific modeling quality according to the SEQUAL framework [15]. For instance, as defined in [16], feasible completeness is one of the main goals/aspects relevant to semantic quality. *Secondly*, we further consider these identified aspects and specialize

them in the alignment context. For instance, feasible completeness means that components and relations among them relevant to the alignment goal have been completely covered. In other words, this is about the scoping of EA. We further identify three dimensions that could define this scope: domain, abstraction level, and timeline. *Thirdly*, for some parts that no model quality is directly related to, we think about general solutions according to our best knowledge and make abstractions to summarize them as aspects. For instance, for alignment maintenance, a general solution is to evaluate the models by organizing regular meetings to collect feedbacks, adjusting, and starting new cycles. Thus, we propose evaluation and cycle as two aspects in this part. Results of Step 1 and 2 are appended to Table 1, as shown in the third and fourth rows of Table 2.

Table 2. Model qualities and modeling aspects relevant to modeling activities.

Alignment process	Alignment Scoping (AS)	Alignment Embodiment (AE)	Alignment Augmentation (AA)	Alignment Real-ization (AR)	Alignment Maintenance (AM)
Modeling activities	Model conceptualization	Model externalization	Model computation	Model activation	Model evolution
Model qualities	Semantic quality	Syntactic quality, physical quality, empirical quality	Pragmatic quality (as general models)	Pragmatic quality (as active models)	
Modeling aspects	<ul style="list-style-type: none"> • Domain • Abstraction level • Timeline 	<ul style="list-style-type: none"> • Intensity • Medium • Repository 	<ul style="list-style-type: none"> • Leveraging computation 	<ul style="list-style-type: none"> • Enabling learning • Enabling actions • Automatic activation 	<ul style="list-style-type: none"> • Evaluation • Cycles

3.2 Formalizing the EA-AIR framework

To make Table 2 easy to use, we simplified it by hiding the two middle rows and use the remainder (bolded parts of Table 2) to formalize the proposed framework, as presented in Table 3. Each part and aspect in the framework are formally defined as below.

Alignment Scoping (AS): this is to define the scope of alignment, namely, which components shall be identified/created, and which relations shall be identified/established. We identified three dimensions where alignment might cover. The first dimension is the domain, such as business domain, data domain, application domain, and service domain. The second dimension is the abstraction level, such as vision, strategy, capability, solution. The third dimension is about time, like "as is" and "to-be."

Alignment Embodiment (AE): this explicitly represents alignment (i.e., relations and relevant components). Three aspects are included here. The first aspect is the intensity indicating how intense the alignment relations are presented (e.g., explicit, based on taxonomies, formally defined with meta-model, verified by tools). The second aspect is the medium. It aims to represent which medium is used for the externalization, such

as physical medium and electronic medium. The third aspect describes how the model artifacts are stored, by using a single digital repository, for instance.

Alignment Augmentation (AA): this is to augment and enhance the alignment relations by calculating them. The augmentation might include static analysis, dynamic simulation, and prediction by leveraging various computation techniques. AA is the place where more added value could be explored and attached to original models.

Alignment Realization (AR): in this part, EA models are used to influence reality. Three aspects are included in this part. The first two aspects describe how models enable human users to learn or take actions (i.e., manual model activation). The third aspect illustrates how to use tools to trigger automatic model activation.

Alignment Maintenance (AM): this is to maintain/ continuously approach the alignment status. Often, it is conducted in terms of periodically evaluating and restarting the whole cycle.

Table 3. Formalization of the EA-AIR conceptual framework.

Alignment Scoping (AS)	Alignment Embodiment (AE)	Alignment Augmentation (AA)	Alignment Realization (AR)	Alignment Maintenance (AM)
<ul style="list-style-type: none"> • Domain • Abstraction level • Timeline 	<ul style="list-style-type: none"> • Intensity • Medium • Repository 	<ul style="list-style-type: none"> • Leveraging computation 	<ul style="list-style-type: none"> • Enabling learning • Enabling actions • Automatic activation 	<ul style="list-style-type: none"> • Evaluation • Cycles

4 Case studies

According to [19], there are typically three schools of thought regarding EA, namely Enterprise IT Architecting, Enterprise Integrating, and Enterprise Ecological Adaptation. The scope and purpose of EA differ a lot for these three thoughts, as summarized in the three right columns of Table 4 [19]. To demonstrate how to use our proposed framework, we chose representative studies for each type as our cases (as shown in Table 4). In these empirical studies, comprehensive descriptions about applying EA to achieve alignment goals can be found.

In the following sub-sections, we analyze how EA has contributed to achieving alignment in typical cases of each of the three schools based on the EA-AIR framework. We also tentatively quantified the results by giving each part of these three cases' alignment process a score. According to the author's preliminary assessment, an integer score between 0 and 3 is given, depending on the extent to which EA is fully utilized in each case according to our proposed framework. By doing so, we compared the results for the three cases in a visualized way. The three cases are summarized as:

Case 1 is about one of the largest insurance companies in the world [20]. The company introduced agile methods on a larger scale in 2016, ran ten large-scale agile development programs with more than 5,000 employees, and decided to initiate the second wave of the transformation by applying agile methods across the enterprise. The EA team was tasked with the alignment of the running large-scale agile development programs, particularly about the technologies and standards used.

Case 2 [21] describes a case of leveraging advanced EA Management (EAM) tools to implement the EU's General Data Protection Regulation (GDPR). GDPR is drawing increasing attention [22], and according to our previous research [23], it might be a very typical scenario where EA and EAM tools can play an important role. Industry/commercial tools are often less observed by academia, although their importance has been recognized [24-26]. We did not find scientific studies where such a case is reported. We analyzed a customer story reported by a leading EAM tool vendor on their official website, therefore [21]. Kommunal Landspensjonskasse (KLP), which is Norway's largest pensions and life insurance company, has used a leading EAM tool, namely ABACUS, since 2016. To comply with GDPR, the company reconsidered the way they capture, manage, and process personal data and fully understood how the data management is aligned to their level of compliance and effectively produce regulatory documents.

Case 3 [27] described a smart city case where data was collected from an organization and a municipality in Norway. In this case, two major EA artifacts were modeled in the language of ArchiMate [28]. One artifact illustrated how individual enterprises were aligned/ collaborated to create and provide services. The other one depicted how business could be aligned and mapped with IT strategies.

Table 4. Cases for different schools of EA thoughts.

Case	EA School	Scope	Purpose
C1	Enterprise IT Architecting	All components of the enterprise IT assets	Effectively execute and operate the overall enterprise strategy for maintaining a competitive advantage by aligning the business and IT strategies such that the proper IT capabilities are developed to support current and future business needs
C2	Enterprise Integrating	All facets of the enterprise	Effectively implement the overall enterprise strategy by designing the various enterprise facets to maximize coherency between them and minimize contradictions
C3	Enterprise Ecological Adaptation	The enterprise and its environment	Help the organization innovate and adapt by designing the various enterprise facets to maximize organizational learning throughout the enterprise and encourage system-in-environment coevolution

4.1 Case 1: EA for Large-Scale Agile Development Environment

We analyze how EA contributed to the alignment goal according to our proposed framework for this case. *First*, EA was scoped as architectural principles, guidelines, and Key Performance Indicators (KPIs). *Second*, the EA artifacts seemed to be presented in an initial and direct way. *Third*, there seemed not to be any computation augmented. *Fourth*, efforts were put on EAM initiatives which complemented the enforcement-centric view of traditional EAM by an influence-centric view. They were exerted by normative and mimetic pressures to enforce principles without encountering agile teams' resistance. Voting on the adoption, refinement, or rejection of EA artifacts also facilitated the learning and actions. *Fifth*, the articulation of EA and continuous interactions between EA and the domain was conducted. Web applications have supported

automated testing and an overview of which guidelines (EA artifact) were applied by which teams. Feedback on using guidelines was collected for guideline adjustment. The result is summarized in Table 5.

Table 5. Scoring alignment levels for Case 1.

AS: 1	AE: 0	AA: 0	AR: 2	AM: 2
Abstraction level: high-level; Domain: architecture principles, guidelines, and KPIs to align organizational-wide goals and implementations	NA	NA	Enabling actions: voting on adoption of EA, normative& mimetic pressures to facilitate the application of EA	Evaluation: collecting feedback to change EA, automated testing, an overview of the appliance

4.2 Case 2: Leveraging EA Tools to Implement GDPR

According to the EA-AIR framework, the *first* aspect is about the alignment scope. To comply with the GDPR, comprehensive data needs to be analyzed in broad scope, including personal data, systems, applications, and business priorities. *Second*, with the advanced commercial tool's support, data can be managed based on well-defined meta models and maintained in a single digital repository. Data can be imported from various applications or collected by inviting corresponding stakeholders to input. *Third*, Avolution [29], as one of the leading EAM tools, provided KLP multiple computation support. Such supports include keeping data up to date when content is changed and providing an "auto-generated multi-page report which details the company's systems and compliance." *Fourth*, learning new knowledge was facilitated. As said in [21], "visualize this analysis, helping people understand." "Day-to-day, this information vault allows them to generate a picture of the technology, an understanding of what each system does and what part of the portfolio it fits into." In addition, collaboration was enabled through inviting data collection and triggering communications. *Fifth*, the team runs a full ABACUS report monthly as part of the company's evidence of compliance. The result is summarized in Table 6.

Table 6. Scoring alignment levels for Case 2.

AS: 3	AE: 3	AA: 3	AR: 1	AM: 1
Domain, abstraction level, timeline: comprehensive data collected in a broad scope	Intensity: well-defined meta-models; Repository: a single digital repository, inviting data collection, data integration	Leveraging computation: Keeping data up to date, automatic report generation	Enable learning: everyday information vault, rich visualization; Enabling actions: triggering communications	Evaluation, cycles: running full report monthly

4.3 Case 3: EA in a Smart Cities Project

According to the framework, *first*, two types of EA artifacts were developed and applied. One artifact covered high-level enterprise collaboration relations, and the other one described how business is aligned with IT strategies. *Second*, EA artifacts were modeled in well-defined language, namely ArchiMate. *Third*, no information was found about if computation was applied to the EA artifacts. *Forth*, the EA models were prepared for each session of a focus group, and it was ensured that all vital issues were discussed. *Fifth*, after each session, the discussion results were presented in models, refined, and confirmed. The analysis is summarized in Table 7.

Table 7. Scoring alignment levels for Case 3.

AS: 2	AE: 2	AA: 0	AR: 1	AM:1
Domain, abstraction level: how enterprises collaborate to provide services, how business is aligned with IT strategies	Intensity: well defined meta-models/ modeling languages	NA	Enabling learning, enable actions: ensuring all issues are discussed based on models	Evaluation/cycles: multiple sessions, refining &confirming models

4.4 Comparing the Three Cases

The results are compared and visualized in Figure 1. As shown in the figure, these three cases present pretty different EA ways to help organizations achieve alignment. While Case 2 focuses more on representing AIR formally and comprehensively by leveraging powerful tools and computations (technical aspects), Case 1 paid more attention to realizing AIR (social aspects). Case 3 comparatively employed a more balanced way to achieve alignment.

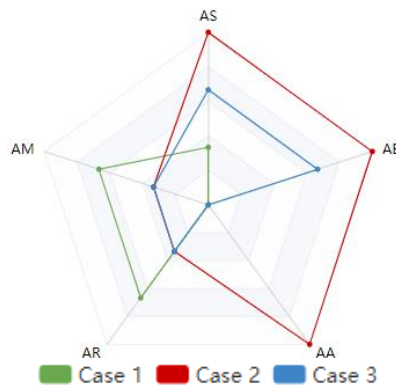


Fig. 1. Comparing the three cases by tentatively quantifying the results.

5 Discussions

We discuss how to apply our proposed framework to use EA better in contributing to organizations' various alignment goals.

"Just enough" AIR: EA should be customized to provide "just enough" AIR in a "just enough" way. EA could provide AIR with different scope, intensity, medium, calculation, and other capabilities. The cost of EA is different accordingly. Considering the ever-existed Return on Investment (ROI) pressure in organizations [30], EA should strive to balance and provide cost-effective AIR. Therefore, EA should focus on users' needs and be "just enough" (lightweight, eliminating wastes, but without compromising necessary quality). To achieve this goal, analyzing each EA artifact (with small granularity) and each modeling aspect (as indicated by the EA-AIR framework), instead of analyzing EA as a whole, might be needed.

Between AIR and the reality: Organizations should complement EA with other resources to use AIR to achieve the best alignment. As a set of models, EA strives to provide the best insights and (learning and acting) recommendations according to organizations' specific scenarios and requirements to achieve alignment. Organizations should think about how to make better use of them. This imply not only direct efforts in AR part of the EA-AIR framework, but also some indirect efforts related to other parts, such as trainings and governance policies.

Use AIR continuously: An organizational environment might be changing due to various reasons. Besides, when EA users learn and act according to AIR, they gain different knowledge and change domains (organizational components and environment). The new knowledge and the changed domain, in turn, might indicate not only changes in the facts on which AIR is based but also changes in AIR requirements. Therefore, AIR often requires to be continuously adapted and applied to keep its effectiveness (AM).

Leverage AIR for organizational agility: It is increasingly important for organizations to keep agile [3]. On the one hand, organizations need AIR to do the right things in the right way so that to keep lean (eliminating waste without compromising quality) and responding to changes. On the other hand, as one component of an organization, EA by itself should be agile. That also indicates why "just enough" and "continuous" AIR is important.

Evaluation and Improvement: The proposed EA-AIR framework could be used for systematically evaluate how well EA has been leveraged for alignment goals, but also could be used for further analyzing how to improve relevant efforts.

6 Conclusion

This article examined notable theories of EA modeling and alignment and proposed a framework named EA-AIR explaining how EA helps organizations achieve alignment. We employed three cases to demonstrate how to use the framework. The result shows that, in these three cases, EA used quite different mechanisms to help achieve the alignment goals, and our proposed framework helped us examine and understand the mechanisms. This indicates that our proposed framework can classify and structure relevant

studies about applying EA for (achieving, measuring, and maintaining) organizational alignment. By doing so, a common understanding of how EA enables alignment could be gained for academia to move forward in this field. With such a picture and relevant knowledge in mind, we expect organizations to leverage EA-relevant techniques and methods systematically and intentionally to achieve alignment effectively and efficiently.

The main limitation of the present research is the lack of further validation of the proposed framework. By far, we have only applied it to three cases which might be representative but far from sufficient. The proposed modeling aspects also need to be further enumerated to be more inclusive and exhaustive. In addition, it is not clear enough how organizations could benefit from this framework concretely and practically. Thus, we plan to review relevant works systematically to validate and enhance the framework. We also plan to apply the framework in real projects. In this way, we will investigate how to deliver feasibly good methods for specific alignment and organizational context based on the proposed framework.

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