Enterprise Architecture Benefit Realization

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Abstract

In today's volatile business environment, organizations need to constantly reshape their operations. Enterprise Architecture (EA) is a promising approach to supporting organizational transformation and providing the necessary agility to respond to environmental changes. Consequently, it has received attention from both academia and industry. In particular, the practical aspects of creating and implementing EA have been addressed in previous research.

Many researchers claim that a multitude of benefits can be realized by EA. These include improved decision making, better alignment of business and IT, and reduced costs. However, the question of how EA creates benefits has received little attention. Only recently have a few models been published on the EA benefit realization process. This refers to a process consisting of several interacting constructs impacting the realization of benefits by EA in an organization, such as EA products (including architecture documentation, i.e., models), different kinds of EA utilization constructs, and social and cultural constructs. Nevertheless, the results are, to a large extent, contradictory and are presented on an abstract level. Consequently, there is no unified view of EA benefit realization.

This thesis focuses on understanding EA benefit realization, taking four different viewpoints on the phenomenon. First, the EA benefit realization process is described on a general level as a data-based model. Second, EA stakeholders are considered to uncover their interaction with EA and their EA-related concerns. Third, EA product and service use (including the utilization of, for example, architecture models and architectural support for development projects) is addressed to discover when, why, and to whom EA benefits actually emerge in practice. Fourth, the measurement of EA benefit realization is scrutinized to form the basis for rationalizing the EA approach and improving EA practice.

The thesis states that EA benefits are realized through a complex process involving several interconnected constructs. There are many stakeholders that interact in the process, having various and even conflicting concerns about EA. EA use is also a complex phenomenon that is heavily intertwined with EA stakeholders, EA products, and services. Concrete measures for the EA benefit realization process constructs are also proposed. The results can be used as a basis of further study, for example, validation of the proposed model. Recommendations for EA practice are also given.

The thesis is article-based and contains six articles. The empirical part of the study is based on a multiple qualitative case study in a large public organization.

Keywords: enterprise architecture, benefit realization, stakeholder, use, measurement

Tiivistelmä

Organisaatioiden on jatkuvasti mukautettava toimintaansa nykypäivän nopeasti muuttuvassa liiketoimintaympäristössä. Kokonaisarkkitehtuuri (KA) on lupaava lähestymistapa organisaation muutoksen tukemiseen. Se mahdollistaa myös muutosten toteuttamisessa tarvittavan ketteryyden. Tästä johtuen se on saanut laajalti kiinnostusta niin tutkijoiden kuin käytännönharjoittajien piirissä. Aiemmassa tutkimuksessa on käsitelty erityisesti KA:n käytännön näkökohtia, kuten mallinnusta ja KA:n jalkautusta.

Monet tutkijat esittävät, että KA voi tuottaa useita hyötyjä, kuten päätöksentekoprosessien tehostuminen, liiketoiminnan ja IT:n parempi yhteentoimivuus sekä kustannussäästöt. Tästä huolimatta kysymys miten hyödyt syntyvät ei ole saanut kovinkaan paljon huomiota. Vasta viime aikoina on julkaistu muutamia KA:n hyötyjen syntymisprosessia kuvaavia malleja. Nämä viittaavat prosessiin, jossa joukko teoreettisia käsitteitä on vuorovaikutuksessa keskenään ja vaikuttaa siten KA:n hyötyjen syntymiseen organisaatiossa. Malleissa esiintyviä käsitteitä ovat muun muassa KA:n tuotteet (sisältäen arkkitehtuurisen dokumentaation, kuten arkkitehtuurimallit), erilaisia KA:n käyttämiseen liittyviä käsitteitä sekä sosiaalisia ja kulttuurillisia käsitteitä. Nämä tulokset ovat kuitenkin suurelta osin keskenään ristiriitaisia ja ne on kuvattu melko abstraktilla tasolla. Tästä johtuen ei ole olemassa yhtenäistä näkemystä KA:n hyötyjen syntymisestä.

Tämä väitöskirja keskittyy KA:n hyötyjen syntymisen ymmärtämiseen. Ilmiötä käsitellään neljästä eri näkökulmasta. Ensiksi hyötyjen syntyprosessi kuvataan yleisellä tasolla empiirisen tutkimusaineiston analyysiin perustuvassa mallissa. Toiseksi käsitellään KA:n sidosryhmiä, jotta voitaisiin ymmärtää niiden vuorovaikutus KA:n kanssa sekä odotukset ja tavoitteet KA:n suhteen. Kolmanneksi tutkitaan KA:n tuotosten ja palveluiden käyttöä (sisältäen esimerkiksi arkkitehtuurimallien ja projektien arkkitehtuurituen hyödyntämisen) sen ymmärtämiseksi, milloin, miksi ja kenelle KA:n hyödyt käytännössä syntyvät. Neljänneksi tutkitaan KA:n hyötyjen syntymisen mittaamista. Tämä muodostaa pohjan KA:n perustelulle ja kehittämiselle.

Tutkimuksen mukaan KA:n hyödyt syntyvät monimutkaisen prosessin kautta, johon liittyy useita toisistaan riippuvia teoreettisia käsitteitä. Prosessiin liittyy myös useita KA:n sidosryhmiä, joilla on monia, myös keskenään ristiriitaisia odotuksia ja tavoitteita KA:n suhteen. Myös KA:n käyttö on monimutkainen ilmiö, johon liittyvät läheisesti esimerkiksi KA:n sidosryhmät sekä KA:n tuotteet ja palvelut. Lisäksi ehdotetaan KA:n hyötyjen mittaamiseen sopivia konkreettisia mittareita. Tuloksia voidaan käyttää jatkotutkimuksen

pohjana, esimerkiksi esitetyn mallin validoinnissa. Tämän lisäksi annetaan suosituksia KA-toiminnan kehittämiseen.

Väitöskirja on artikkelipohjainen ja sisältää kuusi artikkelia. Tutkimuksen empiirinen osa perustuu useaan laadulliseen tapaustutkimukseen suuressa julkishallinnon organisaatiossa.

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Contents

List of Figures

List of Tables

List of Publications

I. Niemi, E. & Pekkola, S. (2016). Enterprise architecture benefit realization: Review of the models and a case study of a public organization. *SIGMIS Database 47*(3).

II. Niemi, E. (2013). Quality attributes for enterprise architecture processes. *Journal of Enterprise Architecture 9*(1), 8-16.

III. Niemi, E. & Pekkola, S. (2013). Enterprise architecture quality attributes: A case study. In Sprague, R.H., Jr. (Ed.), *Proceedings of 46th Hawaii International Conference on Systems Science* (pp. 3878-3887). Los Alamitos, CA: IEEE Computer Society.

IV. Niemi, E. (2007). Enterprise architecture stakeholders—A holistic view. In Hoxmeier, J.A. & Hayne, S. (Eds.), *Proceedings of the 13th Americas Conference on Information Systems* (9 pages). Atlanta, GA: Association for Information Systems.

V. Niemi, E. & Pekkola, S. (2015). Using enterprise architecture artifacts in an organisation. *Enterprise Information Systems*, 1-26.

VI. Niemi, E. & Pekkola, S. (2009). Adapting the DeLone and McLean model for the enterprise architecture benefit realization process. In Sprague, R.H., Jr. (Ed.), *Proceedings of the 42nd Hawaii International Conference on Systems Science* (pp. 1-10). Los Alamitos, CA: IEEE Computer Society.

1 Introduction

In today's volatile business environment, organizations have to constantly adjust their activities to the changing circumstances. Therefore, organizations need to engage in continuous business transformation. To succeed in the market, organizations need to develop a solid foundation for execution, consisting of digitized business processes and supporting IT (Ross et al., 2006, p. 4). However, building this foundation is a challenging task. Issues such as aligning IT with business, and the agility and flexibility of IT in meeting business needs seem to persist among the top IT management challenges year after year (Kappelman et al., 2014). Storing and managing master data separately in silos within distinct information systems (IS), processes, and organizational functions (Silvola et al., 2011) are also typical challenges for today's organizations.

With the long legacy of organizational activities, processes, and IT development, even planning and steering the transformation can be daunting tasks, as complexity has been built into the organization over the years (Lange, 2012, p. 23). Organizations may lack a clear overall view of their business functions, processes, information systems (IS), and individual technical platforms, such as servers and databases, and of their mutual dependencies (Lange, 2012, p. 23). A clear, holistic and detailed view of where the organization wants to be in the future may also be missing. Instead, the organization's target state is usually presented as a relatively high-level strategy, which may be hard to translate into concrete transformation initiatives (Ross et al., 2006, p. 6). To make matters worse, a holistic way of guiding and steering this transformation is missing, as the responsibility is divided into individual disciplines such as process improvement, IT governance, and project and program management.

These challenges make it difficult to steer transformation initiatives in the most beneficial way. As a result, business and IT improvement often takes place in silos, without comprehensively considering the overall dependencies and the organization's transformation as a whole. Transformation projects that are unable to reach their overall goals and overrun their budgets and schedules are all too familiar implications of this challenge (Bloch et al., 2012). Traditional transformation approaches such as strategic planning, process improvement, IT governance, quality management, and program management are, on their own, unable to change this course, as they lack the holistic picture and the “glue” that holds the transformation together (cf. Seppänen, 2014, pp. 51–52).

The Enterprise Architecture (EA) approach has been widely adopted as a planning and governance approach to manage complexity and constant change, and to align organizational resources toward a common goal (Foorthuis et al., 2015; Tamm et al., 2011a). EA encompasses an organization’s business capabilities, business processes, information, IS, and technical infrastructure, and facilitates the integration of strategy, personnel, business, and IT (Kaisler et al., 2005). It helps organizations in managing complexity and constant change, and aligning the organizations’ various resources toward a common goal (van der Raadt, 2011; Tamm et al., 2011a).

Despite the potential benefits, EA implementation endeavors are often questioned and challenged as their benefits are difficult to dissect (Potts, 2010; Rodrigues & Amaral, 2010; Tamm et al., 2015). This is a common challenge for all organizational initiatives, including IS (Pitt et al., 1995). In this respect, the field of EA is in its early stages. There is still no common understanding of EA, or how it should be developed, managed, and used to reap the most benefits from the approach (Lemmetti & Pekkola, 2012; Sidorova & Kappelman, 2011). The field of EA research is also fragmented, missing an overall explanatory theory, especially from the benefit realization perspective (Foorthuis et al., 2015; Tamm et al., 2011a). In particular, concrete benefits resulting from EA have turned out to be challenging to demonstrate, not to mention the process of benefit realization itself: Where do the benefits actually stem from?

Lately, a few empirical studies linking EA activities to actual benefits have appeared (see Foorthuis et al., 2010; Lange et al., 2012; Schmidt & Buxmann, 2011; Tamm et al., 2015). Additionally, the benefit-realization process itself has been addressed (see, e.g., Foorthuis et al., 2015; Lange et al., 2015). Although there is reasonable consensus on what kind of constructs are involved in EA benefit realization, it is unclear how the EA benefits are actually realized from these, as the studies are often abstract or contradictory. For example, while some authors argue that EA benefits emerge directly from having high-quality EA products (i.e., architecture models and other documentation) (Aier, 2014; Lange, 2012), others suggest that benefits can only be realized as the organization’s processes and systems have been improved by the help of EA (e.g., Tamm et al., 2011a).

Although previous findings provide ideas about which concepts the benefits can stem from, details on how the benefits are actually realized in practice are omitted. This is presumably because most of the studies have adopted a quantitative approach (see, e.g., Aier, 2014; Foorthuis et al., 2015; Lange, 2012; Schmidt & Buxmann, 2011). While it provides an excellent way to uncover the causal interrelationships in benefit realization, details are inevitably lost. For example, the constructs are modeled on a high level. Constructs such as EA approach (Foorthuis et al., 2015), use (Lange, 2012) and EA governance (Schmidt & Buxmann, 2011) are used to describe EA benefit realization. Typically, the constructs consist of relatively abstract attributes, especially regarding the measures of EA use. For example, in one of the most comprehensive EA benefit realization models available, the usage of EA management is modeled as "an EA management stakeholder's perceived extent to which the stakeholder intends to continue to engage in EA management" (Lange, 2012, p. 125). This raises the questions of what, where, and when to contribute to benefit realization and who exactly should be assigned to it. Similarly, one model measures "Use and Conformance of EA Standards," without explicitly defining the use and what the extent of conformance to EA standards actually means (Boh & Yellin, 2007). Another model focusing on EA principles has a similar issue (Foorthuis et al., 2015).

These are important questions, as EA is a complex concept and can be utilized in various ways in an organization (van der Raadt & van Vliet, 2008; Winter et al., 2007). Also, the large number of EA stakeholders has been acknowledged (Niemi, 2007; van der Raadt et al., 2008), but few studies provide clues as to which of these should interact with EA and how to enable benefit realization. The use of EA, such as the application of its products and services, seems to be one of the key concepts connected to EA benefit realization (Aier, 2014; Boh & Yellin, 2007; Lange, 2012, p. 213).

Also, the measurement of EA benefit realization would be critical for grounding theories on EA benefit realization and even a crucial antecedent for justifying the EA approach (Rodrigues & Amaral, 2010). Still, even though its importance has been acknowledged, very few organizations are actually carrying out EA measurement, possibly due to the lack of knowledge and usable practices (Hämäläinen, 2008, pp. 15–16). This is a significant shortcoming, as the measurement of EA could be used to support the management of EA, improve EA practices, identify EA use and benefits, and support architectural decision making (Hämäläinen, 2008, p. 75).

As a consequence, the challenges in comprehending EA benefit realization are evident. Due to the lack of understanding, EA implementation projects and their business cases remain difficult to discuss, and continuous EA measurement difficult to set up. The need to strengthen the theoretical foundation of EA benefit realization is evident (cf. Lange, 2012; Lux et al., 2010; Rodrigues & Amaral, 2010).

From these challenges, the initial research question of this thesis is articulated:

How are EA benefits realized?

EA benefit realization is defined as "obtaining direct or indirect positive impacts from EA in an organization." These impacts can be conceptualized on different levels, ranging from organization-level benefits to benefits specific to particular EA stakeholders such as development projects (e.g., Lange et al., 2015). In principle, all benefits are in the scope of the study. There are also different constructs from which the benefits can emerge (e.g., Lange et al., 2015; Tamm et al., 2011a). The starting point for understanding which constructs are involved in EA benefit realization is adopted from the IS discipline. Similar to the IS discipline (see, e.g., DeLone & McLean, 2003), EA benefit realization can be understood as a process, or more specifically as a chain of interrelated constructs leading to the realization of benefits (e.g., Lange, 2012, p. 217).

Therefore, a logical starting point for answering the question is to examine the interaction of different constructs in EA benefit realization. This creates an overall understanding of how EA benefits are realized. Moreover, the viewpoints of EA stakeholders, EA product and service use, and the measurement of EA benefit realization should be considered to understand EA benefit realization in detail.

The rest of the thesis is organized as follows. Chapters 2 and 3 describe the theoretical background for the study, beginning with EA in general and closing with EA benefit realization in particular. In chapter 4, the research questions, methods, process, and relationships of the included articles are described. Chapter 5 summarizes the included articles. In chapter 6, the answers to the research questions are presented. The thesis ends with conclusions and implications, contributions to research, recommendations for practice, limitations, and suggestions for further research.

2 Enterprise architecture

This section presents the theoretical background for the thesis and defines the main concepts.

2.1 Definition of EA

A logical starting point for defining EA is to look at the definitions of its constituents, enterprise and architecture. The Open Group (2011) defines enterprise in its TOGAF standard as “any collection of organizations that has a common set of goals.” Therefore, it is a generic term that can be used to refer to a company, part of a company, a set of companies, or a government agency, for example.

Architecture is also a generic concept, typically denoting the structure of different things. In the IS and EA contexts, the definition for architecture is often taken from the IEEE standard 1471 – 2000 (Hilliard, 2000). It defines architecture as “the fundamental organization of a system embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution.”

Within the EA context, the system in the above definition can be understood as an enterprise. Therefore, EA could be defined as “the fundamental organization of an enterprise, embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution.” This means that EA is a set of documentation that describes the structure of the enterprise and defines how the structure should be developed over time. In practice, the structure is modeled (documented) using different means in a set of architecture products. Some authors point out that EA refers to the structure of the organization, regardless of whether or not it is documented (Seppänen, 2014, p. 21). It is important to note that EA is not only an IT matter: in addition to covering technology, it should also cover business components, such as processes (e.g., Kaisler et al., 2005; Tamm et al., 2011a).

EA is developed and maintained through the process of architecting. This is an important conceptualization of EA in addition to the product (documentation) conceptualization discussed above. Architecting has been defined by the IEEE standard 1471 – 2000 (Hilliard, 2000) as "the activities of defining, documenting, maintaining, improving, and certifying proper implementation of an architecture."

A multitude of definitions for EA have been proposed in the literature. However, there is no single definition that would capture all the different conceptualizations of this complex concept (Hämäläinen, 2008, p. 26). Rather than committing to a single definition, the next section includes a detailed discussion of the different conceptualizations of EA. For the purposes of concisely defining EA at this point, the definition from Tamm et al. (2011a) is presented. According to the discussion in the next section, it seems to be one of the most comprehensive ones.

> [EA] is the definition and representation of a high-level view of an enterprise's business processes and IT systems, their interrelationships, and the extent to which these processes and systems are shared by different parts of the enterprise… Two key components of EA are the planning process (definition), and the direct and tangible outputs of that planning process (representation), i.e., EA documentation (e.g., architecture diagrams, roadmaps, and other artefacts).

The term *EA management* (EAM) has also been used in some EA literature (e.g., Lagerström et al., 2009; Lange, 2012; Lux et al., 2010) instead of the more ambiguous term EA. Although seldom clearly defined, Lange (2012) has defined EA management as:

> The management activities conducted in an organization to provide direction and practical support in the design, management, and transformation of an Enterprise Architecture (EA) to achieve its strategy. To this end, it establishes, maintains, and uses a coherent set of architecture principles, models, services, and governance structures. (p. 25)

By this definition, EA management seems to relate with the abovementioned process (architecting) conceptualization of EA. However, it is not only limited to the management-related activities (e.g., decision making and steering), but also seems to include hands-on activities such as the creation and maintenance of EA documentation. However, authors also relate product conceptualization with it. For example, Lange (2012) includes the construct EAM products as part of his EAM model. This is understandable as EA documentation is closely intertwined with the processes as the documentation is produced and used in the processes.

Thus, EA management seems to be somewhat synonymous with EA. However, as the term EA management can be erroneously associated with only management-related EA activities, the more generic term EA is used in this dissertation.

In practice, EA is an approach to support organizational transformation by translating organizations' strategies and operating models into concrete development initiatives and aligning organizations' resources for the enactment of the strategies (Lange, 2012; Ross et al., 2006; Tamm et al., 2011a). Rather than focusing on only a subset of organizations' resources, it takes a holistic view of all of the capabilities and resources of the organization, including business processes, systems, information, and technology (Kaisler et al., 2005). In this respect, EA can be considered as a comprehensive method or tool, among others, for enterprise governance (Lange, 2012, p. 26). As a collection of structures, processes, and mechanisms, enterprise governance (or corporate governance) is responsible for tackling the potential conflicts of interests to drive the organization toward common strategic goals (Perko, 2009). This objective is synonymous with the objectives of EA. EA can also be perceived as one of the supporting methods for IT governance (Perko, 2009). As a logical constituent of enterprise governance, IT governance is involved with applying IT in alignment with business strategies and needs.

The business and IT strategies formalize the long-term business and IT objectives of the organization. The strategies are then implemented through development initiatives. These typically take the form of individual projects, which are further assembled into development programs. This implementation has been considered challenging in many organizations (Ross et al., 2006, p. 6). Deriving the needs for concrete development initiatives from the strategy and aligning the initiatives towards the goal of overall business transformation instead of local optimizations are hard issues to tackle (Lange, 2012, pp. 25–26).

This is mostly a challenge of coordination and alignment. First, it is difficult to coordinate the different levels of the organization (i.e., overall organization, business units, and development initiatives) as they have different perspectives, goals, and incentives (Ross et al., 2006, pp. 118–121). Second, as these levels typically exist distinctively for both the business and IT sides of the organization, aligning business to IT is another challenge (Ross et al., 2006, pp. 119–120). Indeed, business-IT alignment has been considered one of the major challenges in the IS domain (e.g., Luftman & Brier, 1999). It is a complex concept comprising of several components, including architecture and IT governance (Luftman & Brier, 1999).

For its part, EA provides the means for coping with these challenges. It translates the high-level principles, capabilities, and goals defined in the strategies and operating models into a detailed description of a future operating platform that enables the organization to realize its goals, and a roadmap describing the required transition (Tamm et al., 2011a). The description encompasses a long-term view of the processes, systems, and technologies necessary for the organization's core capabilities (Ross et al., 2006, p. 9). In the definition of the future operating platform, EA also considers the restrictions and opportunities of the current EA operating platform by facilitating the identification of redundancies, bottlenecks, and potential synergies (Tamm et al., 2011a).

EA also steers and guides individual development initiatives in enacting the strategy (Lange, 2012). It enables the development of organization-wide, long-term capabilities instead of merely filling the current or local needs (Ross et al., 2006, p. 9). Moreover, it enables business-IT alignment (cf. Luftman & Brier, 1999) by ensuring that the resulting solutions, such as information systems, are actually suitable for the organization as a whole, contribute to its long-term goals, and are integrated with its processes to enable automation (Ross et al., 2006, pp. 6–8).

To enable this guiding effect, EA needs to be linked with a multitude of planning, management, and governance functions (or disciplines), such as strategic management, IT governance, project and program management, quality management, and portfolio management (Aier et al., 2011; Boucharas et al., 2010; Boyd & Geiger, 2010; Lankhorst, 2009; Winter et al., 2007). For example, in IT governance, EA should be utilized as part of IT planning and decision making to guide IT towards the common goals and align it with business (Ross et al., 2006, pp. 121–123). Similarly, in project management and solutions planning, project and architecture planning can be aligned with the overall EA to avoid siloed solutions (Ross et al., 2006, pp. 128–129).

EA is not only limited to guiding IT development—it can help in business development, such as process optimization (Winter et al., 2007), and can even support the strategic planning of business and IT (Lankhorst, 2009; Simon et al., 2013). EA also has a more generic purpose in communicating the strategic direction to the organization as a whole to increase understanding and buy-in for the transformation (van der Raadt, 2011; Tamm et al., 2011a; Winter et al., 2007).

EA is not the only established architecture approach. Other approaches such as software architecture, service-oriented architecture (SOA), integration architecture (Hämäläinen, 2008, p. 22), (information) system architecture (Smolander et al., 2008), and solution or project architecture are in use. These differ, especially in their scope, focus area, and use (Hämäläinen, 2008, p. 22). There is no common view of the definition of these approaches, let alone their relationship to one another (Hämäläinen, 2008, p. 23). Therefore, the following distinctions need to be made.

EA focuses on the whole organization, describing it in terms of several domains (i.e., business, information, information systems, and technology). Other architectural approaches typically focus on one or two domains (e.g., systems and technology) and are limited in their scope compared to EA. For example, system and software architecture describe the structure of a single software program or IS in terms of its (technical) components, operational principles, and interconnections (Smolander et al., 2008). Solution architecture extends this definition to include functional aspects (e.g., business processes and concepts) related to an IS.

On the other hand, due to its scope, EA is necessarily limited in the abstraction level it provides. Typically, EA descriptions do not go into the details of the elements (e.g., information systems) they describe. For example, the internal structure of an IS is usually not described as part of EA but is left to be described by the implementation project, guided by EA. However, as the term EA is ambiguous, the focus on the data collection was on architecture in general and not specifically on EA. Therefore, in this study, EA is considered to also include these more detailed architecture products, such as project and solution architecture.

Finally, SOA is an architectural paradigm that focuses on IS interoperability by enabling different IS functionalities to be provided and consumed as services (Lankhorst, 2009, p. 44). Thus, it is not an architecture product type *per se* but a set of principles used in designing architecture. For example, EA can be built on service-oriented principles (Lankhorst, 2009, p. 88).

2.2 Conceptualizations of EA

The terminology related to EA is still in an immature state (Schönherr, 2009). Although a multitude of definitions for EA exist (e.g., Ramos & de Sousa Júnior, 2015), there is no definition that would capture all of its conceptualizations as a whole, as different definitions emphasize different conceptualizations (Hämäläinen, 2008, p. 26). However, there is a reasonable unanimity on what EA is comprised of, and, thus, what conceptualizations should be considered. The following paragraphs attempt to capture the conceptualizations of EA as defined in the literature.

EA constructs an abstract representation of the organization into a set of architecture products and services to be used, for example, to guide development initiatives on the organization's continuous journey towards its target state (Lange, 2012; Tamm et al., 2011a). These products and services are produced, maintained, and managed through a set of EA processes (Lange, 2012, pp. 33–34). As the EA plans are realized in development initiatives, the newly improved operating platform (i.e., processes and systems), defined by the EA target state, is implemented (Ross et al., 2006; Tamm et al., 2011a).

These conceptualizations can be divided into three broad categories that define how EA is understood in the literature. First, EA can be conceptualized as an architecture *product* or *artifact* that provides an abstract representation of the organization and a plan guiding its implementation (e.g., Kaisler et al., 2005; Lankhorst, 2009; Tamm et al., 2011a). Second, it has been suggested that the products should be accompanied with *services* to support their realization (e.g., Lange et al., 2015). Third, the creation, maintenance, and governance of EA through EA *processes* (i.e., enterprise architecting) have also been highlighted (Lange, 2012; Lankhorst, 2009; Pulkkinen, 2006). These conceptualizations are outlined in the following section.

2.2.1 EA as a product

The first conceptualization is EA as a *product*. Previous studies agree that EA encompasses a collection of architectural *artifacts* such as architecture models, principles, and other documentation (Boh & Yellin, 2007; Lange, 2012; Tamm et al., 2011a). According to Kaisler et al. (2005), these define "the main components of the organization, its information systems, the ways in which these components work together in order to achieve defined business objectives, and the way in which the information systems support the business processes of the organization."

EA products consist of architectural *models* that provide an abstraction of the organization to be used in communication and decision making, *principles* that steer the organization towards the target state, and a *roadmap* that guides the organization on the implementation of EA (Boh & Yellin, 2007; Boucharas et al., 2010; Lange, 2012; Tamm et al., 2011a). The models typically consist of *elements* that represent different physical or abstract objects, such as information systems, business functions, or processes (e.g., Lankhorst, 2009, pp. 86–87). Also, the *interrelationships* of elements can be modeled (e.g., Lankhorst, 2009, p. 87).

As an all-encompassing architectural model of an organization would be overly complicated and unclear to provide practical value, the information in the products is segregated into different views by certain EA stakeholder concerns (Lankhorst, 2009, p. 57). Generally, the views can be distinguished in terms of domains, abstraction levels, and time orientations. *Domains* typically include business, information, information systems, and technology (Pulkkinen, 2006; van der Raadt, 2011). *Abstraction levels* range from enterprise level and individual line of business (LoB) descriptions to specific projects and solution implementations (Pulkkinen, 2006; van der Raadt, 2011). *Time orientations* include the current and a target state description, and a transition plan (roadmap) to describe the steps necessary to reach the target state (Kaisler et al., 2005; Lange, 2012). Different modeling standards or notations such as ArchiMate, UML, and BPMN are available to be used for different modeling needs (Gill, 2015).

2.2.2 EA as a service

The second conceptualization is EA as a *service*. These services are abstract EA artifacts that the EA team may provide for the EA stakeholders to facilitate the realization of the EA target state in the organization (cf. Lange, 2012). Typical EA services include guidance to development projects in complying with EA and architecture reviews to assure that the project architecture actually complies with EA (Lange, 2012; van der Raadt, 2011).

Lange (2012) proposes that EA services encompass the actual services offered to stakeholders external to the EA team, differentiating them from the EA processes. Indeed, also in this study, EA services are defined as all services resulting from EA processes and provided to EA stakeholders (internal and external to the EA team), aiming at ensuring the EA's guiding effect on the organization's transformation journey.

2.2.3 EA as a process

The third conceptualization is EA as a *process* (Lankhorst, 2009, p. 5). Tamm et al. (2011a) suggest that the process is responsible for the definition of EA (i.e., the creation of architecture models and other documentation). However, other authors argue that the processes encompass all activities related to the planning and decision making on the target state of EA, creation and maintenance of EA products, and governing their usage in guiding implementations (Lange, 2012; van der Raadt, 2011; Ross et al., 2006). This conceptualization also considers the tools, frameworks, methodologies, skills, resources, and organizational structures required in the operation of the processes (van den Berg & Steenbergen, 2010; Kaisler et al., 2005; Lange, 2012; van der Raadt, 2011).

These activities have also been referred to as the act of *enterprise architecting* (Kaisler et al., 2005). A related concept is *EA implementation methodology*, which refers to the methodologies used in EA management, development, and maintenance (Rouhani et al., 2015). The term *EA governance* is also used in some literature to refer to activities that aim at ensuring the guiding effect of EA (Ramos & de Sousa Júnior, 2015). An important distinction between EA processes and services is that the processes are required for providing the service, and the service is the actual service interface (e.g., people, meetings, and provided documentation) visible to EA stakeholders (cf. Lange, 2012).

2.3 Motivation for EA

All organizations operate in continuous interaction with their environment, which is characterized by complexity and constant change (Hämäläinen, 2008, p. 12). Forces external to the organization, such as mergers and acquisitions, regulations and laws, customer needs, and technological trends, drive pressure to align the organization to respond to the changes in the environment to enable its continuity (Lange, 2012, pp. 22–23). The required changes are often significant and are enabled by IT capabilities (Lange, 2012, p. 23). In the public sector, for example, interoperability and digitization (eGovernment) requirements are significant drivers for change (Ramos & de Sousa Júnior, 2015; Seppänen, 2014).

However, organizations face major challenges in implementing the required changes. Large organizations can be complex entities whose agility is hindered by a legacy of misaligned organizational structures and IT environments. Organizational silos and conflicting incentives make it difficult to align the organization toward a common goal instead of local optimizations (Ross et al., 2006, p. 119). Also, complex and inflexible legacy IT environments typically lack the capabilities to facilitate the desired changes (Ross et al., 2006, p. 191).

On the other hand, lack of transparency of the current capabilities, processes, and resources impedes the identification of the required improvements and capabilities that can potentially support the transformation (Lange, 2012, p. 23). Translating the strategic direction of the organization to concrete development initiatives has also been found to be difficult (Lange, 2012, p. 26). And, even if the strategy can be acted upon, it is often implemented gradually, with each strategic initiative resulting in a separate IT solution—making the IT environment more complex (Ross et al., 2006, p. 6). This calls for an overarching approach to support the organizational transformation.

As a holistic approach to planning and development, EA is not new. It has existed in the systems engineering field as a part of data modeling techniques, system analysis, and design methods since the 1970s and 1980s (Kappelman et al., 2008). The Zachman Framework (Zachman, 1987) was the first to formalize these methods as an enterprise-level modeling framework (Kappelman et al., 2008). Since that time, EA has drawn significant practitioner interest (Tamm et al., 2011a) and has become established in both private and public sector organizations (e.g., Dang & Pekkola, 2015). In the public sector, many developed countries have established or are in the process of establishing an EA practice (Dang & Pekkola, 2015; Liimatainen et al., 2007; Ramos & de Sousa Júnior, 2015).

In addition to the self-motivated drive for increasing organizational performance to survive in the ever-changing business environment, regulatory pressures such as legislation and industry regulations drive the development of EA. In the public sector, interoperability and transparency requirements across government sectors, as well as pressures to decrease IT costs, have given birth to regulatory frameworks requiring organizations to develop an EA. In the US, the Clinger-Cohen Act of 1996 states that every government agency must have an integrated IT architecture (Jonkers et al., 2006). In Europe, countries are following similar lines. Also, in Finland, an act was passed in February 2011 that all governmental institutions and municipalities should follow a national EA and its development framework, JHS 179, in their IT development activities (Lemmetti & Pekkola, 2012). In private organizations, accountability frameworks such as Basel II and Solvency II require especially solid architectural approaches to providing the insight necessary to comply with the requirements (Jonkers et al., 2006; Lange, 2012).

Despite the substantial penetration of the EA approach in practice, significant academic interest for it is yet to emerge (Foorthuis et al., 2015; Kappelman et al., 2008; Tamm et al., 2011a). Possibly contributing this is the complexity and extensiveness of the topic. EA is a multidisciplinary theme, covering both social sciences and IS topics (Ramos & de Sousa Júnior, 2015). The majority of EA research has been published after the turn of the century, and most of the publications have originated from the practitioner domain (Kappelman et al., 2008; Tamm et al., 2011a). Practitioner-oriented topics such as EA development, including planning and modeling, have prevailed (Dang & Pekkola, 2015; Foorthuis et al., 2015; Tamm et al., 2011a). In particular, EA frameworks providing an overall structure and guidelines for the documentation of EA have been addressed by numerous authors (Dang & Pekkola, 2015). Fewer researchers have focused on creating a core theory or even a common terminology (Schönherr, 2009), especially regarding how EA creates benefits (Foorthuis et al., 2015; Lange et al., 2015). As a result, a common understanding of what EA is and how it should be developed, managed, and used does not yet exist (Sidorova & Kappelman, 2011).

2.4 EA in organizational context

As an organizational function, EA is perceived to be situated between strategic planning and development initiatives (Lange, 2012; Tamm et al., 2011a). In any case, EA should be positioned in a way that is not seen solely as an IT matter (Seppänen, 2014, p. 27). EA can be established as either a dedicated function (i.e., an EA function or an EA team) or as a development initiative (i.e., EA initiative or project) in the organization (Lange, 2012, p. 25). The EA function includes all roles and bodies responsible for creating, maintaining, and governing EA (van der Raadt, 2011, p. 31). Typically, organizations with only a little experience with EA do not have a dedicated EA function (Lange, 2012, p. 25).

Organizations that opt for a dedicated EA function have several options for its position in the organizational hierarchy. Firstly, it can be situated under IT or business management, or even directly under senior management (van den Berg & Steenbergen, 2010, pp. 108–109). Secondly, it can be central or decentralized. In a central model, all EA roles are situated in one central EA function. In a decentralized EA function, architects are situated in individual business units and are responsible for developing EA autonomously in their own area (van den Berg & Steenbergen, 2010, p. 109). Also, a federated version of the latter is possible, where a central EA function sets the direction for EA development in individual business units (van den Berg & Steenbergen, 2010, p. 110). Outsourcing EA capability, either entirely or partly (for example, only the documentation of EA) to a partner is an option, although at least architectural decision making should stay in the organization (Ross et al., 2006, p. 79).

As discussed earlier, EA needs to be linked with a multitude of organizational functions. Due to its extensively networked nature, EA has a great number of *stakeholders* in an organizational setting. A stakeholder is “any group or individual who can affect or is affected by the achievement of the organization's objectives" (Freeman, 1984, p. 46). Stakeholder theory is extensively documented in the literature and primarily constitutes a stakeholder management philosophy (Donaldson & Preston, 1995).

With regard to EA, stakeholders encompass any individuals, groups, or organizations that have interests in or concerns relative to EA (cf. Hilliard, 2000). In addition to the architects responsible for EA definition and management, typical EA stakeholders include decision-makers such as senior management, line management, projects and programs, and solution designers (van der Raadt, 2011, p. 44). The managerial challenge of EA is to satisfy these often conflicting concerns (cf. Donaldson & Preston, 1995).

There is a need to form cooperative relationships (cf. Ring & Van de Ven, 1994) between stakeholders, such as architects, portfolio managers, and projects (Nakakawa et al., 2011), to allow EA to develop in the right direction and for it to actually have an impact in the organization. This is a continuous process in which the usefulness of the relationship is constantly assessed by the parties involved and both formal and informal factors have an effect (Ring & Van de Ven, 1994). Typically, the desired guiding effect of EA on stakeholders is realized through a combination of formal governance processes and informal cooperation (van der Raadt, 2011, p. 31).

2.5 EA use

The conceptualizations of EA suggest that some kind of *use* needs to exist to realize benefits from EA. It has even been argued that EA, as a set of architecture products, offers no value if it is not properly used (Foorthuis et al., 2015). Similarly, as in the IS domain (cf. DeLone & McLean, 2003), EA use has also been suggested as a critical antecedent for EA benefits (e.g., Lange, 2012). Still, very few studies refer to actual use situations or activities. They usually take a very generic stance, referring to the use of EA as an approach (see Lange, 2012), or suggest high-level purposes for use, usually from the EA process perspective (see, e.g., van der Raadt & van Vliet, 2008). A few studies focus in detail on more specific use situations, but typically limit the analysis to one situation, such as IT acquisition management (Boyd & Geiger, 2010) or IT project guidance (Foorthuis et al., 2015). Most seem to scrutinize technical EA analysis methods in detail (see, e.g., Antunes et al., 2016; Fasanghari et al., 2015; Santana et al., 2016). As a consequence, there is no clear understanding of what is actually used with regard to EA use, by whom or why.

First, some authors refer generally to the use of EA (or EAM) as an approach in the organization—including all related processes, products, and services. Thus, a broad range of organizational benefits have been related to it (Lange et al., 2015). Some refer more concretively to the *purposes of use*, such as guiding development initiatives (Foorthuis &

Brinkkemper, 2008; Lange, 2012; van der Raadt, 2011; Ross et al., 2006) or IT portfolio management (Lux et al., 2010; Quartel et al., 2012).

More specific *use situations* have been suggested, referring to the use of specific EA products and services by different stakeholders for certain purposes (e.g., Lange, 2012; Pulkkinen, 2006; van der Raadt, 2011). For example, the analysis of architectural models can be used for several purposes, including setting project scope, project portfolio planning, and IT service management (Winter et al., 2007). IT standards set by EA can be used to guide technology choices by IT departments and business units (Boh & Yellin, 2007). Services, such as EA compliance assessments, can be offered to facilitate project compliance with EA (Foorthuis et al., 2015).

Indeed, the organizational role of EA implies that EA products and services have to be used by EA stakeholders to enable benefit realization. As EA encompasses a representation of the desired target state of the organization and a plan for how to realize it, the use of EA products for their implementation in individual development initiatives (Kaisler et al., 2005; Tamm et al., 2011a) is an important purpose for use. As parts of the EA plans are thus realized in the development initiatives, areas of the newly improved *EA-guided operating platform* (Tamm et al., 2011a) or *foundation for execution* (Ross et al., 2006, p. 4), including processes, systems, and technology, are implemented. In this process, the target state EA becomes the new current state. Thus, EA use bridges EA products (and services) to EA implementation. The new and improved systems, technologies, and processes realized this way can be considered as the indirect outcomes of EA use. Therefore, EA use refers to the use of EA products and services, which enables the realization of EA benefits.

To be able to align individual development initiatives to enact organizational strategies, it is required that they are guided to conform to relevant EA products, and that this conformance is validated later in the lifecycle of the initiative (Foorthuis & Brinkkemper, 2008; Lange, 2012; van der Raadt, 2011; Ross et al., 2006). This is a typical goal for EA service use. EA also facilitates the specification of project scope and integrations to the environment to avoid redundant development activities (Winter et al., 2007). On the program and portfolio management level, EA helps to identify development initiatives that best realize the strategic goals of the organization (Winter et al., 2007) and which the organization is actually capable of implementing (Perko, 2009).

There are also other uses for EA than just guiding development initiatives. For example, EA products can be used to support the planning and decision making on the EA target state (Lange, 2012; Pulkkinen, 2006; van der Raadt, 2011), strategic planning (Simon et al., 2013), IT acquisition management (Boyd & Geiger, 2010), IT portfolio management (Lux et al., 2010; Quartel et al., 2012), business process optimization, IT service management, and IT consolidation (Winter et al., 2007). EA can serve as a communication tool with a more generic purpose, such as in business-IT alignment (van der Raadt, 2011; Winter et al., 2007) or even organizational alignment at large (Tamm et al., 2011a). EA products can also be used for evaluating their quality (Ylimäki, 2006).

Technical EA analysis methods are a potential tool to be used in deriving information from EA products. These cover a range of techniques used in analyzing, condensing, and interpreting data on EA models (Antunes et al., 2016; Winter et al., 2007). While they can be used to produce analyses to be used as source data in decision making (cf. Antunes et al., 2016; Nakakawa et al., 2011), their use is still not widespread (Winter et al., 2010). This may be because analysis is somewhat laborious, not directly supported by EA frameworks (Lagerström, et al., 2009), and requires a "critical mass" of high-quality EA models, impeding its use in organizations with lower EA maturity.

2.6 EA vs. IS research

EA is closely related to information systems. First, as described before, EA guides and governs IS development and management (Foorthuis & Brinkkemper, 2008; Lange, 2012; van der Raadt, 2011; Ross et al., 2006), contributing to business-IT alignment, among other areas. Therefore, EA can be seen as one of the tools having an impact on the success of an IS, especially from the development and management perspective. To accomplish this, EA includes information systems and their interrelationships as part of its descriptions (e.g., Kaisler et al., 2005).

There are also commonalities between the definitions of EA and IS. This is especially prevalent within the EA product conceptualization. While EA products can be seen as a collection of principles, methods, and models that describe the entire organization in terms of business, information, systems and technology (e.g., Lankhorst, 2009, p. 3) an IS is defined as an organized collection of IT, data, information, processes, and people (Hirschheim et al., 1995). By another definition, an IS artifact incorporates information, technology, and social artifacts, the last referring to "relationships or interactions between or among individuals", including, for example, roles and structures (Lee et al., 2015). Finally, in the definition of architecture (Hilliard, 2000), a system can also refer to an organization as a software-intensive system (Seppänen, 2014, p. 22).

This implies that EA describes the same components that comprise an IS. The IT component of an IS refers to systems and technology architecture in EA, information to information architecture in EA, and processes, people, roles, structures, and other social aspects to business architecture in EA, respectively. It can thus be argued that the organization which is described by EA falls within the definition of an IS (cf. Hirschheim et al., 1995).

EA also has other commonalities with an IS. As with the EA process conceptualization, information systems are developed and managed by specific processes. For example, the IT Infrastructure Library (ITIL) defines processes that could be used to manage the lifecycle of an IS. Moreover, both EA and IS can be considered from the service perspective (Lange, 2012, p. 53). IS organizations are service providers, providing various support services for end-users (DeLone & McLean, 2003). Moreover, information systems themselves can be considered as services from the user's point of view. The main purpose of both EA and IS is also similar: to provide useful information to users. As a result, information systems seem similar to EA by definition.

IS models and theories have thus been utilized in EA research. One of the most widely cited[1] is the DeLone and McLean IS success model (DeLone & McLean, 2003, 1992) for understanding the realization of benefits from IS. Originally, it constituted the interrelated constructs of system quality, information quality, use, user satisfaction, individual impact, and organizational impact (DeLone & McLean, 1992). Later, it was revised by adding a service quality construct, separating an intention to use construct from the use construct, combining individual and organizational impact constructs into a generic net benefits construct, and proposing associations between the constructs (DeLone & McLean, 2003). Figure 1 depicts the updated version of the model (DeLone & McLean, 2003).

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[1] For example, Google Scholar finds over 15,000 citations for the two articles (as of 2-29-2016).

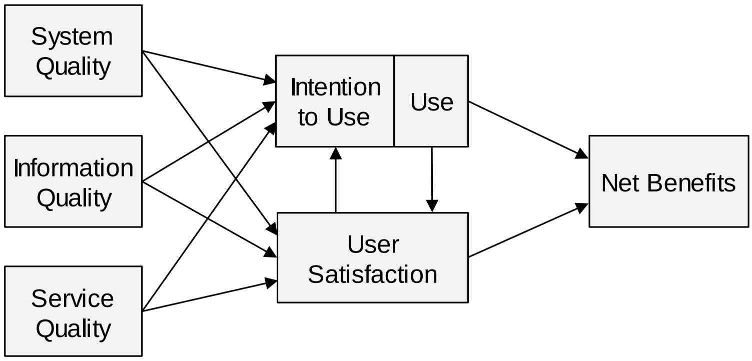

Figure 1. The Updated DeLone and McLean IS success model.

Originally developed as a process model rather than a causal model, a multitude of studies have attempted to validate the model with various levels of success (Petter et al., 2008). The model is based on generic communication and information influence theories (Mason, 1978; Shannon & Weaver, 1949). This suggests that the model could be usable in characterizing any process, making it applicable to other contexts. Actually, in addition to the traditional IS context, the model has been adapted and validated in a multitude of contexts, including e-business (Wang, 2008), knowledge management (Wu & Wang, 2006), e-learning (Holsapple & Lee-Post, 2006) and websites (Pérez-Mira, 2010). The model has also been adapted to the EA context by several authors (Dietzsch et al., 2006; Lange, 2012; Niemi & Pekkola, 2009). Due to its widespread influence and generic process, the framework was also used as a rough framework for data collection and analysis in this study.

3 Enterprise architecture benefit realization

Measurement of the benefits realized from EA has been considered difficult (Hämäläinen, 2008; Rodrigues & Amaral, 2010, p. 15). Still, as with any organizational initiative, EA has to be justified by showing concrete return on investment. The need to realize benefits in return for the resources invested in EA is especially important since EA initiatives typically require substantial investment (Kaisler et al., 2005). While practitioners face increasing pressure to justify the approach (Tamm et al., 2011a), researchers have responded by presenting various benefit claims, metrics, and measurement approaches to EA (Rodrigues & Amaral, 2010). Still, research on EA benefits is in its early stages, as researchers have rather focused on aspects related to EA products (Foorthuis et al., 2015). Consequently, most of these approaches have their challenges with regard to EA benefit measurement.

EA benefit realization has, to date, been approached by five strains of thought in the literature. The first one considers the benefits themselves, attempting to create a comprehensive picture of the benefits potentially realizable by EA. The second one studies the maturity of an EA practice, assuming that high maturity leads to benefits. The third one draws from the organizational performance measurement theory to develop measurement approaches, and operational and financial measures for EA, focusing on measuring the realized benefits. The fourth considers the impact of architectural choices on the qualities of the architecture. Finally, the fifth one attempts to model the process of benefit realization comprehensively.

3.1 Potential EA benefits

The earliest attempts to understand EA benefit realization focused on understanding the potential benefits of EA. This literature is characterized by a multitude of benefit claims, providing an overview of different EA benefits (Rodrigues & Amaral, 2010). These studies are typically based on literature review, surveys, or practical experience. In one of the most extensive literature reviews on EA benefits, based on 50 studies, Tamm et al., (2011a) identify the following 12 high-level EA benefits:

- Increased responsiveness and guidance to change
- Improved decision making
- Improved communication & collaboration
- Reduced (IT) costs
- Business-IT alignment
- Improved business processes
- Improved IT systems
- Reuse of resources
- Improved integration
- Reduced risk
- Regulatory compliance
- Stability

Other studies have presented fairly similar results, differences being mostly in the number of benefits and their level of abstraction (see, e.g., Boucharas et al., 2010; Espinosa et al., 2011; Kappelman et al., 2008; Lange, 2012; Niemi, 2006).

This strain of literature is also concerned with categorizing the benefits to understand their characteristics in more detail and facilitate further research. However, very few categorizations have been adopted as a basis for further research. This may be because the categories are often either based on practical considerations rather than an underlying theoretical framework, or too broad to provide significant value. For example, a traditional broad categorization divides benefits to business and IT benefits (e.g., Moshiri & Hill, 2011). Also, researchers have proposed categorizations that combine elements of the more conventional categories, which are based on organizational function, hierarchy level (Rodrigues & Amaral, 2010), EA stakeholder type, measurement type, and function (Boucharas et al., 2010). However, a few authors have proposed categories within a certain theme, such as level of impact (project or organizational) (Foorthuis et al., 2010; Lange, 2012) or whether the benefits are measurable and/or attributable to EA (Niemi, 2006).

The main challenge with the research on EA benefits is that the benefit claims are seldom based on empirical evidence (Boucharas et al., 2010; Tamm et al., 2011a). Also, many studies have focused on potential benefits, not benefits that have already been accrued (Tamm et al., 2011a). Still, there are some recent case studies that report concrete benefits, such as more effective and efficient IT decision-making processes, successful delivery of transformation projects, better digital business platform (Tamm et al., 2015), improved IT component reuse (Mocker et al., 2015) and better value creation from acquisitions (Toppenberg et al., 2015). Considering all of the evidence, it seems that, under the right circumstances, EA can be highly beneficial.

3.2 EA maturity evaluation

EA maturity models have their roots in the field of quality management, particularly in maturity models published for different functional domains; typically, these are modeled after the Capability Maturity Model (CMM) (van Steenbergen, 2011, p. 8). They provide an approach to measuring the overall quality of the EA practice or EA program and the planning of the necessary improvements (Hämäläinen, 2008; Ylimäki, 2007). Maturity models have originated from practical needs. While they have been published to a large extent by different US government institutions and industry analyst organizations (van Steenbergen, 2011, p. 9), attempts have also been made to develop generic EA maturity models (van den Berg & Steenbergen, 2010; Ross et al., 2006; Ylimäki, 2007).

The models assume that the organization successively progresses through a number of maturity levels (e.g., five), that each have specific functional requirements (van Steenbergen, 2011, p, 8). This suggests that EA should be developed in stages (Kimpimäki, 2014). The evaluation is based on a set of focus areas or capabilities perceived to constitute the overall maturity (van Steenbergen, 2011, p. 72). In this respect, the focus areas included in the models are fairly similar to critical success factors, which have also been studied with regard to EA (e.g., Seppänen, 2014). While many maturity models are focused on the quality of the EA practice (Perko, 2009, p. 82), some focus more on the outcomes of EA adoption (Perko, 2009, p. 84), such as the quality of the actual operating platform (i.e., architecture implementation) (Ross et al., 2006, p. 71).

Even though the approach provides an idea of the degree of development of the EA practice, the effectiveness of the utilization of EA (van Steenbergen, 2011), or even the quality of the architecture implementation (Ross et al., 2006), it does not directly measure benefits received from EA. Thus, the usability of EA maturity models in measuring benefit realization stems from the assumption that a causal relationship exists between EA maturity and benefit realization. While the existence of this causality has been proposed (Lagerström et al., 2011; Rodrigues & Amaral, 2010; Ross et al., 2006), evidence seems to be for the most part related to the maturity of the operating platform (Ross et al., 2006), not necessarily to the maturity of the EA practice itself.

Therefore, maturity models may not measure the benefits stemming from the initial stages of EA utilization, where operating platform improvements are not yet in place. The approach also makes an over-simplified instrument for understanding the constructs impacting benefit realization since it does not model the interaction between the included focus areas or their relative impact to overall maturity (e.g., Perko, 2009; Ylimäki, 2007). Finally, even if EA maturity and the realization of benefits are correlated, it does not automatically imply that EA maturity itself causes the benefits. This makes attributing the potential benefits to a particular EA a challenge.

3.3 EA benefit measurement

Various EA benefit measures constitute another approach to EA benefit realization. For example, Key Performance Indicators (KPIs) (Moshiri & Hill, 2011), measures of effectiveness (Morganwalp & Sage, 2004), structural ratios (Potts, 2010), value trees (Rodrigues & Amaral, 2010), and the Goal Question Metric (GQM) approach (Hämäläinen & Kärkkäinen, 2008) have been proposed as potential measuring approaches to EA benefits.

KPIs are metrics used to indirectly indicate the realization of benefits. For example, it has been argued that KPIs such as product diversity, the number of consolidated multiple redundant systems, and the number of avoided purchases can measure the benefit of less complexity (Moshiri & Hill, 2011). Also, measures of effectiveness aim to indirectly measure the realization of benefits, such as technical adaptability or reduced time of delivery (Morganwalp & Sage, 2004). Structural rations, on the other hand, focus on directly measuring the realized benefits. For instance, profit per monetary unit of operating expenses is suggested as a measure for the structural performance of an organization, which Potts (2010) states is contributed by formalized EA utilization. Value trees can be utilized to divide the measures into smaller components, facilitating the definition of metrics for different abstraction levels (Rodrigues & Amaral, 2010). Similarly, the GQM approach can be used to derive EA metrics from different goals and information needs in a step-by-step fashion (Hämäläinen & Kärkkäinen, 2008).

Even though similar measures are commonly used in the context of organizational performance measurement and provide a potentially objective basis for measuring EA benefits, their usability in the EA context has not been verified (Rodrigues & Amaral, 2010). As the main challenge in benefit measurement is to establish the causality between the EA and the benefits (Rodrigues & Amaral, 2010; Wan et al., 2013), many of the proposed metrics seem insufficient in this respect because they fail to link the measures to the concrete mechanisms by which EA creates value. The large number of potential benefits leads to another challenge in benefit measurement. Due to this, it is difficult to select the exact measurement targets (Rodrigues & Amaral, 2010), possibly leading to an unmanageably large amount of measures. Financial measures are especially problematic in this respect, as they do not capture the potential intangible benefits from EA (Rodrigues & Amaral, 2010).

To date, authors have provided little empirical evidence establishing the necessary causal links between KPIs and EA benefits. Also, the generic structural ratios are insufficient in this respect, as a multitude of other factors may affect them in an organizational setting. However, promising approaches to establishing the required causalities have been proposed. For example, the value tree could be utilized to isolate EA benefits according to their operational determinants (Rodrigues & Amaral, 2010). Structural rations of several divisions utilizing EA to different extents could be compared to pinpoint differences potentially influenced by EA (Potts, 2010). The GQM approach could be used to derive metrics for other aspects of EA besides benefits, such as quality and acceptance, and causalities between the measurement results could be sought (cf. Hämäläinen & Kärkkäinen, 2008). Still, empirically founded applications are yet to be seen.

3.4 EA scenario analysis

The evaluation of alternative EA scenarios also constitutes an approach connected to EA benefit measurement. In the business management contexts, scenario planning and analysis is an established method for creating alternative images of the future for highlighting critical uncertainties and, thus, facilitating decision making (Postma & Liebl, 2005). In the architecture context, it considers the impact of architectural choices or scenarios made in the definition of the architecture target state on the implementation of the architecture, such as a system (Babar et al., 2004). It provides an approach to choosing the optimal target state architecture. Typically, there is no perfect architecture candidate, but trade-offs need to be made between different attributes.

In the architecture domain, the approach typically considers the impact of architecture scenarios on the different quality attributes of the implementation, such as maintainability, performance, or usability (Babar et al., 2004). Also, different business values such as differentiations in products, cost reductions, and communication (Gammelgård et al., 2007), as well as financial measures such as net present value, real options, and financial options have been utilized (Slot, 2010).

Within architecture, the approach has been traditionally used in the software architecture context (Hämäläinen, 2008, p. 45). There, myriad methods have been developed for evaluating SA scenarios, including the Architecture Analysis Method (SAAM) and the Architecture Tradeoff Analysis Method (ATAM), among others (Babar et al., 2004). The approach has also been adopted in the EA domain for supporting decision making on the EA target state (Gammelgård et al., 2007; Slot, 2010).

As such, these approaches focus on predicting the potential benefits of each of the architecture scenarios before the selection and implementation of the preferred scenario. It has not been validated in evaluating previously accrued benefits after the transformation has taken place. It also focuses only on the implementation aspect of EA, omitting potential benefits gained from other sources (e.g., having EA processes in place).

There is also a lack of validation of the approach in the context of EA at large, comprehensively encompassing all EA domains. Typically, scenario evaluation has been applied in the system architecture domain (e.g., Gammelgård et al., 2007; Hämäläinen, 2008). However, in the EA context, the approach may be of value in assessing the quality of the target architecture description (Tamm et al., 2011a).

3.5 EA benefit realization models

Not until the 2010s have researchers turned their attention to the process of EA benefit realization in a comprehensive fashion. Utilizing established theories from the IS discipline (e.g., DeLone & McLean, 2003), initial suggestions on the constructs impacting EA benefit realization were made (e.g., Dietzsch et al., 2006; Niemi & Pekkola, 2009). Since then, efforts have been made to uncover the mechanisms by which EA creates benefits (e.g., Foorthuis et al., 2015; Tamm et al., 2011a), even giving rise to a few dissertations on the topic (see Lange, 2012; van der Raadt, 2011; van Steenbergen, 2011).

Modeling the process of EA benefit realization comprehensively is a relatively new field of research. It is characterized by attempts to understand the constructs interacting in the EA benefit realization process, and their mutual interrelationships. In this respect, the models encompass constructs taking part in EA benefit realization and the benefits realized. The coverage of constructs and their contribution to EA benefits in the models is summarized in Table 1.

Even though the first modeling attempts were made before the 2010s (see, e.g., Dietzsch et al., 2006; Kamogawa & Okada, 2005), the majority of the models have been published after the turn of the decade. Later, several authors proposed models attempting to describe and measure the phenomenon (see, e.g., Boucharas et al., 2010; Foorthuis et al., 2015; Lange, 2012; Lux et al., 2010; van der Raadt, 2011; Tamm et al., 2011a). They are built on various theoretical backgrounds, including resource-based theory (Lux et al., 2010), generic cause-effect theory (van Steenbergen & Brinkkemper, 2008), design science (Aier et al., 2011), research synthesis (Boucharas et al., 2010; Tamm et al., 2011a), or established theories from the IS discipline (Lange, 2012), especially the IS success model (DeLone & McLean, 2003). They also exhibit different degrees of empirical validation. While some approaches are empirically founded (see, e.g., Foorthuis et al., 2015; Lange, 2012; Lux et al., 2010; van Steenbergen & Brinkkemper, 2008), others are based purely on literature review (see, e.g., Boucharas et al., 2010; Tamm et al., 2011a).

The EA benefit realization process consists of several interrelated constructs (cf. Foorthuis et al., 2015; Lange, 2012). Even though the results are somewhat incoherent and even contradictory, there is a reasonable degree of unanimity with regard to which constructs are involved in benefit realization. The conceptualizations of EA—process, products, and services—seem to be covered in most models. However, the models differ significantly in their focus and level of detail. In many models, these conceptualizations are bundled into one construct referred to as EA quality, EA approach, and the like (Foorthuis et al., 2015; Lux et al., 2010; Tamm et al., 2011a). While EA products and processes are often included, EA services are often omitted (Lux et al., 2010; Tamm et al., 2011a) or discussed in a superficial manner (van Steenbergen & Brinkkemper, 2008).

EA use is also covered, although usually in a rather general, superficial, or implicit way. For example, use may be referred to as the use of EA management in general, including the multitude of viewpoints discussed earlier (Lange, 2012), or the focus may be on the outcomes of use, such as information availability (Tamm et al., 2011a). Few studies refer to concrete EA product or service use situations (Foorthuis et al., 2015, 2010). The implementation aspect of EA is explicitly identified in only a few models (see Foorthuis et al., 2015; Lux et al., 2010; Tamm et al., 2011a).

Table 1. *Constructs and Their Contribution to EA Benefits in EA Benefit Realization Models*

Model	**Constructs included**	**Constructs contributing to EA benefits**
Aier, 2014	• EA principles grounding • EA principles management • EA principles guidance • Hierarchical culture • Rational culture • Group culture • Developmental culture • EA principles application • EA consistency • EAM utility	• EA principles application • Hierarchical culture • Rational culture • Group culture • Developmental culture • EA consistency

Boh & Yellin, 2007	• Governance mechanisms for EA standards management
	• Use and conformance to EA standards
	  ◦ EA standards definition
	  ◦ EA standards conformance and use
		• Use and conformance to EA standards

Bourcharas et al., 2010	• Context • Intervention • Mechanism • Outcome	• Mechanism

Dietzsch et al., 2006	• Potential value
	  ◦ System quality
	  ◦ Information quality
	• Perceived/awarded value
	  ◦ Intention to use
	  ◦ User satisfaction
	• Realized value
	  ◦ Net benefits
	• Service quality
	• Use
		• Perceived/awarded value
		• Use

Foorthuis et al., 2010	• Compliance assessments of projects • Assistance for projects • Management propagation of EA • Project conformance to EA • EA benefits for projects • EA benefits for the organization as whole	• Project conformance to EA
Foorthuis et al., 2015	• EA approach • Project conformance with EA • Architectural insight • EA-Induced capabilities • Project performance • Organizational performance	• Project conformance with EA • Architectural insight • EA-Induced capabilities • Project performance

Kamogawa & Okada, 2005	• EA development power
	• Governance
	• EA cognition
	• Business values
	  • Business process excellence
	  • Customer oriented
	  • Innovation
	  • Strategic adaptability
		• EA development power
		• Governance
		• EA cognition

Lagerström et al., 2011	• EAM maturity • Successful execution of IT projects	• EAM maturity
Lange, 2012	• EAM infra. quality • EAM product quality • EAM service quality • EAM cultural aspects • Use • EAM benefits	• EAM product quality • Use
Lange et al., 2015	• EAM infrastructure quality • EAM product quality • EAM service quality • EAM organizational anchoring • Intention to use EAM • User satisfaction with EAM • EAM organizational & project benefits	• EAM organizational anchoring • Intention to use EAM • User satisfaction with EAM

Lux et al., 2010	• IS resources
	  • EAM-related resources
	  • Other IS resources
	• IS capabilities
	  • EAM capability
	  • Other IS capabilities
	• (IT resource exploitation in) Business processes
	• Business process performance
	• Organizational performance
		• IS capabilities
		• (IT resource exploitation in) Business processes
		• Business process performance

Schmidt & Buxmann, 2011	• EAM approach
	  • EA planning
	  • EA documentation
	  • EA programming
	  • EA implementation
	  • EA governance
	  • EA communication & support
	  • Stakeholder participation
	• IT flexibility
	• IT efficiency
	• IT connectivity
	• IT compatibility
	• IT modularity
	• Interaction variables
	• Duration of EA implementation
		• EAM approach
		• IT flexibility
		• IT efficiency
		• Interaction variables
		• Duration of EA implementation

Tamm et al., 2011	• EA quality
	• Benefit enablers
	  • Organizational alignment
	  • Information availability
	  • Resource portfolio optimization
	  • Resource complementarity
	• Organizational benefits
		• EA quality
		• Benefit enablers

Van Steenbergen & Brinkkemper, 2008	• EA practice • Architectural results • Organizational performance • Business goals	• Architectural results • Organizational performance

It has also been proposed that social and cultural factors, such as organizational culture and an organization's understanding of EA, impact EA benefit realization (Aier, 2014; Kimpimäki, 2014; Lange, 2012; Tamm et al., 2011a). Some models include these factors as distinct constructs (Aier, 2014; Lange, 2012). Organizational characteristics such as organization size and complexity, operating platform quality, operating models, and the rate of organizational change, legislation and regulations, and organization type (Aier, 2014; Boucharas et al., 2010; Schmidt & Buxmann, 2011; Tamm et al., 2011a) have also been suggested to impact benefit realization.

Even though several models seem to cover at least a few characteristics of most conceptualizations of EA, most studies are still limited in their coverage of these elements. They either focus only on specific process aspects such as presentation strategies and governance formalization (Dietzsch et al., 2006), on a specific EA product such as EA standards (Boh & Yellin, 2007), or project architecture (Slot, 2010). Others only explore a specific use context such as project EA conformance (Foorthuis et al., 2010, 2015), or a specific category of benefits such as IT benefits (Lagerström et al., 2011; Schmidt & Buxmann, 2011).

A larger challenge is understanding the interaction of constructs in the EA benefit realization process. In earlier research, the interrelationships between the constructs have received less attention than the constructs themselves. EA benefit realization is often considered a rather simple and general level process (e.g., Aier et al., 2011; Lagerström et al., 2011; van der Raadt, 2011; Slot, 2010; van Steenbergen et al., 2011), where only direct relationships between constructs having an effect on benefits and constructs representing the benefits are considered. These models depict benefit realization as a simple cause-and-effect process in which a few constructs directly lead to a number of benefits. In these models, the mutual interaction of constructs impacting benefits is not modeled.

Yet, some authors perceive that the benefits are realized through an intermediary construct (Aier, 2014; Boh & Yellin, 2007; Foorthuis et al., 2010; Lange, 2012; Tamm et al., 2011a). These sources model EA benefit realization as a process in which primary constructs (typically related to EA processes, products and/or services) impact intermediary constructs (typically related to EA use or implementation), which, in turn, impact the benefit constructs.

Recently, a few somewhat more complex models have appeared. They depict EA benefit realization as a more complex and multi-phased process, suggesting that EA benefits are realized through an impact chain of three or more constructs (e.g., Foorthuis et al., 2015; Lange, 2012). The impact chain can also branch (i.e., a construct impacts more than one other construct). This is similar to the conception of benefit realization in the IS discipline (see, e.g., DeLone & McLean, 2003). Many of the models also consider the benefits themselves to influence each other (see Boucharas et al., 2010; Foorthuis et al., 2015; Lux et al., 2010; van Steenbergen & Brinkkemper, 2008; Tamm et al., 2011a). Figure 2 presents an example of an EA benefit realization chain from Lange (2012).

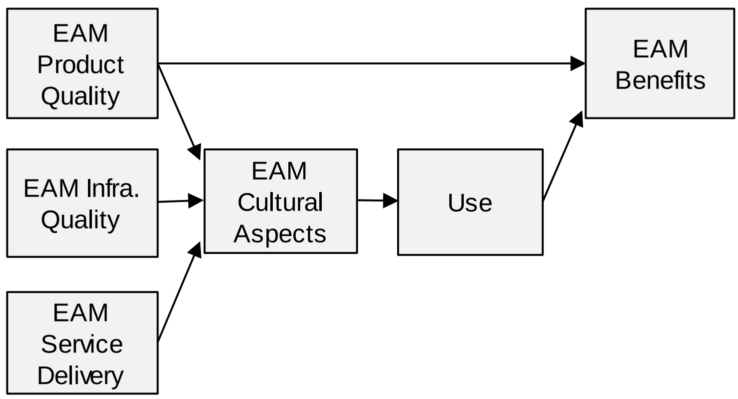

Figure 2. Example of an EA benefit realization chain (Lange, 2012).

The literature is the most contradictory in suggesting from which constructs the EA benefits emerge. EA use seems to be the most often suggested source for benefits. Several studies suggest that EA benefits are realized from the well-governed use of EA products and from utilizing the improved operating platform implemented according to EA, among other strategies (Aier, 2014; Schmidt & Buxmann, 2011; van Steenbergen & Brinkkemper, 2008; Tamm et al., 2011a). Thus, EA use and EA-guided practices have a significant impact on the realized benefits.

The quality of EA products has also been suggested to directly result in benefits (Aier, 2014; Lange, 2012). It has also been proposed to have an indirect role in the process (van Steenbergen & Brinkkemper, 2008; Tamm et al., 2011a). EA services seem to have a more indirect effect, facilitating EA use or social environments favorable for EA use (Aier, 2014; Lange, 2012).

The role of social and cultural factors also seems to be indirect. It has been suggested that social factors, such as top management commitment to EA, stakeholder awareness, and understanding of EA are crucial antecedents for EA use (Lange, 2012). It has also been suggested that organizational culture has a mediating effect on EA use (Aier, 2014). This indicates that EA's grounding in the organization supports its usage.

Process conceptualization is the most seldom suggested conceptualization as a source of EA benefits. EA process factors, such as EA planning and governance (Schmidt & Buxmann, 2011), stakeholder participation (Schmidt & Buxmann, 2011; Tamm et al., 2011a), and communication (Foorthuis et al., 2015; Schmidt & Buxmann, 2011) have been identified to contribute to benefits.

To summarize, there is currently no common understanding of how different constructs interact in EA benefit realization. While benefit realization has initially been considered a rather simple process, a few more complex models have been proposed, suggesting that the process may be more complex than it initially appears. The earlier results are also contradictory in suggesting which constructs contribute to EA benefits. This motivates further scrutinizing of the EA benefit realization process.

4 Research objectives, approach, and methods

This section delineates the research objective and questions, and describes the research setting, methodology, and process. The relation between the included articles and the research methodology and process are also discussed.

4.1 Research objective and questions

The objective of this dissertation is to understand the constituents and process of EA benefit realization. Thus, the main research question of the thesis is formulated as follows:

> RQ1: How are EA benefits realized?

EA benefit realization is defined as a process consisting of several interacting constructs impacting the realization of benefits by EA (cf. DeLone & McLean, 2003; Lange, 2012). As discussed in Chapter 3, the research on the subject is still limited and the results are, to a large extent, contradictory. Therefore, further research is in order.

To investigate EA benefit realization in detail, the constructs, their dimensions (attributes) and mutual interaction need to be understood. Especially, the interaction of constructs should be further investigated, as earlier research has yielded contradictory and abstract results. Thus, RQ1 is appended with the following sub-question:

> RQ1.1: How do different constructs interact in the EA benefit realization process?

This sub-question enables a more coherent and thorough understanding of the interaction of constructs and their dimensions impacting the EA benefit realization process. The thesis proposes that EA benefits are realized through a complex process involving several interconnected constructs. It assumes that the constructs working in the process not only impact the realization of benefits, but also have mutual interrelationships with each other. That means that the chain of constructs leading to benefit realization incorporates more than two constructs and, thus, involves intermediary constructs between those constructs initiating the process and the resulting benefit constructs themselves (cf. Aier, 2014; Foorthuis et al., 2015; Lange, 2012; Tamm et al., 2011a). It also follows Tamm et al. (2011a) in assuming that the benefits have interrelationships with each other.

Answering the first research question and sub-question creates an overview of the EA benefit realization process on a general level. It describes the chain of constructs and their constituents leading to the realization of benefits from EA. However, to comprehensively tackle the realization of benefits, additional research questions are required.

Several critical issues in EA benefit realization are further studied to constitute a practical viewpoint on EA benefit realization – what is actually required to enable the realization of benefits from EA. As discussed in Chapters 2 and 3, EA stakeholders and the use of EA products and services seem to be critical viewpoints for benefit realization. Still, both of them have not been comprehensively studied. In particular, there are very few studies on EA stakeholders. Thus, the second research question is formulated as follows:

> RQ2: How are EA stakeholders and the use of EA products and services related to EA benefit realization?

This research question considers the when and why EA benefits actually emerge in practice, and to whom.

The first viewpoint used to answer this question tackles the stakeholders of EA. EA stakeholders have a multitude of concerns that need to be identified and taken into account in EA work (e.g., Niemi, 2007). As with any organization or function, it is the clients of the function (i.e., stakeholders) that determine its overall success (e.g., van der Raadt, 2011, p. 15). The importance of stakeholders has also been emphasized in other areas of research (e.g., Mitchell et al., 1997).

In other words, stakeholders of EA expect certain benefits from EA. Therefore, it first needs to be uncovered which stakeholders are involved with EA, what benefits they expect from it, and how. This gives rise to the first sub-question:

> RQ2.1: How are EA stakeholders involved with EA?

The second viewpoint deals with the use of EA. It has been identified as one of the most critical antecedents for EA benefit realization (e.g., Lange, 2012). Yet, prior research has not addressed EA use situations extensively or in detail. As particular EA products and services are used, researcher should investigate how they are to be used to enable benefit realization. For example, architectural models, principles, and architectural support for solution development initiatives need more investigation (e.g., Boh & Yellin, 2007; van der Raadt & van Vliet, 2008). The investigation involves uncovering what EA products and services are, how and why are they used, and when are they used, giving rise to the second sub-question:

RQ2.2: How can EA products and services be used to realize EA benefits?

Finally, to actually verify the realization of benefits, metrics and measurement of the benefit realization process are required. This is especially important, as EA measurement has generally been considered difficult (Hämäläinen, 2008, p. 15), and few validated metrics have been proposed for EA benefit realization. Still, measurement is crucial for rationalizing the EA approach (Rodrigues & Amaral, 2010). And, as with any organizational initiative, measurement forms the basis for improving EA practice (Hämäläinen, 2008, p. 35). Development of metrics gives an example of the operationalizability of the uncovered constructs. Not only should metrics be developed for the actual incurred EA benefits, but also for the rest of the benefit realization process to form the basis for the necessary causal links. This gives rise to the third research question:

RQ3: How can EA benefit realization be measured?

The research questions are presented in Figure 3.

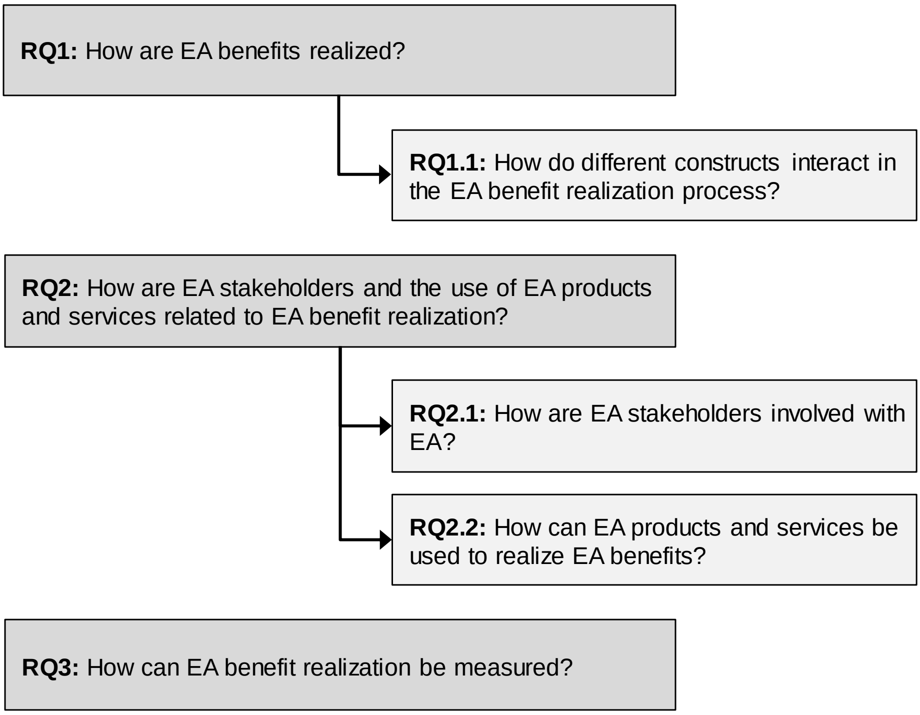

Figure 3. Overview of research questions.

Together, these research questions enable the understanding of the benefit realization process.

4.2 Research scope

The scope of the research should, on the one hand, be defined according to the research questions. On the other hand, it sets requirements for the selection of the research approach and methods.

EA is a complex approach that is extensively interrelated in different organizational functions. Therefore, EA benefit realization can be approached from different directions. For example, the focus could be on EA's effect on the realization of organizations' strategic goals, or its effect on the success of IS development. As the field of research is relatively new, a practice-oriented approach is taken. The focus of the study is, thus, on the benefits of EA practices and strategies. This means that benefits of EA and constructs impacting them are sought from practice without limiting the scope of benefits covered.

Regarding research scope, the conceptualizations of EA to be covered (See Section 2.2) within the investigation of benefit realization is also a critical decision (Lange, 2012). EA benefit realization is a complex process involving several constructs, dimensions (attributes), and interrelationships (cf. DeLone & McLean, 2003; Lange, 2012). Also, considering the multifaceted nature of EA (e.g., Lange, 2012; Tamm et al., 2011a), its processes, products, services, use and resulting implementations, gaining a comprehensive understanding of its benefit realization requires taking all of its conceptualizations into account. Benefits have been suggested to originate from all of these conceptualizations (e.g., Tamm et al., 2011a). Consequently, all of the conceptualizations are in the scope of this thesis. However, the investigation of the phenomenon is limited to these conceptualizations of EA. The impact of other organizational functions, for example strategic planning, IT governance, and project management on the phenomenon is addressed only on a general level, where it closely relates to a specific conceptualization of EA.

Also the level of analysis of the benefits covered within the investigation should be considered (cf. Lange, 2012, p. 15). In the IS discipline, the measurement of benefits has ranged from the individual user to the society as a whole. For example, benefits to the immediate user, different organizational groups, organizations, industries, consumers, and the society have been investigated (DeLone & McLean, 2003). As the field of research is novel, the need to build an understanding of EA's benefits on the organizational level should precede the study of its benefits in larger contexts. Therefore, the investigation is limited to the organizational level of analysis. It encompasses benefits to individuals and groups inside the organization and benefits to the organization as a whole.

Another viewpoint on the scope of benefits covered is their type. Some earlier studies have limited their investigation to specific types of benefits, such as IT benefits (Boh & Yellin, 2007; Schmidt & Buxmann, 2011). In addition to missing some of the potential benefits outside this scope, this limitation is also problematic in the sense that benefit classifications are always somewhat artificial as they consider only one or two aspects of benefits. Benefits can also be of different levels of abstraction and have myriad interrelationships, making their classification difficult. Therefore, this study considers all types of benefits uncovered. Finally, as the focus is on EA benefits, the investigation of costs and other negative impacts of EA are omitted.

4.3 Research process

The research progressed from the generic to the particular, and from the abstract to the detailed. The research originated from the unsolved challenge of understanding how benefits are realized from EA.

The bulk of the research was carried out in two parts occurring in 2006–2008 and 2011–2016. The research was effectively on pause in the time between because of occupational obligations. The first part of the research was carried out during the AISA research project on Enterprise and Software Architecture quality management at the University of Jyväskylä (see Niemi et al., 2008).

The research began with a systematic literature review (Levy & Ellis, 2006), conducted first in 2006–2007. Subsequently, the initial research questions were formulated. Initially, very little literature was available on EA benefit realization. Therefore, the literature review was carried out in an iterative way, adding literature as it became available and constantly accumulating knowledge. Another major literature review was carried out in 2011–2012 before and during the data collection in the main case organization. Before this iteration, several EA benefit realization models had been published and were incorporated in the literature base. At this point, two viewpoints to concretize EA benefit realization were selected: 1) EA stakeholders and 2) the use of EA products and services, conceptualized as RQ2.

The literature review gave an overview of the research domain and its challenges. This phase focused on understanding EA as a phenomenon (i.e., its multiple conceptualizations). At the same time, previous research on EA benefit realization was reviewed to understand the existing research gap. At this point, it came apparent that the earlier results are contradictory and somewhat abstract. Thus, the research approach was shifted toward an interpretive one. Because of the selected research approach, a synthesis of the earlier results or an *a priori* model was not constructed.

For investigating EA stakeholders to answer RQ2.1, a separate study was conducted in 2006–2007. Data for this study was collected by a focus group interview. Subsequently, a theoretical study was conducted in 2007–2008 to clarify the conceptualizations of EA. The study investigated potential constructs for EA benefit realization and proposed metrics for measuring them in the EA benefit realization process by utilizing a real-life EA case. The results relating to measurement were used to answer RQ3. This study was also later used as a basis for defining the interview framework for data collection.

The bulk of the empirical data for addressing RQ1 and RQ2.2 was collected by individual interviews in a case organization. The interviews were carried out between October 2011 and January 2012. The phase focused on gathering data of both an adequate extent and depth to allow the investigation of the EA benefit realization process.

In the next phase, the interview data was used to answer the research question RQ1 and its sub-question. It involved creating a data-based model of EA benefit realization and comparing it to the literature. The model consists of constructs interacting in the benefit realization process and their interconnected dimensions (attributes). Two of the most heavily interrelated constructs, EA processes, and EA results (products and services) were investigated in more detail. In particular, the quality of EA products has been found crucial for benefit realization in earlier research (Lange, 2012, p. 200). However, even though EA processes and services have been found to contribute to benefit realization (Lange, 2012; Tamm et al., 2011a), they have not been the focus of much study. Thus, their further study in the light of the results from this research is justified. The phase was conducted iteratively, beginning in 2012 and concluding in 2015.

Investigation of the use of EA products and services with regard to EA benefit realization was conducted at the same time. To answer the research question RQ2.2, the same interview data was used as a basis.

Finally, the study concluded by summarizing the whole study and drawing general conclusions. This was started in 2012, when the first versions of the articles were finished, and carried out iteratively.

The research process is depicted in Figure 4.

4.4 Research approach and methods

The selection of the research approach and methods was based on the research objective. Also the nature of EA as a discipline sets requirements for the selection. As a both relatively new and practitioner-oriented topic, EA generally lacks established theories (Lange, 2012; Lux et al., 2010; Rodrigues & Amaral, 2010). Also, the multifaceted nature of the EA concept suggests that a multidisciplinary research approach is in order (cf. Ramos & de Sousa Júnior, 2015). Therefore, this dissertation also draws from the more established disciplines such as IS, software engineering, quality management, and management science.

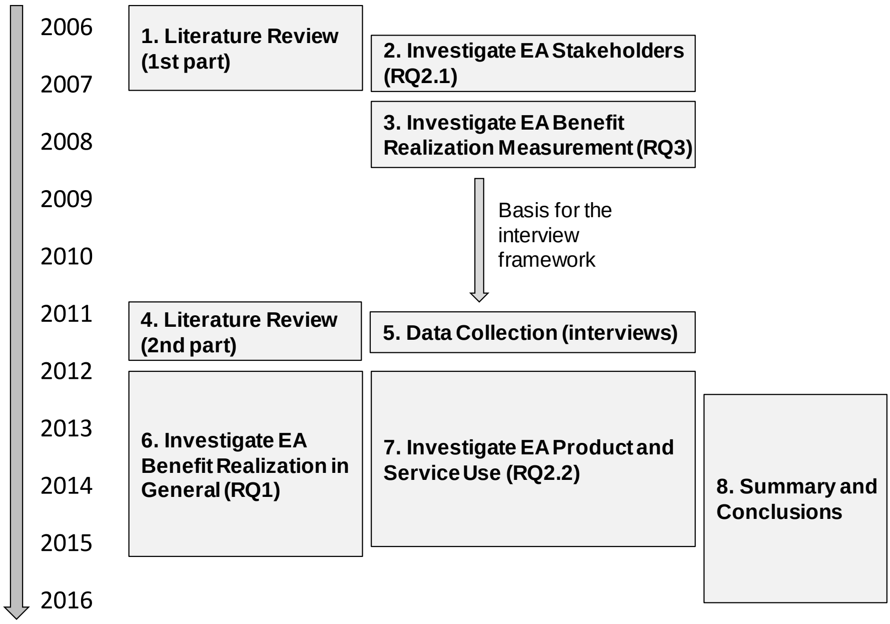

Figure 4. Summary of the research process.

The research questions require, to a large extent, pioneering research in a relatively fresh area of research. It also soon became apparent that the existing theory is contradictory in many ways, especially with regard to the interaction of constructs in benefit realization. Therefore, the theory base was not considered sufficient to allow a strictly positivist or theory-creating approach strongly rooted on existing theory. For these reasons, an interpretive research approach was adopted (cf. Klein & Myers, 1999; Walsham, 1995). The focus was on understanding the complex phenomenon of EA benefit realization rather than building new theory in the area. To address the previously mentioned challenges, a combination of research methods was selected. This allows the investigation of the phenomenon from different viewpoints (triangulation), adding to the reliability of the results (cf. Stake, 2000).

To gain overall understanding of the area of research and to build the required theoretical foundation, the existing theory base was charted by means of a systematic literature review (Levy & Ellis, 2006). The role of the theory was twofold. First, it was used to create the required theoretical foundation for the study. This involved adapting an established model from the IS discipline. As described later, this was a very coarse framework used to guide data collection and not an *a priori* model *per se.* The goal was not to restrict the study too much with the earlier models while still having an initial framework to facilitate effective data collection (cf. Walsham, 1995). Second, the findings from the empirical data were viewed in the context of the existing literature for validation.

The empirical part of the thesis is based on a multiple case study consisting of four cases (cf. Stake, 2000; Walsham, 1995). Each case represents a different viewpoint on the phenomenon of EA benefit realization. The viewpoints were defined according to the research questions. They also represent the units of analysis of this study. Therefore, the topics of the cases (and units of analysis) were as follows:

1. EA benefit realization in general
2. EA stakeholders
3. Use of EA products and services
4. Measurement of EA benefit realization

As EA fundamentally intertwines with the organization it represents and where it is utilized, it should not be studied outside its organizational context. It is also a multifaceted concept, making its various conceptualizations difficult to clearly segregate. Case studies, as a research approach, are suitable for studying a contemporary phenomenon within its real-life context, especially when the phenomenon cannot be studied outside its natural setting (Benbasat et al., 1987). A case study allows the researcher to ask “how” and “why” questions and study a phenomenon in its natural setting (Benbasat et al., 1987). Also, due to the lack of established theory (e.g., Foorthuis et al., 2015), the case study method was selected (cf. Benbasat et al., 1987).

For a novel field, generalizing findings and guiding future research are important. Qualitative data was preferred in data collection, as an in-depth understanding of the phenomenon was required, and the discipline lacked strong theory onto which to build an adequate quantitative design (cf. Denzin & Lincoln, 2005). Also Boucharas et al., (2010) argue that quantitative research design is not the most appropriate for investigating the rich and highly contextual phenomenon of EA benefit realization. The role of the empirical data was to identify concepts and to create the resulting data-based model.

A large Finnish public sector organization was selected as the research setting. The author had followed the situation in the organization for several years in the role of an external consultant before the study took place. It was therefore estimated that the maturity of the organization’s EA practice was appropriate to provide research data of adequate depth and extent. The organization has undertaken EA work for over five years and organized the EA team in a semi-centralized, federated manner. EA processes encompass multiple levels, including EA, reference architecture, line of business (LoB) architecture, project and program architecture, and implementation architecture. A proprietary EA tool and an EA framework are utilized.

To allow interaction with actual EA stakeholders and collection of rich experience-based data on the EA benefit realization process, individual interviews were perceived as an appropriate method. In accordance with the interpretive design, the interview framework was very loosely structured to themes to provide for necessary flexibility while helping the interviewer to use the interview time in an effective manner. Even though the objective was to take the data *as is*, without preliminary assumptions (cf. Walsham, 1995), it was assumed that a high-level interview framework is necessary to guide the interview to focus on roughly the right topics. An initial interview framework adapted from the extensively used IS success model (DeLone & McLean, 2003) was used as a rough guide in data collection. This was not seen a large problem, as the constructs defined in the framework were already fairly established in EA research (e.g., Lange et al., 2015; Tamm et al., 2011a). Still, as the interviews were inspired and consequently influenced by the IS success model, the study is not referred to as a grounded theory study (Corbin & Strauss, 1994).

As the accountability of the benefit claims has been considered a challenge in previous studies (e.g., Tamm et al., 2011a), the narrative interview method (Jovchelovitch & Bauer, 2000) was followed to enable focusing on concrete, real-life examples. Each of the themes was discussed as "stories" by first requesting an example and then breaking it down by utilizing clarifying questions. The sample was chosen by hand-picking a reasonable variety of different types of EA stakeholders from all of the main business units and levels of EA. An initial set of interviewees was identified as a part of a separate EA survey by the author. Then, chain (or snowball) sampling (Paré, 2004) was used to identify the rest of the respondents, and data collection continued until theoretical saturation was reached (Eisenhardt, 1989). The interviews were audio-recorded and transcribed. Notes were also taken. All of the interviews, except one, were conducted by phone. Also documents acquired from the organization were used for understanding the context in more detail.

The data analysis followed an iterative process (cf. Walsham, 1995). The data was first coded by using the themes in the initial theoretical framework as dimensions. This functioned as an initial filter for identifying data relevant for each of the research questions. Subsequently, the coding scheme was refined according to the requirements set by each of the research questions. To further increase the validity of the empirical data, draft versions of all of the articles utilizing data from the case were sent to a key informant from the case organization for review, with no major changes.

4.5 Relationships of the included articles

This thesis is composed of six articles that describe the constructs impacting EA benefit realization and their interaction. The articles are structured according to the research questions and process (see Figure 5), proceeding from the generic to the detailed.

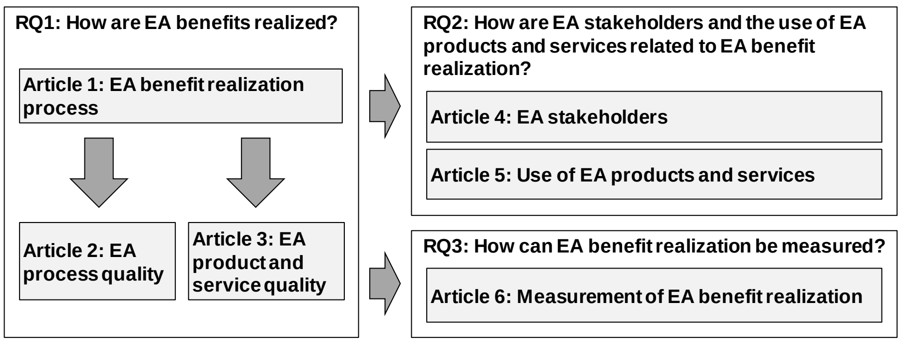

Figure 5. Relationships between the articles.

The first three articles address RQ1 by explaining the EA benefit realization process on a general level. The first article proposes a model for explaining the overall EA benefit realization process, including a set of interrelated constructs and dimensions (attributes). The second and third articles address two of the critical constructs interacting in EA benefit realization in more detail: EA process quality and EA results quality. These constructs are part of the EA benefit realization process and are heavily interrelated with other constructs. In Article 1, the focus was on the interaction of these constructs and less on the constructs themselves. Therefore, they were further investigated to uncover their inherent features.

Articles 4 and 5 address RQ2. They investigate EA benefit realization from two different viewpoints, namely EA stakeholders, and EA product and service use. Article 4 describes how different stakeholders are involved with EA in practice and what benefits they expect. Article 5 adds further detail on how stakeholders interact with EA in practice, from the viewpoint of EA product and service use. It describes concrete use situations, their features and related stakeholder motives.

Finally, Article 6 addresses RQ3 by further exploring how EA benefit realization can be measured. Its role here is to propose metrics for the constructs in the EA benefit realization process, using a real-life EA example as a basis. However, it also proposes preliminary constructs for EA benefit realization, but does not address their interaction or mutual importance with regard to EA benefit realization. From the latter point of view, it was used to preliminarily test if the IS success model is utilizable in the EA context.

4.6 Validity

As this thesis adopted the qualitative, interpretive case study approach, its validity should be evaluated with regard to the validity criteria set for these studies.

Maxwell (1992) suggests evaluating the validity of qualitative studies through five aspects, including descriptive validity, interpretive validity, theoretical validity, generalizability, and evaluative validity. It is important to note that in qualitative research, unlike in quantitative research, threats to validity are difficult to eliminate beforehand, but they should rather be ruled out with supportive evidence after the accounts of the case have been formulated (Maxwell, 1992).

Descriptive validity refers to the factual accuracy of the data—essentially, that the statements reported from the interviews are correct (Maxwell, 1992). Therefore, in this case, descriptive validity is, to a large extent, based on the careful documentation of the interviews, and research ethics. The interviews were audio-recorded and transcribed with the aim to preserve the interviewees' statements as well as possible. Transcription was carried out carefully, with extensive use of pause and replay features to minimize the change of missing data. Taking notes in the interview allowed cross-checking in the cases where parts of the recording were inaudible or incomprehensible.

Interpretive validity signifies what the situation in the research setting, including people, documents, events, and behaviors, means to the people engaged in it (Maxwell, 1992). Naturally, these meanings cannot be accessed directly, but are always constructed by the researcher on the basis of the data and other evidence (Maxwell, 1992). Therefore, the challenge here was to interpret the interviewees' actual meaning (versus what was said). Adding to the challenge is the fact that the interviews were conducted by phone, which caused visual (and probably even auditory) cues, potentially helpful for the interpretation, to be missed. Thus, the most feasible approach was to focus on what was being directly said by the interviewees, rather than to attempt to construct deeper meaning for the accounts on an insufficient basis.

Theoretical validity refers to the validity of the account from the research setting as a theory of a phenomenon, including constructs used in the theory and their interrelationships (Maxwell, 1992). It is particularly important, as this study aims for a comprehensive and accurate understanding of EA benefit realization. In part, the transparency of the research design—how the conclusions were reached—contributes to this understanding. This thesis aims to describe the research setting, process, and methods at an adequate level of detail, within the limits set by confidentiality. Theoretical validity is also established by using multiple sources of evidence, maintaining the chain of evidence, revisiting the data multiple times (iterative approach), and requesting a key informant in the case organization to review the findings (cf. Maxwell, 2005). In addition, joint efforts in research planning and authorship of articles contribute to theoretical validity. For example, the second author independently checked the data coding (cf. Maxwell, 2005).

As the main empirical data was collected in a single case organization, a relatively high number of interviewees were sought in order to include as many sources of evidence as possible. Comprehensive literature reviews also played a large role in enabling the use of constructs with a reasonable degree of support in the research community, and the triangulation of findings. Documents were used as additional evidence, especially in finding out the differences between what should be done (i.e., intent) and what had actually been done. Chain of evidence was maintained between data coding and findings to ensure the soundness of data analysis and to enable returning to the original reasoning behind the findings. Finally, the lead of the EA team was requested to review the findings to ensure their soundness. This verification approach was selected, as the informant was considered to have the best overall view of the utilization of the EA approach in the organization.

Researcher bias is another challenge to be acknowledged, especially in qualitative research (Maxwell, 2005). For example, the researcher’s preconceptions may influence the data coding and these ideas may be imposed on the interviewees, influencing their responses. For example, the IS success model may influence the interpretations. This was mitigated by letting the concepts emerge from the data rather than forcing them. In the interviews, care was taken to use a neutral tone to minimize any subtle cues from the researcher. Also, conducting the interviews by phone contributed to this, as it naturally minimized the impact of visual (and potentially even some auditory) cues.

Generalizability refers to the extent to which the findings from a particular research setting can be generalized to a larger population (Maxwell, 1992). In general, qualitative research does not aim to the generalizability of the results to a larger context, but to the development of a meaningful theory (Maxwell, 1992). Still, in interpretive research, even the resulting theory can only be generalized within the case itself (Lee & Baskerville, 2003). Within this reasoning, the results of this study can only be generalized within the research context. As the empirical data is also based on the interviewees' subjective perceptions and on the researcher's interpretation of them, they cannot be taken as factual statements regarding the EA benefit realization process. However, as the findings support earlier findings to a degree, some extent of generalizability is evident. The results also provide for further generalization in upcoming studies.

Evaluative validity involves the use of an evaluation framework in assessing the objects of study in a research setting (Maxwell, 1992), as in "what is justified" and "what is good". This study does not use an evaluation framework *per se*, but as the focus is on EA benefit realization, beneficial factors are naturally highlighted (i.e., what is beneficial). Similar to theoretical validity, this is based on the interviewees' statements and the researcher's interpretation of them. Interpretation played a large part, as some of the factors were not explicitly referred to by the interviewee, or the interviewee referred to a general benefit (as opposed to something beneficial for the interviewee himself). In these cases, the literature acted as background material for forming opinions on what is generally beneficial.

5 Included articles

This chapter briefly summarizes the original articles comprising the foundation of this dissertation. This dissertation includes six articles, structured according to the research approach. The summaries in the following sections describe each of the articles in terms of objectives, methods, findings, and main contributions. As articles 1, 3, 5, and 6 are co-authored, the contribution of the authors of these articles are also described in the summaries.

Articles 1, 2, 3, and 5 are based on the common interview data of 14 EA practitioners from a large Finnish public sector organization.

5.1 Article 1: EA benefit realization process

Niemi, E. & Pekkola, S. (2016). Enterprise architecture benefit realization: Review of the models and a case study of a public organization. *SIGMIS Database*, *47*(3).

The first article explains how EA benefits are realized on a general level, otherwise known as the EA benefit realization process. Its objective was to understand how EA benefits accumulate and how related constructs influence each other. This was accomplished by proposing a model and criteria for analyzing the explanatory power of the existing EA benefit realization models.

Existing EA benefit realization models were charted by a systematic literature review (Levy & Ellis, 2006). Generally, EA benefit realization is considered as being a simplified, fragmented, general-level process (e.g., Aier et al., 2011; Lagerström et al., 2011; van der

Raadt, 2011; Slot 2010; van Steenbergen et al., 2011). As initial observations from practice seemed to contradict the literature, it was decided to conduct an exploratory study, which resulted in a model and criteria to analyze the existing EA benefit realization models in order to illustrate their strengths and weaknesses.

The analysis resulted in a data-driven model for understanding the EA benefit realization process, including eight constructs, 51 interconnected dimensions (attributes) related to the constructs, and 695 distinct interrelationships between them. The results support earlier findings, thereby contributing to the enhancement of the relevance and generalizability of the constructs presented in earlier studies. However, as there are substantial differences in the existing EA benefit realization models, the results indicate that no existing EA benefit realization model fully captures the complex phenomenon of EA benefit realization. The resulting model suggests that some EA benefits are always and only realized through a chain of several interconnected constructs. It highlights the importance of EA process quality, EA service quality, and a supportive social environment.

The article was planned and written by Eetu Niemi and Samuli Pekkola. The literature review, data collection and analysis, and model construction were conducted by Eetu Niemi. Samuli Pekkola independently checked the data coding and analysis to ensure correct interpretation.

5.2 Article 2: EA process quality

Niemi, E. (2013). Quality attributes for enterprise architecture processes. *Journal of Enterprise Architecture*, *9*(1), 8-16.

The second article scrutinizes the EA Process Quality construct in the EA benefit realization process. The objective of the article was to define the attributes for high-quality EA processes. The article begins with a literature survey covering earlier perceptions on the dimensions of EA processes, namely EA planning, EA documentation, EA governance, process support, and organization (Pulkkinen, 2006; van der Raadt & van Vliet, 2008; Tamm et al., 2011b). It also synthesizes the somewhat fragmented field of research by discussing earlier perceptions of EA process quality (Aier et al., 2011; Foorthuis et al., 2010; Lagerström et al., 2011; Tamm et al., 2011a; Ylimäki, 2006).

The empirical findings indicate that EA process quality is comprised of 16 attributes. These are largely supported by the existing literature. However, there is no single source that provides as comprehensive a view of EA process quality as the interview data. The empirical findings indicate that EA process quality is comprised of clear scope and purpose, alignment with business and other governance approaches at large, appropriate management and documentation practices, cooperation, routinization of EA work, appropriate support tools and documentation, and adequate resources. As completely new findings, the importance of practical EA governance over formal governance mechanisms (cf. Foorthuis et al., 2010; Lange, 2012), the routinization of EA work on the project level, and internal cooperation within the EA team were highlighted.

The article provides a comprehensive framework of EA process quality that is especially important as EA process quality dimensions have not been clearly segregated from other EA quality dimensions and contextual dimensions in the literature. The framework can be directly utilized to model EA process quality in the context of EA benefit realization.

This study was planned and conducted by Eetu Niemi.

5.3 Article 3: EA product and service quality

Niemi, E. & Pekkola, S. (2013). Enterprise architecture quality attributes: A case study. In Sprague, R.H., Jr. (Ed.), *Proceedings of 46th Hawaii International Conference on Systems Science* (pp. 3878-3887). Los Alamitos, CA: IEEE Computer Society.

The third article focuses on the EA results quality construct as a part of the EA benefit realization process. The objective was to define the attributes for high-quality EA results, namely EA products and services. The literature review covers earlier perceptions of EA product and service quality, topics not extensively addressed in research.

The findings demonstrate that EA product quality is constituted of six dimensions (attributes), including clarity and conciseness, granularity, uniformity and cohesion, availability, correctness, and usefulness. EA service quality, on the other hand, is defined by four dimensions that include availability and timing, awareness, activeness, and usefulness. Each of the dimensions is further comprised of several sub-dimensions.

By systematically comparing the findings to the literature, it was discovered that the literature covers only a subset of the identified attributes (Hämäläinen & Markkula, 2009; Iivari 2005; Lange, 2012; Pitt et al., 1995; Ylimäki, 2006). In particular, the availability of EA products is not considered a quality attribute in the literature. As yet, the adaptation of the

IS success model to the EA domain by Lange (2012) and the related quality measures provide the most comprehensive views. The results provide a framework for understanding EA product and service quality, to be directly utilizable in further research on EA benefit realization.

The article was planned and written by Eetu Niemi and Samuli Pekkola. The literature analysis, empirical data gathering and analysis, and contextualization of the study in the literature were conducted by Eetu Niemi.

5.4 Article 4: EA stakeholders

Niemi E. (2007). Enterprise architecture stakeholders—A holistic view. In Hoxmeier J.A. & Hayne, S. (Eds.), *Proceedings of the 13th Americas Conference on Information Systems* (9 pages). Atlanta, GA: Association for Information Systems.

The fourth article scrutinizes EA benefit realization from the viewpoint of EA stakeholders. EA has a multitude of stakeholders, with varying set of goals and concerns that need to be addressed by EA. The objective of the study was to identify EA stakeholders and their EA-related concerns. While an extensively studied topic in management literature (Mitchell et al., 1997), in the EA discipline no consistent view of stakeholders had been presented.

Due to the objective of the study and the state of the theory base, a systematic literature review (Levy & Ellis, 2006) and focus group interview (Krueger & Casey, 2000) were selected as research methods. The role of the latter was to evaluate the theoretical findings and complement them with experience-based empirical data. The focus group participants included seven practitioners from five Finnish or international organizations all carrying out work on EA.

Through the literature review and analysis, the views of stakeholders and concerns from the disciplines of EA, software architecture, systems development, and management were synthesized. First, 13 initial stakeholder roles were identified from the literature. From these, more detailed stakeholder individuals, groups, and organizations were derived; these were presented in hierarchical and text formats to the focus group of seven practitioners from five Finnish or international organizations conducting work on EA. Although the group generally agreed with the initial results, they did not perceive the hierarchy of stakeholders generalizable. As categorizations for stakeholders do not exist in the EA discipline, a generic model categorizing the stakeholders to EA producers, facilitators (supporters, managers and maintainers of EA), and users was applied.

The results of the literature review, complemented by the focus group interview, provide a comprehensive, generalized view of EA stakeholders and their typical concerns related to EA, categorized according to the model. The study revealed an extensive number (29) of stakeholder individuals, groups, and organizations for EA, with diverse concerns. While EA facilitators and users generally provide certain requirements for EA, producers are concerned that EA satisfies these requirements. EA users, in turn, can be involved in EA work by disclosing requirements and feedback. Despite these generalized views, the study concluded that the hierarchy and the organizational position of the EA team vary across organizations, potentially impacting the concerns and categorization of stakeholders in different organizational contexts.

This study was planned and conducted by Eetu Niemi.

5.5 Article 5: Use of EA products and services

Niemi, E. & Pekkola, S. (2015). Using enterprise architecture artifacts in an organisation. *Enterprise Information Systems*, 1-26.

The fifth article further examines EA benefit realization from the viewpoint of EA product and service (artifact) use. As EA results use was identified as a significant factor in EA benefit realization, it was considered important to investigate how EA products and services are and should be used. Thus, the objective of the article was to enrich the understanding of why, how, when and by whom EA products and services are used in practice by analyzing real-life EA use situations. It results in a theoretical framework of EA use.

As the field of research is fragmented and lacks theoretical models (Purao et al., 2011; Winter et al., 2007), a system use framework from the IS field (Burton-Jones & Straub, 2006) was adopted as the theoretical framework for the study. The adaptation was considered valid as EA use resembles IS use (cf. Hirschheim et al., 1995; Lankhorst, 2009). As in the EA context, it could be critical to assure that the EA products are introduced in development initiatives at the correct time to actually have an impact on the implementation (Foorthuis & Brinkkemper, 2008; Lange, 2012; van der Raadt, 2011; Ross et al., 2006); timing of use was also included in the framework. This resulted in a framework including the dimensions of motives, stakeholders, EA artifacts, and the development phase.

Fifteen distinct EA use situations were identified from the interview data, suggesting a wide variety of uses for EA artifacts. These situations emphasize that EA artifact use is a very complex phenomenon that should be considered comprehensively, including its motivation, involved stakeholders, and EA results, and the phase of the project where EA artifacts are used. All of these items seemed to have an impact on EA artifact use. EA use also seems to be more complex and diverse than the use of software architecture (cf. Smolander et al., 2008).

Also, the myriad of EA stakeholders was evident in EA use situations. While the EA team and projects were most involved in EA artifact use, management, IT maintenance, and consultant partners were involved to some extent. The value EA delivers to projects is dependent on the time the EA artifacts are incorporated into the project.

The article was planned and written by Eetu Niemi and Samuli Pekkola. The literature analysis, data gathering and analysis, and evaluation were conducted by Eetu Niemi.

5.6 Article 6: Measurement of EA benefit realization

Niemi, E. & Pekkola, S. (2009). Adapting the DeLone and McLean model for the enterprise architecture benefit realization process. In Sprague, R.H., Jr. (Ed.), *Proceedings of the 42th Hawaii International Conference on Systems Science* (pp. 1-10). Los Alamitos, CA: IEEE Computer Society.

The last article concretizes EA benefit realization by scrutinizing its measurement. The objective of the article was to preliminarily identify the constructs impacting the EA benefit realization process and to provide suggestions on how they can be measured.

The study is based on a conceptual analysis of the literature utilizing the IS success model (DeLone & McLean, 2003) adapted to the EA discipline as the theoretical framework. The conceptual-analytical research approach was selected owing to the research objective. As the EA discipline lacked utilizable frameworks, an established model from the IS discipline was selected as the theoretical framework because of its generic theory base and extensive validation (Petter et al., 2008).

Each of the seven constructs contributing to benefit realization in the model—information quality, system quality, service quality, intention to use, use, user satisfaction, and net benefits—was scrutinized to create an understanding of the meaning of each construct and its potential metrics in the EA context. However, due to the multifaceted nature of the EA concept, the original model in its current form was considered to be insufficient and incomplete to accommodate the whole concept of EA. As the aim was not to limit the analysis to only specific constructs, each of the original constructs was analyzed from four different viewpoints, namely process, product, outcome and impact. This resulted in a 7x4 matrix that defines the meaning of each of the IS success model constructs from the four EA-specific viewpoints. The viewpoints were defined according to the conceptualizations of EA identified from the literature, the outcome viewpoint corresponding to the outcomes from EA use, and impact on the realized benefits.

Even though preliminary constructs were proposed for EA benefit realization, their interaction or mutual importance with regard to benefit realization was not addressed. Therefore, the focus of this article was first on uncovering preliminary topics to be used to guide the interviews, and second, on suggesting practice-oriented metrics for the initial constructs.

The adapted model was tested by mapping a real-life case (Andersin & Hämäläinen, 2007) to the model. This case was chosen because it was one of the few documented examples at the time. Each of the identified constructs was analyzed against the data from the case and metrics were suggested for each as examples. Metrics were also proposed for the constructs: EA products and services, EA process, EA product and service use, user satisfaction, and net benefits. The proposed metrics were based on the particular situation in the case organization (i.e., early stage EA) and included generic quality attributes and measures adapted from the IS domain. Given the lack of existing metrics, custom EA metrics were also proposed.

The article was planned and written by Eetu Niemi and Samuli Pekkola. The literature review and model testing were conducted by Eetu Niemi.

6 Discussion

This chapter discusses the results of the thesis. The overall research question addressed in the thesis asked how EA benefits are realized. The following sections provide answers to the question by addressing each of its sub-questions.

6.1 EA benefit realization in general

Understanding the interaction of constructs in EA benefit realization in detail is required as a basis for a comprehensive EA benefit realization model. The first research question, RQ1, asked how EA benefit are realized and its sub-question, RQ1.1, asked how different construct interact in EA benefit realization. Both of these questions aim to identify the constructs interacting in EA benefit realization and their interrelationships. It was examined by a case study on EA benefit realization. As a result, a data-based model of EA benefit realization was created.

The model provides answers to the research questions by identifying 1) eight constructs interacting in EA benefit realization, and 2) interrelationships between the constructs. It describes the process (i.e., the chain of constructs and interrelationships) through which EA benefits emerge. The model depicting the constructs and interrelationships between the constructs is depicted in Figure 6. The model is described in more detail in Article 1. Interrelationships are defined between the dimensions of the constructs.

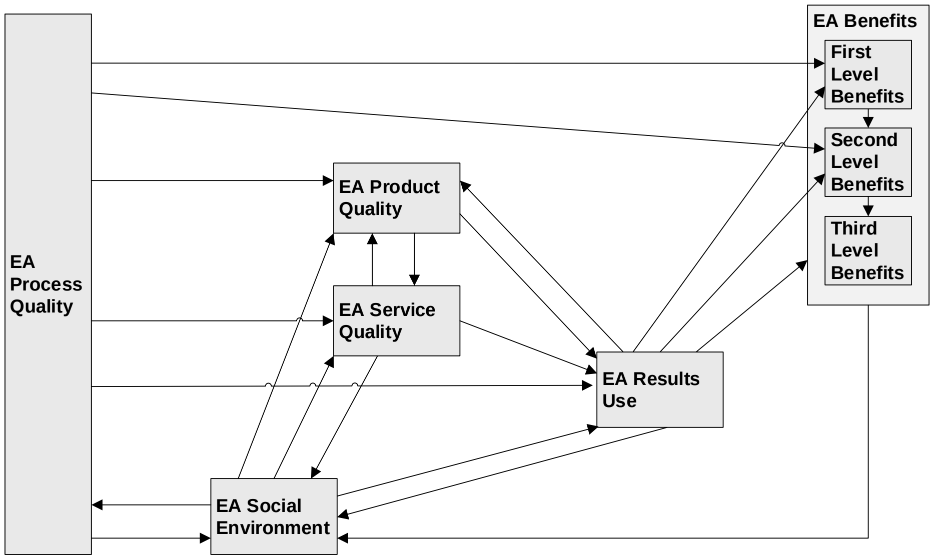

Figure 6. Constructs and their interrelationships in EA benefit realization.

The constructs and their dimensions (attributes) included in the model are described in Table 2.

EA benefit realization is a multi-phased process where eight constructs are interconnected in a complex manner. The model suggests that EA benefit realization is not a simple process, but that some EA benefits are always and only realized through a chain of several interconnected constructs. The findings largely support the earlier conceptions on the constructs interacting in the EA benefit realization process. They also encompass all of the conceptualizations of EA. In this respect, the extent of the identified constructs can be considered sufficient. With regard to the interrelationships of the constructs, they seem to be significantly more complex than previously described. This indicates that no existing EA benefit realization model fully captures the phenomenon of EA benefit realization.

EA benefits can be realized in two ways: by appropriately using EA products and services for different purposes (i.e., through the EA results use construct), or by having high-quality EA processes in place (i.e., the EA process quality construct). No existing study shares this view, although the EA use has been identified as a critical antecedent for EA benefit realization in several studies (e.g., Foorthuis et al., 2015; Lange, 2012; Tamm et al., 2011a).

Table 2. *Constructs and Dimensions Interacting in the EA Benefit Realization Process*

Construct	Definition	Dimensions
EA process quality	Measures of EA processes, methodology, tools and organization.	• Clear EA scope and purpose • Cohesion with other governance methods • EA framework quality • EA modeling conventions • EA modeling tool quality • EA process task timing • Non-architecture source material quality • Resource availability • Stakeholder participation • Support documentation quality
EA product quality	Measures of EA products.	• Availability • Clarity • Cohesion and uniformity • Correctness • Granularity • Usefulness
EA service quality	Measures of EA services.	• Activeness • Availability • Competence • Usefulness
EA results use	Consumption of the output of EA processes (i.e., EA results) by EA stakeholders.	• Amount of use • EA results used • Motives of use • Stakeholders • Timing of use • User satisfaction
First level benefits	Effects of EA that arise directly from the EA processes.	• Allow project to proceed • Identify dependencies • Improve alignment • Improve implemented solutions • Improve project governance • Improve project management • Improve service management • Increase understanding/new insight • Provide answers quickly

		• Provide common vocabulary • Provide example • Provide guiding framework • Provide overview • Provide standards • Reduce duplication • Reduce workload in EA work
Second level benefits	Effects of EA that arise (depending on the situation) either directly from the EA processes or as a result of the first level benefits.	• Improve decision making • Increase interoperability between solutions • Increase standardization in solution portfolio • Provide requirements and restrictions • Speed up project initialization
Third level benefits	Effects of EA that arise as a result of the Second level benefits.	• Decrease IT costs
EA social environment	Organizational factors external to the EA undertaking that have an effect on the EA benefit realization process.	• Common approval and understanding of EA • Top management commitment • Understanding of EA work in other organizations

EA product and service use seem to be the key in the process as they have an impact on significantly more benefits than EA processes. They also have impacts on the EA social environment and the EA product quality, interrelationships that have not been identified before. Indeed, participating in EA use seems to improve the understanding of EA in the organization. Using EA products may even bring out improvements in them.

EA results use is impacted by all other constructs (except EA benefits). This means that, in addition to having high-quality EA products and services to be used, appropriate processes and organization need to be in place (e.g., adequate resources), and EA needs to be sufficiently grounded in the organization as an approach (e.g., supported by top management). Consequently, high-quality EA products and services have value as the quality has an effect on how well products and services can be used. Although previously referred to with regard to EA services (e.g., Aier, 2014; Foorthuis et al., 2015, 2010), this impact has not, surprisingly, been previously identified with regard to EA products. Some studies have contradictory results. Lange (2012) suggests that EA use is only influenced by EA's organizational grounding (i.e., EA social environment). Surprisingly, a feedback loop from EA benefits, meaning, for example, that realizing EA benefits leads to more use, was not identified. This is also the case in previous models.

More direct impact on benefits has been suggested for EA products before (Lange, 2012; Schmidt & Buxmann, 2011; Tamm et al., 2011a). The results of this study signify that EA products (and services) do not lead to benefits themseves, but through their appropriate use. Also Hämäläinen (2008, p. 76) suggests that architecture product quality is the prerequisite for understanding the architecture, and, therefore, also for its application. EA product and service quality constructs also have effects on one another, meaning that high-quality EA products also make the EA services better (as products are often used as part of services), and by utilizing EA services, the quality of EA products can be improved. This mutual impact has not been identified before. All in all, only a few studies (see Foorthuis et al., 2015; Schmidt & Buxmann, 2011) have previously identified EA services as a key contributor for benefit realization.

EA processes are important, as they have an impact on several other constructs in the process. Naturally, EA process quality has a direct effect on the quality of the results of the processes, namely the EA product and EA service quality constructs. It also directly affects the use of EA products and services. Moreover, it has an effect on EA social environment, facilitating building an environment favorable for EA. Such an extensive effect is not present in earlier studies, which point toward an effect on EA use (Foorthuis et al., 2015; Tamm et al., 2011a), social factors (Lange, 2012) or IT benefits (Schmidt & Buxmann, 2011). All in all, EA process quality factors seem not to have received the attention they would deserve in light of this study.

EA social environment is also critical, as it has an impact on most other constructs. Consequently, the organizational grounding of EA seems to have an impact on all parts of the benefit realization process. The importance of EA's organizational grounding has been acknowledged before (Aier, 2014; Lange, 2012; Weiss & Winter, 2012), but to a more limited extent. The importance of top management support and commitment has been identified before as well (e.g., Lange, 2012; Seppänen, 2014; Wan et al., 2013). EA social environment is also influenced by most constructs, highlighting the notion that having the right basis in place for EA (i.e., EA process quality), high quality EA services, appropriate EA use, and benefits gained from EA further builds up an environment favorable for EA. This is partly supported by earlier research (Lange, 2012; Weiss & Winter, 2012).

It is also evident from the results that the benefits themselves have mutual interrelationships, as is also suggested in the literature (e.g., Aier, 2014; Boucharas et al., 2010; Foorthuis et al., 2015; Schmidt & Buxmann, 2011). That means that, in some cases, realizing a certain benefit is required for realizing another benefit. First level benefits are, for the most part, ones that the stakeholder immediately gains in using EA products or services, such as improved understanding of a certain target area of the organization.

Most of the second level benefits are ones that can be realized with that understanding. This also seems to refer to the implementation aspect of EA (cf. Foorthuis et al., 2015; Schmidt & Buxmann, 2011; Tamm et al., 2011a), as several first level benefits and EA results use contribute to second level benefits related to the improved operating platform (i.e., increased interoperability between solutions and increased standardization in solution portfolio). This means that some benefits are only realized after the EA plans have been implemented. The single third level benefit can only be realized through second level benefits.

Some interrelationships may also refer to a temporal relationship between the benefits (i.e., time needs to pass before a benefit is realized). For example, EA products provide an overview and can help in identifying interrelationships, which can lead to better decision making. Still, exceptions exist. For example, some second level benefits are directly influenced by EA results use, in addition to first level benefits. This highlights the complexity of the EA results use construct.

To identify what makes EA processes, products, and services of high quality, the study identified 15 EA process quality attributes, six EA product quality attributes, and four EA service quality attributes. These are described in detail in articles 2 and 3, respectively. They are, to a large extent, supported by earlier findings (e.g., Aier et al., 2011; Foorthuis et al., 2010; Lagerström et al., 2011; Lange, 2012; Pitt et al., 1995; Tamm et al., 2011a; Ylimäki, 2006). However, even though most of the attributes have been identified in the literature, there is no single source that provides as comprehensive a view of EA process, product, and service quality attributes.

Within EA process quality, attributes such as clear scope and purpose, and appropriate management, documentation, and governance practices were considered important. Cooperation within the EA team and routinization of EA work were also identified as critical attributes, which, somewhat surprisingly, have been disregarded in previous research. Even though not identified before, this is an important attribute related to the practicality of EA and signifies the use of EA as a part of everyday work, similarly to some of the other overarching disciplines, such as information security.

A related attribute, the alignment of other organizational functions, has also been addressed in the literature rather superficially. The findings indicate that EA governance should be geared towards practical architecture support for EA stakeholders, rather than formal governance establishment (cf. Foorthuis et al., 2010; Lange, 2012). While some formal governance practices, such as architecture reviews, may be needed to enforce EA compliance in projects (cf. Foorthuis et al., 2015), this was not emphasized in the findings.

EA should also be aligned with business to actually be realistic and usable (e.g., van den Berg & Steenbergen, 2010, pp. 156–158). Obviously, EA tools and methodologies should be sound and adequately documented, and adequate resources should be available.

Regarding EA product quality, typical document quality attributes such as clarity and conciseness, right granularity, uniformity and cohesion, availability, correctness, and usefulness seem to also apply for EA products. Availability, as a new attribute, seems to be highlighted, as, in practice, the necessary EA products may not even be available. With EA service quality, availability and timing, awareness, activeness, and usefulness were identified. With EA services, the timing aspect is highlighted, as it is critical that the services are available at the right time, like project architecture support early in the project lifecycle. Also, awareness should be specifically mentioned because, in practice, it may be difficult to get a view of the available services and their benefits for the user, especially for non-architect stakeholders. In the literature, attributes for particular EA services were relatively seldom referred to, with the notable exception of Lange (2012).

6.2 Relation of EA stakeholders and the use of EA products and services to EA benefit realization

The second research question (How are EA stakeholders and the use of EA products and services related to EA benefit realization?) provides answer on when, why, and to whom EA benefits actually emerge in practice. It was studied by focusing on two practical viewpoints: 1) EA stakeholders and 2) EA product and service use.

6.2.1 EA stakeholders

The study on EA stakeholders, documented in Article 4, attempts to identify how EA stakeholders are involved with EA. It was studied as a separate case study. The sub-question can be answered by investigating who the stakeholders are, how they interact with EA and what their main needs and expectations (concerns) towards EA are. It aimed for a comprehensive view of EA stakeholders, attempting to identify all relevant stakeholder roles. The study identified 29 different EA stakeholders, including individuals, groups, and organizations, with diverse involvement with, and diverse concerns towards, EA (details can be found from Article 4 and its Appendix). According to their involvement with EA, the stakeholders can be divided into three generic groups: EA producers, EA facilitators, and EA users. Analyzing these categories of EA stakeholders provides an answer to the sub-question.

Producers are stakeholders carrying out EA planning and development. These stakeholders include obvious ones, such as architects, but also IT and project personnel as they create project and solution-level architecture. While EA facilitators and users generally provide certain requirements for EA, producers are concerned that EA satisfies these requirements.

Facilitators are stakeholders that perform EA governance, management, and maintenance. They also sponsor and support EA work, by providing resources and requirements, but without directly conducting EA planning or development. Facilitators include stakeholders such as EA decision-making bodies (e.g., architecture boards), EA executive sponsors, management in general, and other organizational disciplines, such as program management offices.

EA users, in turn, utilize EA work and its products in their daily work. However, they do not carry out EA work or directly affect EA. Still, they can be involved in EA work by disclosing requirements and feedback. They include numerous stakeholders, such as architects, projects, IT development and maintenance, management, and other organizational disciplines.

It is important to note that a certain stakeholder can act in multiple roles. For example, architects, depending on the position, can act as EA producers, facilitators, and users. Therefore, their concerns could also be diverse. The concerns identified were relatively high-level statements of what the stakeholder expects from EA. For example, architects are concerned with the alignment of EA and business requirements, the completeness and consistency of EA products, and the traceability between requirements and EA.

These generalized views aside, the study concluded that the hierarchy and the organizational position of the EA team vary across organizations, potentially impacting the concerns and categorization of stakeholders in different organizational contexts. Therefore, stakeholder analysis needs to be carried out on a case-by-case basis. Even though the literature suggests some typical concerns for stakeholders, these are necessarily on a very high level, like business and IT alignment (see, e.g., Isomäki & Liimatainen, 2008; van der Raadt et al., 2008).

Surprisingly, there are relatively few studies focusing on EA stakeholders, even though stakeholders are often referred to. One of the few studies on the topic generally supports the findings on stakeholder roles (van der Raadt et al., 2008). Also Lange (2012, p. 227) refers to similar stakeholders. These studies utilize a different framework for classifying stakeholders, categorizing them by aspect area (business, information, information systems, or technical infrastructure) as well as by their organizational level (enterprise, domain, project, operational) (see van der Raadt et al., 2008). This seems to be a useful categorization, especially for determining the organizational position of the stakeholder. EA stakeholders have also been categorized generally into EA creators and users, omitting the facilitator category (Foorthuis et al., 2015). Other categorizations have been proposed in the stakeholder theory literature. For example, they can be categorized on the basis of their power to influence, the legitimacy of the stakeholder's relationship with EA (e.g., by contract), and the urgency of the stakeholder's claim (Mitchell et al., 1997).

Literature supports the view that the stakeholders have varying goals and concerns, which can even be conflicting (van der Raadt et al., 2008). Thus, it is difficult to satisfy all stakeholders. In any case, stakeholders should be prioritized and strategies set for meeting their concerns (van der Raadt et al., 2008). The literature on stakeholder theory varies in opinion on how stakeholders should be managed and which criteria should be emphasized in prioritizing stakeholders’ concerns (Donaldson & Preston, 1995). Stakeholder categorization provides a basis for identifying the stakeholders and gives a clue to the importance of their concerns (Mitchell et al., 1997).

Also, research on cooperative relationships (e.g., Ring & Van de Ven, 1994) creates insight on how stakeholder relationships form and develop. Critical aspects to consider are sense of trust and risk by the parties, formal and informal commitment, roles, and informal relationships (Ring & Van de Ven, 1994). In these relationships, balance needs to be sought between formal and informal social-psychological processes (Ring & Van de Ven, 1994). A typical challenge is EA teams’ often limited formal influence in the organization (Seppänen, 2014, p. 48). Especially in this situation, creating a half-formal contract, or EA charter, with key stakeholders as suggested by the TOGAF standard (The Open Group, 2011), may be beneficial to add formal commitment.

6.2.2 Use of EA products and services

EA product and service use was investigated as a part of the main case study, documented in Article 5. It attempted to answer the second sub-question regarding how EA products and services should be used to realize benefits. It can be answered by scrutinizing the different aspects of EA product and service (artifact) use, such as why EA products and services are used, what EA products and services actually are, who the stakeholders using them are, and when the EA products and services are used. The focus of this study was more on EA products and services than on stakeholders, but, naturally, stakeholders had to be considered as they are an important part of EA use.

The question was approached by identifying and analyzing 15 different real-life EA use situations (see details in Article 5). The theoretical framework utilized in the analysis, adapted from the IS field (see Burton-Jones & Straub 2006), included four items: motivation, involved stakeholders, EA results, and the phase of the project where EA products and services are used. The use situations were named after their purpose; for example, one is called “create EA product and provide support for projects.” The resulting analysis provides answers to the sub-question.

The motives of utilizing EA products and services fell into four categories: supporting target state decision making, guiding the implementation, supporting other planning activities, and supporting communication. These are supported by the literature (e.g., Lange, 2012; Pulkkinen, 2006; van der Raadt, 2011; Winter et al., 2007). In a typical situation, a stakeholder uses EA products(s), potentially complemented with EA services, as input in the stakeholder’s own work. This can involve, for example, the creation of another EA product or making a decision (cf. Kaisler et al., 2005; Pulkkinen, 2006). The results also indicate that EA products are created and maintained on several levels that are dependent on each other (i.e., EA, LoB, and project) by different stakeholders. This is in line with Pulkkinen (2006).

An important distinction is that in the case project architecture support (as part of guiding implementation) was more focused on compliance with the EA framework and whether sufficient project architecture documentation exists, instead of evaluating the content of the project architecture against EA. This contradicts the literature (e.g., van der Raadt & van Vliet, 2008; Ren & Lyytinen, 2008). EA products and services should rather bring value to all stakeholders and not be produced merely for their own sake.

Also, technical EA product analysis methods, often referred to in the literature (e.g., Johnson et al., 2007; Sasa & Krisper, 2011; Winter et al., 2007), were not used. In the case of this study, the analysis was based more on informal analysis of the products (e.g., finding out dependencies between architectural objects). Moreover, evaluating EA products, utilizing architecture trade-off methods, or using EA products in IT acquisition and portfolio management processes were not explicitly mentioned (cf. Babar et al., 2004; Boyd & Geiger, 2010; Clerc et al., 2007; Quartel et al., 2012; Ylimäki, 2006).

The use situations involved several stakeholders, the main ones including project architects and EA team members (i.e., architects), with relatively few references to management and IT line organization. Thus, stakeholders, both within the EA team and external to it, are involved in EA product and service use. This naturally sets different requirements for the features of EA products and services used by different stakeholders.

The same framework used to categorize stakeholders in the case study on EA stakeholders (see Article 4) could also be applied in this study, with the important exception that facilitator-type stakeholders were not identified from the data. It was also evident that the number of stakeholders identified from the data of this study was significantly smaller than in the study on EA stakeholders (Article 4). This can be explained partly by using different abstraction levels in defining the stakeholder roles, which were much coarser in this study. It also stresses the importance of taking a comprehensive view of EA stakeholders, as they are numerous. Also, most of the use situations were either related to the work of the EA team, or at the project level. It seems that, in the case of this study, EA products and services were not extensively utilized on other levels.

Several generic types of EA products were identified. They were classified by their domain (i.e., business, system, or technology, with business also including information) and abstraction level (i.e., EA, reference architecture, line-of-business architecture, project/solution architecture, and implementation architecture). In most of the situations, EA products describing all domains were required. On the other hand, the required abstraction levels depended more on the use situation in question, but also, here, many situations involved most or all levels. The time dimension of EA products (i.e., current state, target state, or transition plan) was not explicitly referred to, potentially suggesting that the time dimension may be always similar in a certain situation, or that all time dimensions were required (Lemmetti & Pekkola, 2012).

Most of the use situations also involved some kind of EA service. The services seemed important, especially in situations which involved non-architect stakeholders. The services involved supporting EA product use by non-architect stakeholders, such as management. This is supported by the literature (Lange, 2012; van der Raadt, 2011).

The timing of use was relevant only for use situations that were related to a certain project, typically IT development. According to the study, most EA product and service use should occur in the project initiation phase as the EA value for projects is dependent on the time the EA products and services are taken advantage of. This is in line with recommendations by Ross et al. (2006, p. 136).

As suggested by the study on EA stakeholders (Article 4), the stakeholders involved in EA use situations have varying needs. Thus, the use of EA products and services varies by stakeholder. For example, architects and non-architects have different requirements for EA products with regard to their format and appearance. Therefore, a reasonable variety of EA products, covering the most important domains and abstraction levels, is required to fulfill the needs of the stakeholders.

In general, the results emphasize that EA artifact use is a very complex phenomenon that should be considered comprehensively, including the four viewpoints presented. Especially when comparing it to the context of software architectures (cf. Smolander et al., 2008), EA use seems to be significantly more diverse than software architecture use. This means that even though EA use can be categorized using software architecture metaphors (see Smolander et al., 2008), including blueprint, language, decision, and literature, a single EA use situation typically covers multiple metaphors. This further highlights the complexity of EA and its products and services.

6.3 Measurement of EA benefit realization

The measurement of EA benefit realization was examined as a separate theoretical study, documented in Article 6, seeking to answer research question three, which asked how EA benefit realization can be measured. The study aimed to preliminarily identify the constructs impacting the EA benefit realization process and to provide suggestions on how they can be measured. The IS success model (DeLone & McLean, 2003) was taken as the basis for this.

Because the aim was to scrutinize the constructs taking part in benefit realization from all relevant viewpoints, and due to the complex and multifaceted nature of EA, the model was appended with four different viewpoints: process, product, outcome, and impact. These align with the identified conceptualizations of EA (see Section 2.2), the outcome viewpoint referring to the implementation of EA through EA product and service use, and impacts referring to benefits. This resulted in each of the IS success model constructs being analyzed from these four viewpoints. However, direct equivalents were not found for all of the viewpoints.

The adapted model was tested by mapping a real-life case (Andersin & Hämäläinen, 2007) to the model. Each of the model constructs was analyzed against the data from the case and metrics were suggested for each. The constructs for which metrics were suggested were, for the most part, in line with the EA benefit realization constructs identified in the main case study (Article 1). However, due to the starting point of the study (the IS success model), EA social environment was not covered. It only surfaced later in the main case study. Still, metrics can be proposed for it as a result of the main case study and recent literature.

It should be noted that in the case used for model testing and deriving measures, work on EA was in an initial stage, which affected the selection of suitable metrics. However, most of them can be of value for all organizations utilizing EA. In addition to the abovementioned case, more measures have been later proposed in other studies (e.g., Foorthuis et al., 2015; Lange, 2012). In addition to the metrics proposed in the literature, the constructs and dimensions of the EA benefit realization process (see Table 2) provide a basis for alternative metrics. However, they should first be operationalized. Also, as they were related to the particular organization and situation, they should be filtered to arrive at a set of metrics useful for an organization with a different EA situation and goals.

Table 3 presents all of these metrics and related measurement targets (i.e., what to measure), mapped to the EA benefit realization process constructs from this thesis (see Table 2).

Table 3. *Examples of Metrics for the EA Benefit Realization Process Constructs*.

Construct	**Metrics**
EA process quality	• Generic process quality criteria, such as cycle time (e.g., the time to give architectural guidance to a project), throughput (e.g., the number of project that received architectural guidance), and costs (e.g., average cost of a certain product or service produced). • EAM infrastructure quality metrics such as level of EA governance formalization, tool support, and skills availability (Lange, 2012, p. 132) • EA approach metrics such as knowledge exchange and document templates (Foorthuis et al., 2015) • EA standard management governance mechanism metrics, including definition of key roles and stakeholder involvement (Boh & Yellin, 2007), potentially adapted for other EA products, too • Measures developed from the attributes identified in this thesis
EA product quality	• Architectural documentation quality criteria such as obtainability, understandability, availability, and ability to inform different stakeholders (Hämäläinen & Markkula, 2009) • Generic information quality criteria such as timeliness and reliability (DeLone & McLean, 2003) • EAM product quality metrics such as timeliness, completeness, and level of detail (Lange, 2012, p. 125)

	• Measures developed from the attributes identified in this thesis
EA service quality	• Customized SERVQUAL instrument (Pitt et al., 1995) • Adapted communication audit metrics (e.g., Zwijze-Koning & de Jong, 2007) • Service process metrics, such as stakeholder satisfaction toward architecture guidance, and their knowledge on how to obtain EA products and services in the organization • EAM service quality metrics including communication, top management involvement and project support (Lange, 2012, p. 133) • EA approach metrics such as compliance assessments and providing assistance (Foorthuis et al., 2015) • EA standard management governance mechanism metrics including the formality of EA standards compliance monitoring, potentially adapted for other EA products also (Boh & Yellin, 2007) • Measures developed from the attributes identified in this thesis
EA results use	• Project EA compliance metrics, such as the distribution of projects that received architecture guidance, used EA models or principles, received architecture review, or complied/did not comply with the results of the architecture review (e.g., The Open Group, 2011). Also, a single-item project compliance metric can be used (Foorthuis et al., 2015) • Adapted IS use metrics, such as amount of use, frequency of use, nature of use, appropriateness of use, extent of use, and purpose of use (cf. Petter et al., 2008) • Satisfaction metrics such as stakeholders' satisfaction toward EA or EA function in general • EAM use metrics including stakeholder engagement and regulatory mandate (Lange, 2012, p. 125) • EA standard use and conformance metrics, potentially adapted for other EA products, too (Boh & Yellin, 2007) • Measures developed from the attributes identified in this thesis
First level benefits Second level benefits Third level benefits	• Derive metrics from organization's EA goals using the GQM approach (Van Solingen et al., 2002) • Benefit measures derived from the concrete EA-related needs of the most important stakeholders • EA use or implementation outcome metrics such as number of sys-

	tems (management of complexity), number of point-to-point interfaces (management of complexity), time to implement a new business requirement to systems/processes (increased flexibility), number of proactive/reactive change projects (increased flexibility/knowledge), level of stakeholder satisfaction toward EA's support to decision making (increased knowledge), number of new improvements, features, services or products (increased knowledge), customer satisfaction (increased customer orientation), and the level of customer acquisition/retention (increased customer orientation) • Project and organizational benefit metrics (Lange, 2012, pp. 125–126) • Architectural insight, EA-induced capabilities, project and organizational performance metrics (Foorthuis et al., 2015) • IT outcome measures (Boh & Yellin, 2007) • Measures developed from the attributes identified in this thesis
EA social environment	• EAM cultural aspects metrics top management commitment, and awareness and understanding of EA (Lange, 2012, p. 133) • Organizational culture measures covering group, developmental, hierarchical, and rational culture (Aier, 2014) • EAM institutionalization measures (Weiss & Winter, 2012) • Measures developed from the attributes identified in this thesis, such as common approval and understanding of EA, top management commitment, and understanding of EA work in other organizations

The set of metrics suggested above is extensive and thus laborious to implement as a continuous activity. The used metrics should be selected according to the goals of the organization and the measurement, including the concerns and needs of EA stakeholders (cf. Hämäläinen, 2008, p. 78). An iterative approach to defining the metrics is also recommended (Hämäläinen, 2008, p. 76). The maturity of the EA approach can also give a clue as to what should be measured. For example, if EA work has just been initiated, it is not feasible to measure EA use or benefits from the EA implementation viewpoint, simply because no implementations exist yet. Also, useful EA products and services may take time to be created. Moreover, as suggested by the results on EA benefit realization, benefits may take a long time to uncover.

Whether or not the EA process or its outputs (i.e., products and services) should be measured poses another question. EA products can be measured to not only have an idea of the quality of the products themselves, but also of the processes that created them. This gives the most accurate view on the quality of the products, but may be infeasible in practice, as EA products are numerous and their measurement is labor intensive (Tamm et al., 2011a). However, measuring the products may be feasible from the practical point of view since it can be used to ensure the quality of the products at their creation (Hämäläinen, 2008, p. 76). Still, it may be more cost-effective to measure the aspects of EA processes that have been observed to impact high-quality results (Tamm et al., 2011a). On the other hand, measuring a process in its initial stages may also be infeasible, as it may later significantly improve through routinization.

As brought out before, EA use is a critical concept and should therefore also be present in EA benefit realization measurements. In the IS domain, use has been criticized as a success measure. Some researchers consider that use must precede benefits, but it does not cause them (DeLone & McLean, 2003). However, this critique may be due to the sometimes simplistic conceptualization of use (Burton-Jones & Straub, 2006; DeLone & McLean, 2003), considering, for example, only amount of use. Therefore, EA use metrics should include a rich set of items.

The important thing to note in evaluating the EA benefit realization process is the data gathering for the metrics (Hämäläinen, 2008, p. 39). It should be decided whether quantitative or qualitative data (or both) will be used. It has been suggested that qualitative measures may actually be more feasible with regard to EA (Wan et al., 2013). While data for some measures can be derived from objective data sources such as financial and process performance data, most of them involve asking EA stakeholders. These need to be selected carefully depending on the measurement goals. For example, if the general reach of EA is measured, then (almost) every EA stakeholder should be asked in order to get a realistic result. However, if specific parts of the EA benefit realization process are measured, it may be necessary to select the target population more specifically. Especially if EA is in the initiation phase, only a few stakeholders may even be knowledgeable about EA processes, products, and services. Also organizational benefits may be visible to only a few people. Thus, it can be infeasible to include all stakeholders as respondents in this case. Besides architects, projects are typically good candidates for measurement as they usually interact with EA first through architectural support.

The metrics also need to be concrete. In particular, metrics related to benefits should not be too abstract, as it may be difficult for the respondents to express an opinion on these. Possibly, a good approach would be to focus on benefits directly related to the stakeholders' daily work, at least in first measurements. First and second level benefits, as defined in Table 2, could be used as a starting point.

As for when measurement should be carried out Hämäläinen (2008) states that it can be used in different stages of the EA process or lifecycle (p. 75). For example, both EA planning and governance could be measured, requiring that measurement is carried out at an appropriate time to capture the particular situation.

7 Conclusions

This chapter presents the conclusions of the study and discusses its reliability, validity, and relevance. This is followed by a discussion of the contributions of the study to research and practice, and suggests directions for future research.

7.1 Conclusions and implications

This thesis proposes that EA benefit realization is a complex process (see Figure 6 and Article 1). Within this process, EA benefits that can be objectively measured and have a clear financial impact on the organization (i.e., third level benefits) can only be realized indirectly through other benefits. These, in turn, are only contributed by EA processes and the use of EA products and services. As EA process quality also contributes to high-quality EA results, which, in turn, impact their use, process quality may be a slightly more important construct in this respect. These findings have several implications, discussed in the following section.

First, it signifies that providing the preconditions for high-quality EA processes is crucial. Process quality is especially important since it impacts the greatest number of other constructs in the EA benefit realization process. The identified EA process quality attributes (see Article 2) determine characteristics which constitute EA processes of high quality, and ultimately impact the realization of benefits. For example, the quality of EA tools, framework, support documentation, and alignment with business were observed to contribute to benefit realization.

Second, EA results use should be appropriate to realize the benefits (cf. Foorthuis et al., 2015). The dimensions of use define which aspects have an effect on EA use. Use is a complex phenomenon where the motives of use, timing of use, and EA stakeholders, products, and services involved in use all have an effect on the benefits realized through use. The identified EA use situations also give an idea of how EA products and services could be used in practice to contribute to benefit realization. The findings indicate that there exist a multitude of contexts where EA use can be incorporated. EA governance, which has been the main focus in the literature on EA use (e.g., Foorthuis et al., 2015), is not the only context where EA is used. Several stakeholders, both internal and external to the EA team, are involved in use. The use situations are also intertwined with each other, such as one providing input for another.

Third, as an important antecedent for EA use, EA results quality indirectly contributes to benefit realization. The quality of EA products and services should be sufficient to facilitate use. The results indicate that the quality of both EA products and services impacts EA use, and that products and services are intertwined in practice. Thus, required support services should accompany EA products to facilitate their use, especially for stakeholders with less knowledge and experience of EA and its use. The identified EA product and service quality attributes (see Article 3) denote characteristics of EA results that can have an effect on their overall quality.

Fourth, the impact of social attributes on EA benefit realization should not be disregarded. While attributes of a social environment favorable for EA, such as top management commitment, common approval, and understanding of EA contribute to the use of EA results, they also have an effect on the quality of EA processes, products, and services. The EA social environment is also extensively impacted by other constructs of the benefit realization process, including EA processes, services, EA results use, and EA benefits.

Fifth, EA benefits have several “layers” which impact one another. First level benefits are those directly achieved by EA stakeholders by participating in EA processes (e.g., creating EA products) and using EA results. For example, EA can help identify interrelationships between systems and processes and provide an overview of a certain area. These benefits, in turn, contribute to second level benefits, whose impact extends beyond a certain stakeholder. For example, the information gained from EA products can improve decision making (e.g., in portfolio planning) and, as time passes, ultimately increase standardization in the solution portfolio. Some of the second level benefits can also be realized directly by EA processes and EA results use. Finally, those EA benefits that have a direct effect on the performance of the organization (i.e., third level benefits) can only be realized indirectly through second level benefits. The only third level benefit identified was lower IT costs. This indicates that these benefits may be more organizational in nature and can have a direct impact on the bottom line. A second explanation could be that they are more long-term benefits, taking a long time to be realized. Possibly no other third level benefits have yet been realized in the case organization. The mechanism for realizing these benefits seems to be through EA implementation, namely, the improved operating platform implemented by realizing the EA plans. Also, Tamm et al. (2011a) argue that the organizational benefits are, to the largest extent, dependent on realizing the EA plans.

The study also revealed that EA stakeholders are numerous and have varying concerns relative to EA. Stakeholders can also act in multiple roles with regard to EA, so their concerns can be diverse. Some stakeholders are heavily involved in EA product and service use, while others are less involved. To make matters more complex, stakeholders and concerns are, to some extent, organization-specific. Thus, careful stakeholder analysis is the key to managing stakeholders and their concerns. Useful categorization of stakeholders provides a basis for stakeholder management (cf. Mitchell et al., 1997).

Metrics were suggested for each of the EA benefit realization process constructs. These were based on the literature and applied to a real-life EA case. Other potential metrics have also been proposed in the literature (e.g., Lange, 2012). Also, the dimensions identified in this study provide a starting point for developing measures for the EA benefit realization process. Whatever metrics and data are used, EA benefit realization should be measured as a whole, including all of its constructs. This is crucial in forming the causal links necessary for attributing the benefits to EA specifically.

7.2 Contributions to research

This thesis makes several contributions to the body of research by providing novel results on the EA benefit realization process and building up the much-needed theory in the area.

First, the resulting model (see Figure 6) synthesizes the somewhat fragmented views on the EA benefit realization process and enhances the relevance and generalizability of the constructs present in previous studies. It provides an empirically evaluated, comprehensive model of EA benefit realization. It can be considered comprehensive because 1) the constructs interacting in the process encompass all conceptualizations of EA; 2) it takes into account the complex interrelationships between the constructs; and 3) it considers the layered nature of EA benefits. Before, there was no one model which would consider all of these constructs and dimensions.

The model can be directly used as a basis for further research. An important consideration is its further validation. The results allow the modeling of the constructs involved in further research, for example, defining and operationalizing detailed measures for each of the constructs to be used in validation of the model. Furthermore, ready measures from the literature have been suggested for the constructs. This provides a basis for measuring the EA benefit realization process.

In addition to potentially bringing a continuous tradition to the field of EA benefit realization research, it may also help to understand value creation in the larger context. It may be utilizable as a unifying model in the context of organizational and customer value creation, a field currently characterized by several strands of theory (Amit & Zott, 2001; Bowman & Ambrosini, 2000). The model could also complement the existing benefit realization models in the IS discipline. In particular, the impact of process quality has been disregarded in many of the existing models, and benefits have been considered as not having an impact on one another (cf. e.g., DeLone & McLean, 2003; Gable et al., 2008).

Second, the results also provide new insights, especially on the interaction of constructs in EA benefit realization. The resulting model presents benefit realization as a complex, multi-phased process. EA benefits can only be realized through EA process quality and the use of EA results. Moreover, the benefits that actually have an impact on organizational performance are only realized indirectly by utilizing the knowledge in EA and taking advantage of the implemented EA-guided operating platform. Also, the importance of social dimensions is supported (cf. Lange, 2012), even though, in this study, their impact seems to be even greater than suggested before. The results also highlight the importance of EA use (cf. Lange, 2012). A completely new finding is the extensive impact of EA processes in the benefit realization process. Such an impact has not been suggested before. Important dimensions not identified before include the availability of EA products, the routinization of EA work, alignment of EA with other organizational governance functions, and the cooperation within the EA team.

Third, the identified dimensions of the constructs provide frameworks for understanding them in detail. Again, even though many of the constructs have been identified earlier, there is no framework that would encompass all of them comprehensively. There are also few studies that clearly segregate dimensions related to these constructs from each other. Especially regarding EA use, the relatively scarce literature base is strengthened by the analysis of EA use situations. The large number of use situations was confirmed, and several completely new use situations were identified (cf. van der Raadt, 2011). The features of the use situations emphasize the complex and extensive nature of EA use, especially compared to software architecture (cf. Smolander et al., 2008). This further supports the claim of the complexity and extent of EA benefit realization as a phenomenon. In addition, the applicability of the IS use framework (Burton-Jones & Straub, 2006) to model EA product and service use was confirmed by the results.

Fourth, the large number of stakeholders involved with EA was confirmed (cf. Lange, 2012; van der Raadt, 2011). The results also clarify the ways stakeholders are involved with EA in practice, which has received little attention before. The results especially show how stakeholders are involved in EA product and service use situations and what kind of EA products and services they favor. The study provides a useful classification and set of generalized stakeholders and concerns.

7.3 Recommendations for practice

Several recommendations for practitioners can be derived from the results of the study. In the following section, key lessons learned are discussed. They are, for the most part, of value for the EA team, particularly the chief architect and other architects, in planning a new EA program or improving an existing one. In addition, they provide guidelines for EA facilitators (such as top management) on what is required by the EA team (for example, resources and sufficient mandate) to successfully carry out EA work.

Most importantly, the resulting model provides a picture of how benefits can be realized from EA. This can be used by the EA team to improve the EA practice in order to realize benefits to a larger extent. The quality of EA processes, and EA results use were identified as the prerequisites for EA benefit realization. Therefore, attention should be turned to improving these constructs in particular. The importance of EA results quality and the EA social environment should still not be forgotten, as they both impact EA results use.

The multilayered nature of EA benefits also has practical implications. Benefits that have organizational performance impact are only realized indirectly by two different mechanisms. First, by participating in the EA processes and utilizing EA products and services, knowledge is acquired that then has to be appropriately used in decision making and planning. Second, the improved EA-guided operating platform directly creates benefits. The latter requires that the EA plans are actually realized in development initiatives.

Consequently, the participation of business stakeholders in the EA processes should be ensured by architects, and EA results use by both development initiatives and other stakeholders supported by the EA team. EA products are all too often produced in a silo, without considering the business stakeholders at large. As plans for the target state of the whole organization, EA products require extensive buy-in in the organization. Involving stakeholders also provides a method for informing and training them on EA concepts and content. Prerequisites for this are thorough stakeholder analysis and planning of EA results use by the EA team. Ideas on who the EA stakeholders could be and how EA results could be used can be derived from the results of the study. The proposed classification scheme can be used as an initial guide.

Appropriate high-quality EA services provide a way to facilitate the use of EA products and ensure compliance with EA plans. Increased support should be provided to stakeholders less familiar with EA. The services should be first used to inform stakeholders on the available EA products and how they can be used. The second purpose of the EA services is to guide development initiatives, such as projects, to comply with EA. Support should be initiated in the early phases of the development initiative (preferably in pre-planning or similar) to maximize the impact of existing EA products in project planning and implement appropriate project architecture planning practices. Even though some compulsion and decision-making power from the EA team are required to enforce EA compliance, voluntary use of EA services that are actually deemed useful by the stakeholders themselves should be the main objective.

Obviously, EA products should be of appropriate quality to allow use by different types of stakeholders. Even though they do not directly result in benefits, they are the main substance of EA that, in the end, enables benefit realization. Traditional document quality attributes can guide in delivering high-quality EA products, but perhaps a more effective rule of thumb would be to ensure that each and every EA product serves some EA stakeholder. Regarding content, it should be remembered that the key elements to be described in EA products depend on the operating model of the organization (Ross et al., 2006, p. 47). EA content quantity does not ensure quality; for example, a single one-page core diagram has been found the most usable in communicating the EA target state in a clear way (Ross et al., 2006, p. 50). The identified quality attributes also provide an idea of how to improve EA products and services.

Regarding EA process quality, sufficient tool support, an adequate EA framework, and other supporting documentation, such as architecture templates, provide the required foundation for carrying out EA planning and documentation successfully. The EA tool should be repository-based and allow easy access to the EA products, even by non-architect stakeholders. Business stakeholders, especially, should participate in EA planning, and EA governance should be aligned with other organizational governance approaches. This means that the different governance approaches should not require development initiatives to produce the same information in different formats for each of them.

Obviously, adequate resources such as personnel, training, and funding should be provided. Prioritizing EA work above project and line responsibilities for architects and defining clear scope and purpose for EA help to target the use of the available resources to the most important areas. As EA planning and documentation are carried out on many different levels (e.g., the whole organization, lines of business, and individual projects), all components and their dependencies should be considered when improving EA processes. For example, it should be defined how project architectures are harmonized and incorporated in the overall EA.

Creating a supportive environment for EA and its use is important. Unfortunately, there are no easy answers as to how to accomplish this. As shown many times in the IS discipline, having an executive sponsor for the work is crucial. In general, EA as an approach should also be understood by the organization at large. This can be accomplished through communication. Also, stakeholders' positive experiences with EA may have an effect. Even though organizational benefits, such as cost savings, are highlighted from the organizational point of view, stakeholder-specific benefits (e.g., EA making work easier) could be important here. Again, stakeholder analysis should be carried out by identifying stakeholders and their concerns so that they can be managed (cf. Donaldson & Preston, 1995). Useful categorization of stakeholders can act as a starting point. By categorizing EA stakeholders into EA producers, facilitators, and users, the study provides one feasible framework for identifying stakeholders and their concerns. Others have been proposed in the literature (e.g., Mitchell et al., 1997).

As with any organizational initiative, measurement of EA is crucial for continuous improvement (Hämäläinen, 2008, pp. 34–35). Still, according to practical experience, it is often omitted. Perhaps the best approach is to measure the EA benefit realization process in its entirety (instead of focusing only on the resulting benefits). This provides an extensive view of the state of EA in the organization and can be used as a basis for improving its various aspects. It also facilitates forming the much-needed causal links between EA benefits and other parts of the benefit realization process. Benchmarking with other organizations from the EA perspective can also provide a view of the state of EA and what to improve (cf. Wan et al., 2013). This thesis provides ideas on how to initiate EA measurement.

It should be kept in mind that EA is not an all-compassing approach to managing organizations or a replacement for the existing management and governance functions and processes. It is merely a tool for improving the existing processes and functions by providing structured views on the organization and support for their appropriate use. Thus, EA as an organizational function should mainly be focused on supporting EA stakeholders and meeting their needs. Avoidance of the often-mentioned “ivory tower syndrome” (i.e., maintaining EA only for its own sake) is crucial.

To actually function in this role, integration of EA with other management and governance functions is essential. Overlap should be avoided. Here, stakeholder analysis also comes into play to understand the other functions and their capability to incorporate EA in their processes. This also requires that the other functions have sufficient maturity to be able to utilize EA results. Development efforts should be targeted on improving these functions, in addition to EA.

Finally, EA facilitators should note that it may be difficult to quantify the benefits of EA by traditional means, such as return on investment (ROI). This is the case especially in the initial phases of EA adoption. Organization-level benefits may take a long time to realize because they are indirect (cf. Perko, 2009, p. 36) and it may be difficult to attribute them to EA because of the complexity of the benefit realization process. Consequently, especially in the first years of the EA program, trust is required from EA stakeholders that EA will eventually yield benefits. According to this and earlier research, many benefits can be realized from EA. It can be argued that EA is a strategic asset (Kimpimäki, 2014, pp. 90–91), or even as much of a necessary organizational function as marketing or security. Even if they do not immediately yield concrete benefits, their absence may be critically harmful for the organization. Nevertheless, this study has produced results that can be used to actually show the often necessary quick wins from EA (cf. Kimpimäki, 2014, p. 90).

7.4 Reliability, validity, and relevance

The conduct of the study had certain limitations that affect its reliability and validity and, thus, need to be considered in evaluating the results. First, the main empirical data of the study was based on data from a single case organization. Even though this allowed in-depth investigation of the phenomenon in the context (Benbasat et al., 1987), the results represent only this particular context and are, thus, limited in generalizability (Maxwell, 1992). The results could have been potentially improved by incorporating additional case organizations. Also, selecting a public organization may be perceived as a limitation, as public sector workers have been a minority of the respondents in previous studies on the subject (Lange, 2012). Although Kappelman et al. (2008) suggest that demographic attributes have no effect on stakeholder perceptions of EA benefit realization, the effect of demographic attributes such as nationality and organization size should not be disregarded. These limitations should be taken into account in considering the generalization of the results to other contexts.

Second, the data was collected mainly by interviews. Thus, the subjective opinions of the interviewees may have affected the results, in addition to the facts conveyed in the interviews. This was mitigated by including a relatively large number of interviewees. In any case, the use of supplementary research methods to collect the main data would have allowed better triangulation and, thus, increased the validity of the results (cf. Maxwell, 2005). However, documents received from the research organization were used in this respect for triangulation with the interview data. The use of the focus group interview to validate and complement part of the results is also justified. Using this method, other qualitative methods, or quantitative methods to cover the entire scope of the study could potentially have improved the validity and reliability of the results.

Third, as common threats to validity in qualitative research, researcher preconceptions of EA benefit realization and researcher influence on the interviewees may have affected the results (Maxwell, 2005). In interviewing, it is possible to affect the results by (often unconsciously) disclosing researcher’s conceptions of the subject under discussion. Also, the data analysis might have been affected by researcher’s preconceptions (Maxwell, 2005). Still, utilizing the narrative interview method worked towards minimizing the impact of the researcher on the results by letting the interviewees tell the story. Conducting the interviews by phone minimized the effect of researcher’s body language. In the coding process, the concepts were allowed to surface from the data rather than forcing them (cf. Maxwell, 2005). The second author independently checked the data coding to decrease the chance of interpretation bias. Also, requesting a key informant to review the findings was a necessary reality check for the results.

Using the IS success model (DeLone & McLean, 2003) as a rough guide in data collection may be seen as contrary to the spirit of interpretive research (cf. Klein & Myers, 1999; Walsham, 1995). However, this was deemed necessary to facilitate focusing on aspects relevant for the research questions in the limited time allotted for the interviews. Moreover, as the high-level constructs included in the model are fairly established in EA benefit realization research (see Chapter 2), this was not seen as a critical problem. The results support earlier findings, but also bring out key differences, especially regarding interrelationships between the EA benefit realization process constructs.

Fourth, the thesis takes the viewpoint of the organization to the benefit realization process. The viewpoints of external organizations, such as partners and customers, are not considered, even though EA has been seen as an approach to improve cooperation with partners and increase customer satisfaction (Tamm et al., 2011a). Thus, the resulting model remains unevaluated in term of whether it also applies in the context of networked organizations.

The relevance of the study is mainly due to the grounding of the research objective on a topic highly relevant for both researchers and practitioners. The relevance of the topic was verified by means of a systematic literature review. In this regard, the lack of established theory (e.g., Foorthuis et al., 2015) acted as the main driver. The conception of the high relevance of the topic was also strengthened in the course of the study by the emergence of several new studies on the phenomenon (e.g., Foorthuis et al., 2015; Lange, 2012), and by the emphasis put on the topic in the research setting. According to experiences from EA consulting in practice, the topic continues to be highly relevant.

7.5 Topics for further study

Directions for further research arise from both the results and the conduct of this study. First, the resulting model should be validated in other research settings. In addition to qualitative research approaches, the model, with its constructs and accompanying detailed dimensions, provides a basis for quantitative research. The other identified metrics should be further validated and utilized. While this allows triangulation, it also enables comparison to other promising quantitative models of EA benefit realization (e.g., Foorthuis et al., 2015; Lange, 2012).

Second, the constructs and dimensions themselves provide another avenue for further research. The relative importance of both constructs and dimensions should be further studied, especially to provide guidance for improving the EA practice. The mutual interrelationships of the dimensions provide another direction for further research. Some of the dimensions also require further scrutiny, as they have been studied very little. In particular, EA results use should be further studied. It should be verified what kind of EA use yields the greatest benefits. Also, the interaction of stakeholders with EA should be further studied, especially from the perspective of what the most beneficial practices in this regard are. This study has provided a framework as a basis for further research and initial results on possible EA use situations and EA stakeholders.

The impact and dimensions of the EA social environment provides other avenues for further research. Even though the construct has been suggested earlier (Lange, 2012), it has been studied very little. For example, the ways the dimensions of the social environment support EA activities and how environments supportive for EA can be built merit further investigation. As EA social environment dimensions are extensively interrelated to other constructs, it should also be verified whether these actually form a distinct construct or are part of the overall organizational context of EA.

Third, the impacts of EA form an important direction for further research. As most of the research has focused on benefits, negative impacts should be considered in upcoming studies, as suggested by Rodrigues & Amaral (2010). EA benefits have also been studied very little above the level of the organization. As suggested by DeLone & McLean (2003) in the IS discipline, the evaluation of EA benefit measurement should be taken to the industry and national levels.

Fourth, as studies have, for the most part, focused on dimensions closely related to the EA approach (with the exception of EA social environment attributes), the effect of more general organizational dimensions on EA benefit realization should be further studied. Dimensions suggested to have an effect on the process include organizational culture (Aier, 2014) and problems with legacy systems (Boh & Yellin, 2007). Also, contextual factors, such as organizational size and complexity, operating platform quality, operating model, and the rate of organizational change, legislation, regulations (Tamm et al., 2011a), demographic factors (Aier et al., 2011), and organization type (Boucharas et al., 2010) may have an effect.

Finally, as this study has focused particularly on EA benefit realization, it should be studied whether the results can be applied to the IS context. For example, the impact of IS development processes could be further scrutinized as this construct has been omitted in the most influential models (e.g., DeLone & McLean, 2003).

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Enterprise Architecture Benefit Realization: Review of the Models and a Case Study of a Public Organization

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Abstract

In recent years, Enterprise Architecture (EA) has been of interest to both researchers and practitioners. However, EA benefit realization has not been focused on much. Even though a few studies have addressed the subject, the results are somewhat fragmented and are subjected to limited empirical validation, particularly from the viewpoint of different theoretical constructs and their interrelations in the benefit realization process. To understand how the EA benefits accumulate and how related constructs influence each other, we propose a model and criteria for analyzing the explanatory power of the existing EA benefit realization models. Our model emerged from the data of a qualitative case study with 14 semi-structured EA stakeholder interviews. The results support earlier findings, thereby contributing to the enhancement of the relevance and generalizability of the constructs present in previous studies. However, the results also indicate that no existing EA benefit realization model fully captures the complex process of EA benefit realization. Our findings highlight the following: the importance of EA process quality; EA service quality and supportive social environment; constructs that have received less attention in previous studies.

Keywords: Enterprise architecture, benefit realization process, impact, value, case study

ACM Categories: K.6.0, K.6.4

Introduction

Enterprise Architecture (EA) is an established planning and governance approach used to help organizations manage complexity and constant change, and to align their resources towards a common goal (van der Raadt, 2011; Tamm, Seddon, Shanks, & Reynolds, 2011). By definition, EA is a holistic approach encompassing an organization's business capabilities, business processes, information, information systems (IS), and technical infrastructure (Kaisler, Armour, & Valivullah, 2005; van der Raadt, 2011). Consequently, EA is often used in managing the complexity of the organization's structures, IT and business environments, and in facilitating the integration of strategy, personnel, business and IT (Dietzsch, Kluge, & Rosemann, 2006; Goethals, Snoeck, Lemahieu, & Vandenbulcke, 2006; Shaw & Holland, 2009).

Organizational EA investments look for its concrete value in business operations (Rodrigues & Amaral, 2010). Consequently, numerous claims about EA benefits, such as increased responsiveness to

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change, improved decision-making, improved communication and collaboration, and reduced costs, have been made. Unfortunately, these claims are rarely based on empirical evidence, explained, or even clearly defined (Boucharas, Steenbergen, Jansen, & Brinkkemper, 2010; Tamm, et al., 2011). Nevertheless, there is reasonable unanimity about what kind of potential benefits can be realized from EA.

Despite the fact that both academics and practitioners have proposed several models, methods, and metrics for measuring the EA benefits, the benefit realization process itself has remained a mystery until the last few years (Rodrigues & Amaral, 2010). Similarly, the benefits are rarely validated empirically and little effort has been made in attributing the benefits explicitly to EA (Moshiri & Hill, 2011; Potts, 2010; Rodrigues & Amaral, 2010). Only recently has empirical research focused on these issues (Boh & Yellin, 2007; Foorthuis, et al., 2010; Lange, Mendling, & Recker, 2012; Schmidt & Buxmann, 2011). In addition, a number of models attempting to comprehensively explain the EA benefit realization process have been recently suggested (Foorthuis, et al., 2015; Lange, 2012; Lux, Riempp, & Urbach, 2010; van Steenbergen & Brinkkemper, 2008; Tamm, et al., 2011). These models however, present contradictory views on how EA benefits are actually realized. Also, because there is no common understanding of what EA is and how it should be developed, managed and used (Lemmetti & Pekkola, 2012; Sidorova & Kappelman, 2011), the challenges in comprehending EA benefit realization are obvious. These deficiencies call for an established theoretical foundation (Lange, 2012; Lux, et al., 2010; Rodrigues & Amaral, 2010).

The abovementioned issues motivated our study. We want to gain a comprehensive understanding of EA benefit realization. For this purpose, we conducted an analysis of the various models of the EA benefit realization process, which refers to the interrelated constructs contributing to benefits realization. Our initial observations from practice seem to contradict with the literature, where the process is considered being simplified and fragmented, general level process. We thus decided to conduct an exploratory study which resulted in a model and criteria to analyze the existing EA benefit realization models in order to illustrate their strengths and weaknesses. Our model emerged from a qualitative case study in a large Finnish public sector organization.

The study results in an analysis of the explanatory power of the existing EA benefit realization models. The results support earlier findings, thereby contributing to the enhancement of the relevance and generalizability of the constructs present in previous studies. It also brings out potential areas of further improvement in modeling EA benefit realization. These can be used to further improve the theory of EA benefit realization.

This paper is organized as follows: In the next section, we describe the theoretical background of EA benefit realization. In the section that follows, we conduct our case study and develop the model of EA benefit realization. Finally, existing EA benefit realization models are analyzed by reflecting them to our results.

Theoretical Background

Enterprise Architecture

EA is defined *as "the definition and representation of a high-level view of an enterprise's business processes and IT systems, their interrelationships, and the extent to which these processes and systems are shared by different parts of the enterprise"* (Tamm, et al., 2011). This emphasizes EA being both a process (definition) and its product (representation).

EA processes are about EA management operations. They provide direction and support in the design, management, and transformation of EA to support the organizational strategy (Lange, 2012). This encompasses activities such as EA planning, documentation, and governance (Lange, 2012; Tamm, et al., 2011). EA planning deals with decisions about the EA target state documented into new and existing EA documents such as models and principles (Pulkkinen, 2006). EA governance seeks to ensure that the documents are used in and for guiding the development activities (van der Raadt, 2011) and also, for facilitating the compliance of solutions towards EA (Ren & Lyytinen, 2008). An EA framework, such as TOGAF or the Zachman framework, is typically used as a guide in documenting the EA and organizing EA work (Lagerström, Sommestad, Buschle, & Ekstedt, 2011; Lange, 2012).

EA products are the outputs of EA processes such as documentation and services (cf. Tamm, et al., 2011). EA documentation includes architectural models, standards, principles, and other knowledge items targeted at guiding development activities (Aier, 2014; Boh & Yellin, 2007; Boucharas, et al., 2010; Lange, 2012; Tamm, et al., 2011). They describe the organization in terms of multiple domains, including business, information, IS and technology, on different levels of abstraction and with regard to several time orientations, depicting both current and target states and including a transition plan from the current state to the target state (Hjort-Madsen & Pries-Heje, 2009; Kaisler, et al., 2005; Pulkkinen, 2006; Tamm, et al., 2011). EA services are conceptualized as communication and collaboration interfaces of EA processes towards EA stakeholders (Lange, 2012). They can be broadly categorized as implementation support services, facilitating and enforcing the conformity of development initiatives with EA, and EA planning support services, supporting management decision-making on the EA target state (Lange, 2012; van der Raadt, 2011).

As EA describes the organization's target state and a plan of how to reach it, EA products are primarily used for guiding the EA realization in individual development initiatives (Kaisler, et al., 2005; Tamm, et al., 2011). As parts of the EA plans become realized, areas of the new EA-guided operating platform, such as systems and processes, are implemented (Tamm, et al., 2011). EA products also support decision-making and communication (Lange, 2012; Pulkkinen, 2006; van der Raadt, 2011), strategic management (Simon, Fischbach, & Schoder, 2013), and IT and business planning activities (Aier, Gleichauf, & Winter, 2011; Boucharas, et al., 2010; Boyd & Geiger, 2010; Winter, Bucher, Fischer, & Kurpjuweit, 2007). EA products can also be used for quality evaluation purposes (Ylimäki, 2006).

Benefits in the EA Context

The Collins English Dictionary defines benefit as "1. Something that improves or promotes", and "2. Advantage or sake", among others (HarperCollins, 2009). The literature on potential EA benefits indeed focuses on different advantages or positive impacts (Tamm, et al., 2011). Here, the term EA benefit denotes an individual positive effect that originates from EA.

Tamm, et al. (2011) identified twelve high-level EA benefits which are as follows: increased responsiveness and guidance to change; improved decision-making; improved communication & collaboration; reduced (IT) costs; business-IT alignment; improved business processes; improved IT systems; re-use of resources; improved integration; reduced risk; regulatory compliance; providing stability. The results of other studies are parallel to this one (Boucharas, et al., 2010; Kappelman, McGinnis, Pettite, & Sidorova, 2008; Lange, 2012; Niemi, 2006). Very few studies actually define the benefits explicitly, making it difficult to comprehend where the benefits stem from, or what their mutual interrelationships are.

Moreover, benefits realization research lacks large scale empirical evidence. Tamm, et al. (2011) reviewed 50 studies out of which only six provided empirical data. This can be explained by the focus on the hypothetical or potential benefits of EA but not on the concretized benefits (Kappelman, et al., 2008; Tamm, et al., 2011). Recently, studies have started to address actual benefits. They however do not clarify the mechanisms of how the benefits are realized (Aier, et al., 2011; Lagerström, et al., 2011). Consequently, the benefits are not only difficult to measure but also, associating them explicitly with EA is a challenge (Rodrigues & Amaral, 2010; Wan, Johansson, Luo, & Carlsson, 2013).

EA scenarios are also related to EA benefit measurement. Scenario evaluation considers the impact of architectural choices or scenarios made in the definition of the target state architecture on their implementation. This assists the selection of the target state architecture according to certain criteria, such as maintainability, performance or usability (Babar, Zhu, & Jeffery, 2004). However, it has not been validated whether the criteria were actually materialized when the architecture was implemented.

It has been argued that the organization's level of EA maturity is related to the realization of its benefits (Ross & Weill, 2005). EA maturity models provide a tool for measuring the overall quality or effectiveness of the EA practice (van Steenbergen, 2011; Ylimäki, 2007). However, even though a positive causality between EA maturity and EA benefits has been suggested (Lagerström, et al., 2011; Rodrigues & Amaral, 2010; Ross & Weill, 2005), maturity models do not directly measure the benefits received from EA or specify where the benefits actually arise from.

It seems difficult to form a consistent view of EA benefits, their interrelationships and potential sources. EA benefits cannot be understood by merely considering the different impacts of EA because of its extensive scope and complex nature. Neither do maturity evaluation or EA scenario analysis offer sufficient tools for understanding how the benefits are realized. This calls for deeper understanding of the constructs and dimensions that have an impact on EA benefit realization.

EA Benefit Realization Models

EA benefit realization is often seen as a simple process where only the direct relationships between theoretical constructs having an impact on benefits and the constructs representing the realized benefits are considered (Aier, et al., 2011; Lagerström, et al., 2011; van der Raadt, 2011; Slot, 2010; van Steenbergen, et al., 2011). The benefits may also be realized indirectly through one or more intermediary constructs, such as EA use or implementation (Aier, 2014; Boh & Yellin, 2007; Foorthuis, et al., 2010; Lange, 2012; Tamm, et al., 2011). EA benefit realization is thus a complex, multi-phased process. This suggests that EA benefits are realized through an impact chain of three or more constructs (Lange, 2012; Lux, et al., 2010; Niemi & Pekkola, 2009; van Steenbergen & Brinkkemper, 2008; Tamm, et al., 2011). This resembles benefit realization in the IS discipline (DeLone & McLean, 2003). Some models also assume that the benefits themselves have causal relationships with one another. They thus form chains of intertwined benefit constructs (Boucharas, et al., 2010; Lux, et al., 2010; Schmidt & Buxmann, 2011; van Steenbergen & Brinkkemper, 2008; Tamm, et al., 2011).

Different constructs describe EA benefit realization. They build on various theoretical backgrounds, constituting varying sets of different constructs and interrelationships, and different points of foci. For example, the foci ranges from the impacts of EA processes to EA benefits (Kamogawa & Okada, 2005; Lagerström, et al., 2011; van der Raadt, 2011), and EA products and their utilization (Ring, 2009) to presentation strategies and governance formalization, (Dietzsch, et al., 2006) and specific EA products, such as EA standards (Boh & Yellin, 2007), EA principles (Aier, 2014) and project architecture (Slot, 2010). Similarly, interrelationships vary from the ones between the benefits and non-benefit constructs only, (Schmidt & Buxmann, 2011) to those between the non-benefit constructs (Aier, 2014; Boh & Yellin, 2007; Foorthuis, et al., 2010; Lange, 2012; Tamm, et al., 2011). The models also differ in terms of contexts, such as project EA conformance (Foorthuis, et al., 2010) and EA's effect on IS capabilities (Lux, et al., 2010), and of specific categories of benefits, such as IT benefits (Lagerström, et al., 2011; Schmidt & Buxmann, 2011). Some studies also differentiate between benefits (direct benefits) that arise directly from EA and benefits (indirect benefits) that can only be achieved through the realization of EA plans (Tamm, et al., 2011). Different benefit realization models are presented after the case study which provides the criteria for their analysis.

The Case and Research Methods

Case Organization

The study was conducted as a single qualitative case study (Stake, 2000; Walsham, 1995). The case organization is a large Finnish public sector organization, which has undertaken EA work for over eight years. Governed by a centralized group administration, the organization has several fairly independent lines of business (LoBs). At a given time, the organization has a multitude of development initiatives underway; they are governed by typical corporate governance processes such as portfolio management, project[1] management, procurement and IT governance in addition to EA.

The case organization utilizes EA to concretize strategic plans into high-level EA blueprints, set architectural guidelines for development initiatives, guide individual projects in conforming to EA, and assure sufficient quality of the project architecture. Guided by an established EA framework and methodology, the EA work is carried out by a semi-centralized EA team on multiple architectural levels: EA, reference architecture, LoB architecture, project architecture, and implementation architecture. The central EA team is responsible for EA, reference architecture and LoB architecture, which are mainly used to set direction for development at a high level. Project architecture and implementation architecture are defined in individual development projects and constitute a detailed view of the particular project and its dependencies on the overall EA.

At the time of the study, the organization had established EA work in terms of defining the framework, methodology, roles and objectives seven years earlier. For the most part, the architects had been assigned and the owners named for the EA viewpoints. Even though the architects in the central EA team were full-time ones, most architects were not as they also had extensive line and project responsibilities. Thus, the EA methodology and the role descriptions was not fully realized in practice. Also, the ownership of systems portfolio and conceptual data model were unclear. Even though the lack of resources in EA work was often seen as a major problem, the EA organization structure and methodology were also regarded as overly heavy. As a consequence, there were plans on streamlining and rationalizing the EA organization and methodology.

EA was somewhat separate from the other planning and governance methods. Although EA uses the products of strategy and business planning when creating its products, there was no formal two-way interface between the functions. Also, on the project level, EA was not formally linked to requirements management (cf. TOGAF). However, in both of these areas, development projects were underway.

The projects were required to adhere to a number of governance methods, including EA. They were also required to create a project architecture description, which was then formally reviewed at certain project phases. Even though instructions and templates were available, they were seen as demanding and resource-consuming tasks. The main challenge seemed to be that the governance methods partly

[1] We use the term *project* to refer to both projects and programs.

overlapped; similar information was required from the projects in different formats, causing extra burden.

The architects carried out EA modeling with a proprietary EA modeling tool. This was the repository for “official” EA products. In addition, normal office tools were utilized within projects and the business. For communicating outside the architect community, EA models were extracted from the EA tool into reports, presentation materials, and other documents. Generally, using the repository-based tool was perceived to be challenging. Only the most experienced architects appreciated it.

The EA framework was customized for the organization from a widely used, more generic framework. EA work methodology was also completely customized. EA work was not formally measured.

At the time of the study, the first versions of the EA documentation, such as EA, reference architecture, and several LoB architectures were already completed. Also some project architectures had been finished in some larger projects. They had received some EA support, which was often welcomed and received with pleasure, but the scope had been narrow because of resource constraints. Sometimes, the project members either had not been aware of the available services or had not wanted the EA involvement because of dread for complexity and extra work. Technical and modeling experts were few and loaded with support requests. A consulting partner was used to carry out specific EA tasks, mostly modeling and methodology development.

Centralized EA architects were typical users of EA results. They were used as source material and support for creating new EA products (e.g. LoB architecture models). In addition to this, EA results were most often used in projects. For that purpose, the use focused on creating the project architecture and on supporting the systems analysis. It was assumed that an architect was available to support the projects. The need was emphasized since using the EA target state descriptions as a basis for development was the most effective means of steering the organization towards the target state.

Research Methods

The first author followed the situation in the case organization for two years as an external consultant before the study took place. It was therefore estimated that the organization’s EA capability was appropriate to provide adequate data for the EA benefit realization process.

The data was collected by the first author through 14 semi-structured theme interviews. Initially, a set of five interviewees were handpicked from the organization: the centralized EA team, all the main business units, and major ongoing projects. Then snowball sampling was used to identify the rest of the respondents; every interview was concluded with a question seeking the interviewee to suggest two additional persons to be also interviewed. Data collection continued until theoretical saturation was reached (Eisenhardt, 1989). The interviewees and their characteristics are presented in Table 1.

Moreover, documentation on the EA framework, methodologies and organization in general were used for understanding the application of the EA approach in the organization. Different types of EA products were also studied, such as models in the EA tool and documents (reports) in office tool formats. These were mostly enterprise-level architecture documentation. EA products customized for a specific situation or project were not included.

The interviews followed the narrative interview method (Jovchelovitch & Bauer, 2000), focusing on concrete examples as “stories”. DeLone and McLean IS success model inspired us in formulating the topics for the theme interview (see Appendix A).

The themes are in line with the theoretical foundations of our study, but they were not used as an *a priori* model *per se*. Rather, they enabled us to focus on the quality, use, user satisfaction and benefits of EA products and services. Each theme was approached by first requesting an example and then asking clarifying questions: what’s, why’s and how’s.

The phone interviews[2], which were conducted between October 2011 and January 2012 lasted from 35 to 82 minutes; an average of 57 minutes, totaling 12.4 hours. They were audio-recorded and transcribed. Detailed notes were also taken to facilitate data analysis and to identify relevant issues for subsequent interviews.

Data coding and analysis were carried out by the first author following the interpretive research approach (Klein & Myers, 1999; Walsham, 1995)[3], where the findings emerge from the data, so that a wide-ranging view on the EA benefit realization process can be gained rather than one limited to just the application of the DeLone and McLean model or other models.

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[2] One interview was done face-to-face.

[3] This resembles Strausian grounded theory (Corbin & Strauss, 1994), but as the interviews were inspired and consequently influenced by the IS success model, we would not like to refer our study as a grounded theory study.

Table 1. Interviewees and their characteristics

Interviewee	Work Role	Level	EA Team
Architect A	Technical-Functional Architect	LoB	Central
Architect B	Domain Architect	EA	Central
Specialist C	EA Framework Specialist	LoB	Central
Specialist D	Lifecycle Management Specialist	LoB	Decentralized
Project Manager E	Project Manager	Project	N.A.
Line Manager F	Line Manager, specialist in a project	Project	Decentralized
CIO G	Head of Information Systems	LoB	Decentralized
Project Manager H	Project Manager	Project	N.A.
Development Manager I	Development Manager	EA	Central
Architect J	Technical Architect	LoB	Central
Program Manager K	Program Manager	Project	N.A.
Project Manager L	Project Manager	Project	N.A.
Architect M	Functional Architect	LoB	Central
Architect N	Architect	LoB	Central

The second author independently checked the data coding and analysis to ensure correct interpretation.

Table 2 defines the terms related to data coding and analysis. Table 3 illustrates the coding process by providing examples of the coding categories. The transcripts were first coded by using the interview themes as the initial coding categories. During the analysis, additional coding categories emerged. Then the data was reanalyzed in order to identify the dimensions and interrelationships impacting EA benefit realization. This was achieved by first classifying each data fragment on the basis of whether it described a dimension and/or an interrelationship. Identical data sets describing dimensions were iteratively grouped together and named descriptively. The coding resulted to 581 individual coded data fragments.

Third, the sets of dimensions were reanalyzed to identify different constructs impacting benefit realization. Based on the coding categories (association), the dimensions were grouped into constructs. EA process, EA governance model, and EA tool categories were merged, as were environment/culture, organization, LoBs and stakeholders categories. This analysis resulted in six constructs presented in Table 4. In the Table, the EA Benefits construct is already divided into three constructs as described in the next paragraph.

Finally, interrelationships (impacts) were analyzed. Each data fragment was mapped to a pair of dimensions as their interrelationship. Also, the direction was identified. If an interrelationship could not be mapped to a specific dimension, as in the case of insufficiently detailed data, mapping to the corresponding construct was allowed. These interrelationships were mostly related to EA use. At this point, the benefit dimensions were divided into three constructs on the basis of their interrelationships, totaling eight constructs altogether. A graph illustrating the constructs, dimensions and interrelationships that emerged from the data was drawn accordingly (see Figure 1 for a simplified presentation).

Finally, the findings were sent to a key informant in the case organization for review with no major comments.

All this resulted in a data-driven model to be used in understanding EA benefit realization.

Findings

The analysis provided definitions for eight independent constructs. Moreover, 51 descriptive dimensions of the constructs were identified. Table 4 defines the constructs with descriptive quotes from the interviews. The definitions have been adapted from DeLone & McLean (2003). Table 5 presents the constructs' dimensions and the number of their instantiations[4] in the data.

Detailed analysis revealed 695 distinct interrelationships between the dimensions of the constructs. The dimensions of EA Process Quality,

[4] Number of instantiations refers to the number of data fragments in which the dimension is mentioned. Thus, 14 interviews can lead to hundreds of instantiations of a particular dimension.

EA Results Use and EA Social Environment turned out to be intermingled and mutually dependent as they are related to over 20 dimensions in up to six other constructs.

The constructs, interrelationships and dimensions that emerged from the data are depicted in Figure 1. In the Figure, the number of the interrelationships represent the number of instantiations of the particular dimension in the interview data. The codes refer to the dimensions impacting on the interrelationship. The interrelationships between the dimensions of the same construct (three within EA Process Quality and one within EA Social Environment) are not depicted in the Figure.

Next, we will discuss the interrelationships from each construct in details as they emerged from the data.

On EA Process Quality

The EA Process Quality construct covers the creation, maintenance and governance of EA documentation. This construct influences six other constructs: EA Product Quality, EA Service Quality, EA Results Use, First Level Benefits, Second Level Benefits and EA Social Environment.

Having high-quality (as defined by the dimensions of EA Process Quality), EA processes in place supports the creation of high-quality EA results (i.e. EA products and services). All the dimensions of EA Process Quality (with the exception of EA process task timing) seem to influence either or both EA Product and Service Quality. For example, the quality of the EA modeling tool, EA framework, and documentation practices are crucial antecedents for the quality of the resulting EA products. Architect A said that the framework itself is important as it *"…unifies and simplifies documentation"*. Architect N saw the framework and other architecture instructions as potentially improving the quality of EA products created by external partners.

Table 2. Terms used in the data coding and analysis

Term	Definition
Interview theme / Initial coding category	A coding category that directly represents the themes from the interview protocol (Appendix A). Data was first coded according to the interview themes.
Coding category	An individual code used to classify (code) the interview data (i.e. data fragments). Coding categories include all interview themes (i.e. initial coding categories), additional coding categories, constructs, dimensions, and interrelationships. Thus, they can be of different levels of abstraction.
Additional coding category	A new coding category that arose from the initial data analysis and coding. These included EA process, EA governance model, EA tool, environment/culture, organization, LoBs and stakeholders.
Data fragment	A piece of interview data, typically a few sentences long. Data fragment is coded to a certain coding category or categories. As a result, one data fragment can refer to several constructs, dimensions and/or interrelationships. One interview can result in dozens of data fragments and one interview quote can include several data fragments.
Construct	A high-level causal factor that takes part in the EA benefit realization process. EA Benefit constructs represent the resulting set of benefits from the process.
Dimension	A causal factor (attribute) that describes a specific construct. In the case of EA Benefit constructs, dimensions are individual EA benefits.
Interrelationship	A causal relationship (impact) between two dimensions or constructs, with a set direction. Interrelationships between the dimensions of a specific pair of constructs can be abstracted as an interrelationship between the constructs.

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Table 3. Examples of coding categories used in data analysis

Interview themes and additional coding categories	Construct categories	Dimension categories	Example from the interviews
Code	**Code**	**Code**	
EA product quality	EA Product Quality	Availability	“[The reference architectures] have been in draft state, their definition has been pretty weak, so in a sense they could not have been used as a reference.” [Architect A]
		Granularity	“[An EA product] should have the granularity required by the user…” [Line Manager F]
EA product use EA service use	EA Results Use	Motives of use	“… and especially, there were other programs that had distinct interfaces to our program, and they had finished architecture descriptions, which we utilized as well [in describing our program architecture].” [Program Manager K]
		EA results used	“… in this framework, I especially like the system architecture… it is very useful in describing the functionality, interfaces and communication…” [Line Manager F]
EA product user satisfaction and benefits EA service user satisfaction and benefits	First Level Benefits	Provide overview	“… should understand the big picture and how things relate to one another… personally these overall views helped tremendously and why not should they also be beneficial on a larger scale.” [Architect J]
		Improve alignment	“… that [a new project] would truly be integrated to the whole by utilizing architecture, by identifying mandatory guiding architecture documentation.” [Project Manager L]
		Improve decision-making	“I think that without [the functional architecture descriptions] we have made along the way, it would be pretty hard for the decision-maker to understand how this goes… with the finished descriptions, the matter was clarified pretty quickly… and we reached a decision favorable for us.” [Architect J]
	Second Level Benefits	Speed up project initialization	“… [EA] defines the selected products and tools, so one can say that these are used, period. I find it good, it speeds up the process…” [Architect N]

Interrelationship categories

Code (examples)	Example from the interviews
EA Process Quality (EA framework quality) -> EA Product Quality (Cohesion)	“…if we think of an [EA] product made according to an architecture framework, it is superior in a way that… it is an unbroken and consistent whole…” [Specialist D]
EA Process Quality (EA modeling tool quality) -> First Level Benefits (Identify dependencies)	“… what I like about [the EA modeling tool] is that it builds the whole, that the links exist… it can show the logic on many levels; if we had only documents we would miss the interrelationships” [Architect N]

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EA Process Quality (Stakeholder participation) -> EA Product Quality (Correctness) EA Results Use (EA results, Motives, Stakeholders) -> EA Product Quality (Correctness)	"Well, it was produced in a way, that we have these different architectures, domain architectures and system architectures and enterprise architecture, and from them a service view was created with the consultant partner, and properly speaking, the owners of services and architectures did not take part in it, so it is probably even erroneous…" [Architect A]
EA Product Quality (Granularity) -> EA Results Use (EA results, Motives)	"…I open these architectural views and then check if there are relevant ones [to use in domain architecture support], particularly the high-level views are those that are relevant…" [Architect B]

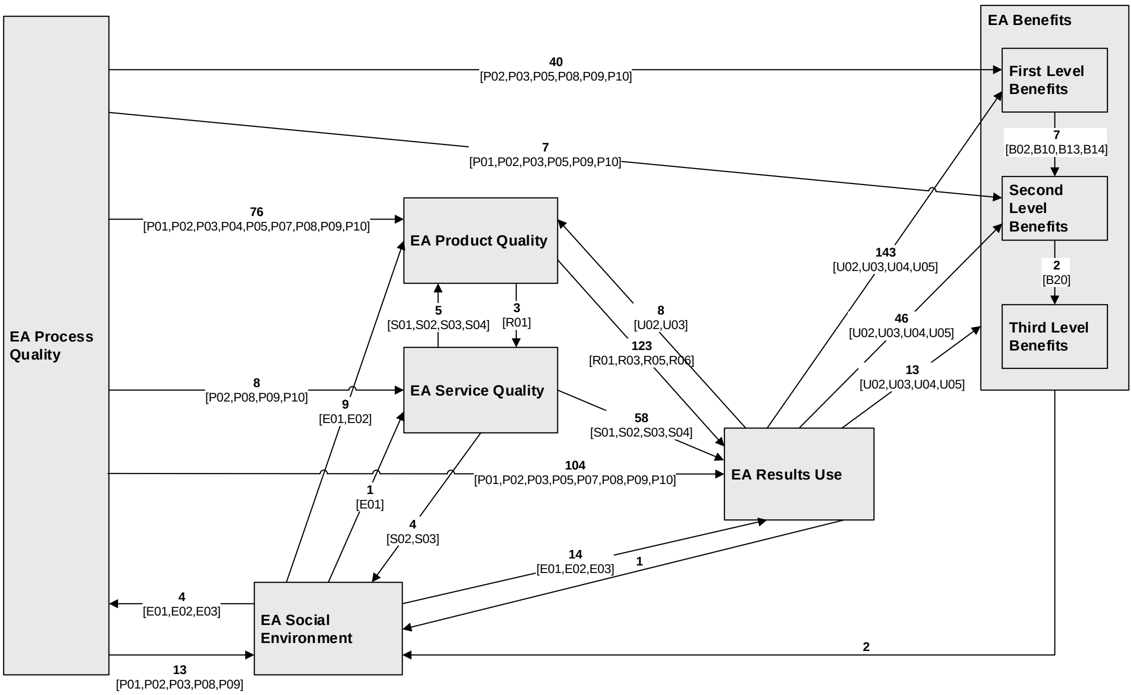

Figure 1. Interacting constructs in the EA benefit realization process (the dimensions and their codes are listed in Table 5)[5]

[5] For two interrelationships, a code is not marked as specific impacting dimension(s) could not be identified, though it was clear which constructs impact on these interrelationships.

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Table 4. Construct definitions and examples from the interviews

Construct	Definition	Examples from the interviews
EA Process Quality	Measures of EA processes, methodology, tools and organization.	"…what is the purpose of architecture and what is being pursued by it… it should be clear to the ones creating architecture" [Architect N] "… that [EA] would truly support project work and would not overlap with project planning and other governance methods" [Project Manager E]
EA Product Quality	Measures of EA products.	"the most important thing is that the products of the [EA team] would be easily available to users" [Project Manager H] "architecture should never exist only for the sake of architecture…" [Architect B]
EA Service Quality	Measures of EA services.	"when a program starts… there should always be someone interested and immediately guiding it" [Project Manager L] "high quality architecture services and their products should serve the users, should be produced in a timely manner and be maintained and updated." [Architect A]
EA Results Use	Consumption of the output of EA processes (i.e. EA results) by EA stakeholders.	"when we begin to further develop a system, we can use the existing descriptions" [Architect N] "… I open specific views and check if there are relevant ones [for supporting the project]. Mostly the high-level ones are relevant, and on the other hand if earlier domain architecture descriptions exist, we get underway with these…" [Architect B]
First Level Benefits	Effects of EA that arise directly from the EA processes.	"[the architecture definition instructions] support the manageability of the project because they not only tell what needs to be done from the governance point of view, but also describe what substance needs to be completed" [Architect B] "… getting to know a system, architectural descriptions are a pretty good approach to get to know a new area" [Architect A]
Second Level Benefits	Effects of EA that arise (depending on the situation) either directly from the EA processes or as a result of the First Level Benefits.	"… there should be an integration description… If it does not exist, we have to start digging very deep to get this information" [Project Manager H] "… we should now be able to use the architecture description at the point where we are acquiring new capabilities and such, that they integrate to the existing system… that we get [system integrations] to work without pretty difficult black box arrangements…" [Line Manager F]
Third Level Benefits	Effects of EA that arise as a result of the Second Level Benefits.	"…the architecture should impact the project in the very beginning… starting from the requirements analysis… as we are currently in the first pilot implementation, adding or changing any requirements at this point would cost hundreds of thousands or even millions, regardless of how small they are…" [Architect J]
EA Social Environment	Organizational factors external to the EA undertaking that have an effect on the EA benefit realization process.	"common approval [of the EA framework and processes] is crucial" [Architect B] "I think it is because the top program management does not understand the benefits of organized, phased architecture planning" [Development Manager I]

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Table 5. Construct dimensions impacting EA benefit realization

Construct	Dimensions	Number of instantiations[4]
EA Process Quality	P01 Clear EA scope and purpose	9
	P02 Cohesion with other governance methods	61
	P03 EA framework quality	45
	P04 EA modeling conventions	2
	P05 EA modeling tool quality	34
	P06 EA process task timing	6
	P07 Non-architecture source material quality	12
	P08 Resource availability	64
	P09 Stakeholder participation	15
	P10 Support documentation quality	29
EA Product Quality	R01 Availability	25
	R02 Clarity	3
	R03 Cohesion and uniformity	6
	R04 Correctness	10
	R05 Granularity	16
	R06 Usefulness	8
EA Service Quality	S01 Activeness	5
	S02 Availability	17
	S03 Competence	3
	S04 Usefulness	12
EA Results Use	U01 Amount of use	9
	U02 EA results used	115
	U03 Motives of use	109
	U04 Stakeholders	38
	U05 Timing of use	13
	U06 User satisfaction	2
First Level Benefits	B01 Allow project to proceed	4
	B02 Identify dependencies	25
	B03 Improve alignment	7
	B04 Improve implemented solutions	3
	B05 Improve project governance	4
	B06 Improve project management	5
	B07 Improve service management	1
	B08 Increase understanding / new insight	2
	B09 Provide answers quickly	1
	B10 Provide common vocabulary	9
	B11 Provide example	9
	B12 Provide guiding framework	13
	B13 Provide overview	18
	B14 Provide standards	16
	B15 Reduce duplication	4
	B16 Reduce workload in EA work	1
Second Level Benefits	B17 Improve decision-making	4
	B18 Increase interoperability between solutions	5
	B19 Increase standardization in solution portfolio	2
	B20 Provide requirements and restrictions	20
	B21 Speed up project initialization	4
Third Level Benefits	B22 Decrease IT costs	2
EA Social Environment	E01 Common approval and understanding of EA	31
	E02 Top management commitment	3
	E03 Understanding of EA work in other organizations	1

Also, stakeholder participation in the creation of EA documentation endorses richer and more correct views on the part of the described enterprise in contrast to the situations where only documentation is used. For example, a certain EA view was considered to exhibit poor quality as it was created by just utilizing documentation without consulting the business owners.

Similarly *“adequate resourcing would make a high-quality service possible”* (Architect M) and designated project or program architect would improve the architecture planning in projects. Consequently, the availability of adequate architecture resources influences EA Results Quality and the realization of First Level Benefits.

All of the EA Results Use dimensions were affected by EA Process Quality. Yet there seem to be six different mechanisms working in this interrelationship. First, having clear scope and purpose for EA in general facilitates EA use, especially by providing pragmatic guidelines for EA utilization. For example, Specialist D observed that it is important to define

“…what the scope of architecture application is, where it is applied and where it is not…”.

Second, cohesion with other governance methods creates more EA product use as the stakeholders are not overwhelmed by the amount of redundant documentation required by the methods. In other words, they are motivated to use EA for real benefits instead of a necessity. Development Manager I brought out a potential solution for this: *“[EA governance] should be synchronized with program management, requirements management and IT governance, so that [they] support each other in parallel, not successively.”*

Third, the quality of the EA framework and other support documentation also impacted use. Obviously, the diffusion and availability of guiding documentation has an effect on how and what EA results are used and by whom. Also, the acceptance and usability of these guidelines in practice had an effect on stakeholder’s willingness to use EA results and the resulting user satisfaction. For example, Project Manager E was satisfied with the instructions on how to utilize the EA framework in creating project architecture. The impact on the benefits can be immediate or long-term. Specialist C disclosed an example of benefits incurred over time: *“... architecture is created in programs, so now with this EA framework it would be possible to consolidate solutions and get interfaces in control...”*

Fourth, the quality of the EA tool allows the use of existing EA documentation, stored in the tool, in a variety of use situations (i.e. motives of use) by more stakeholders. The use can then also involve more types of products. Architect N articulated this by saying that a user-friendly reporting tool can be utilized in collecting relevant EA products as source material for a project. This potentially increases their use in the projects.

Fifth, non-architecture source material (such as business requirements and conceptual business descriptions) is widely used in EA product use situations, influencing the use.

Finally, the resourcing of EA work and participation of EA stakeholders had an impact on the extent of use: the motives, the EA results and (obviously) the stakeholders. For example, the effect of skills on creating project architecture was highlighted: *“…[identifying requirements and standards from EA] has to be done by those adept in EA, so probably the program or project manager is not able to do it…”* [Architect J].

EA Process Quality also influences the realization of First and Second Level Benefits. There appear to be four mechanisms behind this interrelationship. First, the documentation used in the EA processes provides intrinsically a framework for steering the architecture work, for example on the project level.

Second, the quality of the EA tool (e.g. usability and modeling features) seems to influence the derivation of useful information from the existing EA products. For example, both Architect A and Development Manager I considered the modeling tool’s capability to model and present dependencies between different models and their elements to have a direct impact on the potential to derive useful information from the EA products allowing the analysis of interdependencies between the systems and processes.

Third, the participation of EA stakeholders in the EA processes may in itself provide the stakeholders with increased knowledge of the enterprise. For example, Architect J stressed the importance of having a sufficiently large group for identifying requirements for project architecture.

Fourth, the availability of resources had an impact on benefits; for example, Architect N considered adequate resourcing for project architecture crucial for the manageability of the project.

Regarding EA Social Environment, several dimensions of EA Process Quality seem to improve common approval and understanding of EA. For example, similar to the effect on EA Results Use, Cohesion with other governance methods impacts stakeholder willingness to utilize EA: *“if, for every [governance mechanism], you have to consider the same things over and over again, the motivation* *starts to erode when you finally have reached EA governance [stage]"* [Project Manager E]. Also, the clearness of communication and appropriate skills are seen as means of increasing knowledge on EA and reducing resistance to change.

Interrelationships within the EA Process Quality dimensions include EA framework quality, Cohesion with other governance methods. They have an effect on EA process task timing because they determine when certain EA products are produced and used. Moreover, as the project architects may be tied up with interfacing with other governance methods besides EA, cohesion with other governance methods also influences resource availability.

On EA Product Quality

EA Product Quality had a relatively straightforward interrelationship with EA Results Use. Having more high-quality EA products initiates more extensive use. Obviously, the availability of EA products had an impact on what products can be used, by whom, and when. Also, the cohesion and granularity of EA products had an effect. Yet the favored domains and level of granularity of EA products varied between the stakeholders: *"…while abstract functional architecture descriptions are valued above the project level, individual projects are particularly interested in detailed technical views that cover what, with which product, and with which configuration [the implementation] needs to be done"* [Architect J]. This had an effect on which situations the available EA products are useful: *"[the EA description] was on a pretty different level, because in this program we went to a concrete level… that is why it only gave a sort of framework for our work"* [Program Manager K].

EA Product Quality also had an impact on EA Service Quality. This is explained by the use of EA products as examples and other source materials in providing EA services. Thus, EA service quality is affected by whether the right EA products are available or not.

On EA Service Quality

The effect of EA Service Quality on EA Results Use is similar to that of EA Product Quality. All dimensions of EA Service Quality impacted on EA Results Use. Obviously, the availability and awareness of services has an effect on their successful use. Also, activeness had an impact since stakeholders are not necessarily knowledgeable on the available EA services. According to Development Manager I, *"it does not work out that services are only requested from me; I have to actively offer them"*.

The quality of EA services also had a special impact on the timing of its use: offering EA services actively, influences the use of EA documentation early in a project, enabling it to have more impact on the project architecture.

EA Service Quality also had a mutual impact on EA Product Quality. For example, the effectiveness of project EA governance had an effect on project architecture quality, especially its cohesion and uniformity.

EA Service Quality was perceived to have an impact on EA Social Environment. If the centralized EA team takes the burden of EA description from the EA stakeholders (e.g. projects), common approval and understanding of EA increases. As Line Manager F put it: *"I understand that if we want to maintain the EA system, it is necessary to collect information and create these descriptions, otherwise it does not work; and I did not see [project architecture description] as burden as in practice the work was carried out by [the EA team]…"* [Line Manager F].

On EA Results Use

EA Results Use dimensions had impacts on both First and Second Level Benefits. This means that the benefits can arise from many kinds of use situations: from using different kinds of EA results, by various EA stakeholders, and with the right timing. All First and Second Level Benefits were impacted on by EA Results Use.

Most of the benefits arose immediately from utilizing EA products and services in projects, decision-making, and self-motivated familiarization. For example, EA products can be used to identify dependencies within existing systems and projects. This was pointed out by a technical architect: *"by utilizing the architectural descriptions of the neighboring projects, but also by crafting our own views, we noticed that we still need to discuss some issues with neighboring projects"* [Program Manager K]. EA products were also used in familiarizing oneself with domain architecture and in identifying the dependencies between the sub-systems. It was quickly discovered that they were extensively dependent on each other and on the business processes.

Also, specific EA products were mentioned regarding benefits from their use: *"…technical architecture is the document that I start searching for, when I receive a requirement for integrating some systems, for example… for in some way getting to know what the system means, or what it contains"*. [Project Manager H]. Again, the EA results used should be appropriate for the stakeholders using them to reach the objectives.

The timing of use had an effect on what benefits can be realized. For example, project architecture work should be started early so as to benefit from the overview and knowledge on requirements, restrictions and dependencies provided by EA: *“if we had started the project architecture work in the brainstorming phase, we would have perhaps received much more benefits from it”* [Program Manager K]. If the EA results are introduced early enough, project initialization can be expedited. Particularly, EA results can provide ready-to-use standards by which work-intensive technology evaluations can be avoided [Architect J].

Secondly, some benefits arose indirectly from EA Results Use; by utilizing EA results, interoperability between solutions and standardization can be improved. In the words of Specialist D: *“I have encountered problems related to system interoperability, whose existence indicates that EA guidance has not worked… there should always be a guiding architecture on every level, which would give certain requirements and restrictions for development”*. Line Manager F even suggested that *“many issues related to interfaces and interoperability could be alleviated and partly solved”* by utilizing EA.

In many situations, the quality of the utilized EA products and/or services had an indirect effect on the realized benefits through EA Results Use. For example, Program Manager K mentioned a situation where the granularity of a guiding architecture description did not suit the project’s needs, diminishing its value.

EA Results Use also influenced EA Social Environment. Particularly, the use of the project architecture support services had an impact on common understanding and approval of EA.

On First Level Benefits

First Level Benefits had impacts on several Second Level Benefits. All Second Level Benefits were also impacted, in other situations, by EA Process Quality and/or EA Results Use. As mentioned before regarding EA Results Use, the use of architecture standards can speed up project initialization and increase standardization. A good overview of systems can improve decision-making. Finally, using EA as a tool for unified communication can ensure that procured interfaces will work as planned.

On Second Level Benefits

Only one dimension of Third Level Benefits (Decrease IT costs) was identified and influenced by EA’s ability to provide requirements and restrictions. As observed by Architect J, *“if [EA] has not been able to influence a project in the requirements analysis… there the larger problems arise… it is more expensive, if even impossible, to make changes later”.*

On EA Benefits

One interrelationship from EA Benefits to EA Social Environment was identified. This was related to benefits in general, not to any individual benefit: if EA is considered beneficial by stakeholders, common understanding, approval, and acceptance of EA increase. If stakeholders do not perceive EA as beneficial, this may lead top management to lighten EA governance. This may in turn lessen the EA future benefits due to EA’s decreased impact on projects.

On EA Social Environment

EA Social Environment was related to EA Process Quality, EA Product and Service Quality, and EA Results Use. Top management commitment had impacts on EA Process Quality, EA Product Quality and EA Results Use. For example, Development Manager I believed that *“if the topmost program management does not fully understand architecture work, they do not demand it, and as a result the middle management in the program does not implement it”*. This affects both EA Product Quality and EA Results Use, especially at the project level, as they are dependent on the prioritization of EA work.

Top management commitment to EA also affected availability of resources. A project manager suggested that *“the degree of appreciation towards [an organizational function] can be clearly deduced from the amount of resources the management assigns to it”* [Project Manager H]. Top management commitment also had an impact on common approval and understanding of EA, within the EA Social Environment construct.

Common understanding and approval of EA had effects on EA Results Use and on EA Product and Service Quality. For example, according to Development Manager I, if EA stakeholders are not aware of EA services and their benefits, the EA team needs to actively offer services to them (impacting Activeness as part of EA Service Quality). The effect is similar on EA Results Use; it is obviously less extensive if stakeholders are not aware of available EA results. The stakeholders’ understanding of EA and their willingness to invest in producing EA products have a direct effect on EA Product Quality dimensions, such as granularity. Overall routinization of EA work in the organization also has an impact on the extent of EA use.

Finally, benchmarking EA work in other organizations can improve EA Process Quality.

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Related EA Models

We conducted a review[6] of EA benefit realization literature to uncover the models relevant for the analysis. The analysis was done by utilizing our case study findings as criteria.

First, the models should cover preferably as many constructs as in our model. Second, the models should include interrelationships between constructs, some of them illustrating the impact of certain constructs on realized EA benefits. According to our view, these criteria capture the multidimensional nature of EA and the incremental nature of the EA benefit realization process (Lankhorst, 2012). The models should also be generic in terms of benefits and contexts, and empirically validated.

The selected models, and their constructs and interrelationships are depicted in Figure 2. There, the constructs (columns) originate from our model. As suggested by some studies (Aier, 2014; Boucharas, et al., 2010; Schmidt & Buxmann, 2011; Tamm, et al., 2011), Organizational Characteristics are included as a construct even though they are not present in our model.

We excluded some studies due to the following reasons: 1) not proposing a model *per se* (with constructs and interrelationships) (Kamogawa & Okada, 2005; Kappelman, et al., 2008; Niemi, 2006; van der Raadt, 2011; Ring, 2009; Ross & Weill, 2005; Slot, 2010), 2) having only a few constructs (Dietzsch, et al., 2006; Lagerström, et al., 2011), 3) not addressing interrelationships (Boucharas, et al., 2010; Niemi & Pekkola, 2009), and 4) addressing factors for the success of EA but not explicitly addressing the benefit realization (Aier & Weiss, 2012; Hauder, Roth, & Matthes, 2013; Ylimäki, 2006).

We included the model by Tamm, et al. (2011) even though it is not empirically validated. Several models (Aier, 2014; Boh & Yellin, 2007; Foorthuis, et al., 2010; Lux, et al., 2010; Schmidt & Buxmann, 2011) were included even though they were somewhat limited in context and/or types of benefits covered. The IS success model (DeLone & McLean, 2003) is also included for comparison—as inspired by Lange (2012) and Niemi and Pekkola (2009).

The Models

EA process quality factors are considered as a part of the EA benefit realization process. The quality of EA results (EA products and services) in the process is also included. In many models, these categories are bundled into one construct referred to as EA quality (Tamm, et al., 2011), EA approach (Foorthuis, van Steenbergen, Brinkkemper, & Bruls, 2015) or EA management related resources (Lux, et al., 2010). However, the models differ significantly in their focus and level of detail. While Lange (2012) covered a large number of attributes for EA process, product and service quality, some did not consider EA services (Lux, et al., 2010; Tamm, et al., 2011) or discussed them only in a superficial manner (van Steenbergen & Brinkkemper (2008).

Similarly, the models consider the use of EA results, although the focus varies. For example, Lange (2012) refers to the use of EA management (EAM), including EA products, services, processes, organization and culture, but not the use of EA results per se. EA Results Use may also be related to EA capabilities (Lux, et al., 2010). The connection between the effects of use, such as information availability and complementary resources, and EA quality has been studied (Tamm, et al., 2011). This means that EA Results Use is implicitly presented in the interrelationships between EA quality and benefit enablers. Still, some studies refer to concrete EA Results Use situations, such as compliance reviews and project support for ensuring project compliance to EA (Foorthuis, et al., 2010, 2015).

Social, cultural and organizational issues, such as organizational culture and the organization's understanding of EA and its foundations, have impacts on the process (Aier, 2014; Lange, 2012; Tamm, et al., 2011). Still, only a few models (Aier, 2014; Lange, 2012) include these factors as distinct constructs. Tamm, et al. (2011) see them as a part of the EA quality construct.

The models provide different views on how EA benefits emerge. For example, Tamm, et al. (2011) and Schmidt & Buxmann (2011) suggest that EA benefits arise from high-quality EA processes, from the well-governed use of EA products, and from utilizing the improved operating platform implemented according to EA.

[6] The review focused on IS journals such as MISQ, DATA BASE and EJIS. In addition, search was conducted on Google Scholar. Search terms such as Enterprise Architecture, Architecture and Architect with terms Benefit and Value were used. The initial search resulted in 123 relevant articles, from which 18 articles were proposing models for EA benefit realization. From these, 10 were selected for the analysis.

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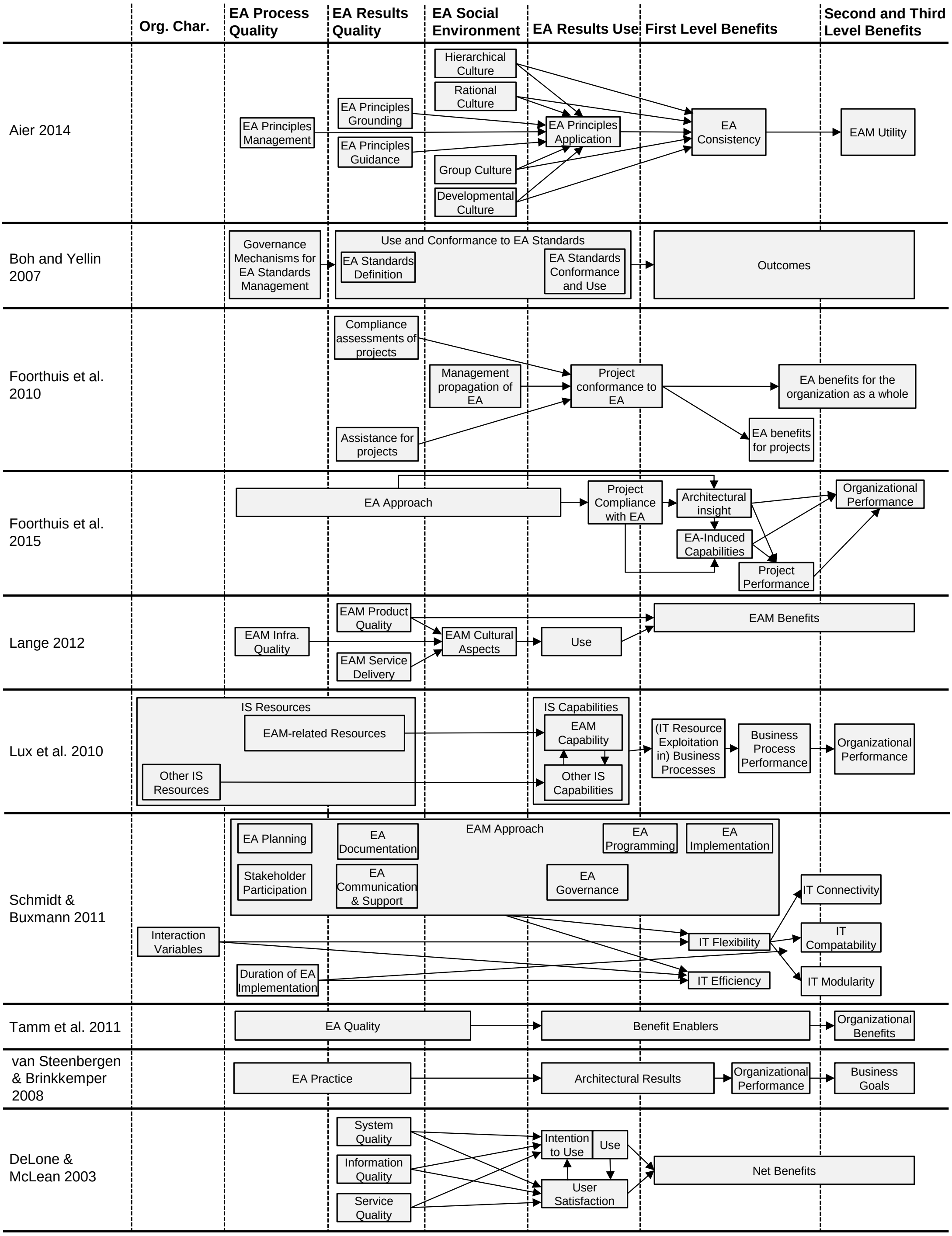

Figure 2. Synthesis of the comprehensive EA benefit realization models

Van Steenbergen & Brinkkemper (2008) suggest that EA use and implementation lead to organizational benefits. Lux, et al. (2010) see improved IT platform and consequential business process performance improvements as results of EA.

Aier (2014) found that the consistency of the operating platform results in benefits. EA use and EA-guided practices have a significant impact on the realized benefits. EA product quality directly impacts the benefits (Aier, 2014; Lange, 2012) even though it may also have an indirect role in the benefit realization process (van Steenbergen & Brinkkemper, 2008; Tamm, et al., 2011).

The role of social factors is also indirect: factors such as top management commitment to EA and stakeholder awareness and understanding of EA are crucial for bridging EA use, the quality of EA processes, products and services (Lange, 2012). This indicates that the EA's grounding in the organization supports EA's usage. It has also been suggested that organizational culture has a mediating effect on the usage of EA principles, impacting both the application of EA principles and the benefits incurred from it (Aier, 2014).

Regarding organizational characteristics, organization size and complexity, operating platform quality, operating model, and the rate of organizational change, legislation and regulations (Schmidt & Buxmann, 2011; Tamm, et al., 2011), organizational culture (Aier, 2014) and organization type (Boucharas, et al., 2010) have been suggested to impact benefit realization.

Surprisingly, EA processes are seldom suggested as sources of benefits. Schmidt & Buxmann (2011) state that EA process factors such as EA planning, EA programming (referring to rules and standards set by EA to guide change projects), EA governance, stakeholder participation and EA communication are antecedents for IT benefits. Also, Tamm, et al. (2011) refers to EA process factors such as skilled EA team, suitable management practices and stakeholder involvement. Foorthuis, et al. (2015) suggests that communication between architects and explicit linking of EA to business goals contributes to benefits.

Analyzing the Models

An analysis of EA benefit realization models by using the synthesis of earlier models (Figure 2) and our model (Figure 1) is summarized in Table 6. Although there are no exactly similar models in literature, there are several commonalities between them. Lange (2012) proposes an empirically based, complex benefit realization process covering similarly broad set of constructs, with similar granularity in dimensions. While Tamm, et al. (2011)'s model is complex and similarly extensive, it does not differentiate EA product and process quality and has limited granularity in their consideration.

Schmidt & Buxmann (2011) present a detailed complex model, although focusing merely on IT benefits. Also, Aier (2014) presents a complex model, with significantly more detailed consideration of cultural dimensions. However, the model has a narrower focus as it focuses only on EA principles. Boh & Yellin (2007) and Foorthuis, et al. (2010) models are similarly complex, but their contexts are limited to EA standards and project EA conformance. Foorthuis, et al. (2015) also developed an updated version of their model (although validated with the same data), taking the EA benefit realization process to the broader organizational context. Lux, et al. (2010) however, focus merely on EA's effect on IS capabilities. Van Steenbergen & Brinkkemper (2008) present empirical findings including interrelationships and some dimensions similar to our model, but they did not propose synthesized model from the findings. Only some models consider interrelationships between benefits (Aier, 2014; Lux, et al., 2010; Schmidt & Buxmann, 2011; van Steenbergen & Brinkkemper, 2008; Tamm, et al., 2011). Lux, et al. (2010) focused only on non-benefit constructs with limited granularity.

Regarding construct coverage, EA Product Quality, EA Process Quality, EA Results Use and EA Benefits are present in all EA models including ours. EA Service Quality is covered in only a few models (Foorthuis, et al., 2010; Lange, 2012; Lux, et al., 2010; van Steenbergen & Brinkkemper, 2008); however, its importance is emphasized in our case. Social Environment was included in a few models (Aier, 2014; Lange, 2012; Schmidt & Buxmann, 2011); it is also present in our case. Finally, Organizational Characteristics were included in a few models (Lux, et al., 2010; Schmidt & Buxmann, 2011) but are absent in our model.

There seems to be significant disparities in the analyzed models of the constructs contributing to EA Benefits. The only commonality here is EA Results Use; as in all the other studies, we found it to impact EA Benefits. We also found EA Process Quality to contribute to benefits, even though relatively few associate EA processes with benefit realization (Foorthuis, et al., 2015; Schmidt & Buxmann, 2011; Tamm, et al., 2011).

Other models have identified different contributors to EA Benefits. Similar to our model, Foorthuis, et al. (2015) did not find EA Product Quality to contribute to benefits but instead, found EA Service Quality to be a significant contributor. Still, several other models consider EA benefits to directly arise from high-quality EA results, especially EA Product Quality (Boh & Yellin, 2007; Lange, 2012; Schmidt & Buxmann, 2011). Similar to our results, Tamm, et al. (2011) and Aier (2014) found EA Social Environment to have an effect. Organizational Characteristics (such as size, structure and recent history of mergers & acquisitions) have also been identified to have a direct effect on benefits (Lux, et al., 2010; Schmidt & Buxmann, 2011), but this construct is obviously absent in our results due to the research setting.

No single model completely shares our view that EA benefits may arise from EA processes, the use of EA results, and from EA-guided practices. Other models also generally have less complex and extensive interrelationships. According to our model, EA Process Quality seems to have an extensive impact on the EA benefits. EA Process Quality not only have an impact on EA Product and Service Quality but also, directly contributes to EA Benefits (Lange, 2012; (Tamm, et al., 2011), and further to EA Results Use and EA Social Environment. This extensive impact is not present in earlier models (cf. Foorthuis, et al., 2015; Lange, 2012; Schmidt & Buxmann, 2011; Tamm, et al., 2011).

Discussion

EA Benefit Realization

EA benefit realization is a multi-phased process where numerous constructs, eight in our case, are interconnected in a complex manner. Our data-based model (Figure 3) suggests that some EA benefits are always and only realized through a chain of several interconnected constructs.

Table 6. EA benefit realization model analysis summary

EA Benefit Realization Model	Construct coverage[7]							Constructs contributing to benefits[5]						Types of benefits covered	Model context	Empirically validated
	PQ	RQ	SQ	RU	B	SE	OC	PQ	RQ	SQ	RU	SE	OC			
Our Model	●	●	●	●	●	●		●			●			Generic	Generic	Yes
Aier 2014	●	●		●	●	●					●	●		Generic	EA principles	Yes
Boh and Yellin 2007	●	●		●	●				●		●			IT benefits	EA standards	Yes
Foorthuis et al. 2010	●	●	●	●	●						●			Generic	Project EA conformance	Yes
Foorthuis et al. 2015	●	●	●	●	●			●			●			Generic	Generic	Yes
Lange 2012	●	●	●	●	●	●			●		●			Generic	Generic	Yes
Lux et al. 2010	●	●	●	●	●		●				●			Generic	Effect on IS capabilities	Yes
Schmidt & Buxmann 2011	●	●		●	●		●	●	●	●	●		●	IT benefits	Generic	Yes
Tamm et al. 2011	●	●		●	●	●		●	●		●	●		Generic	Generic	No
van Steenbergen & Brinkkemper 2008	●	●	●	●	●				●	●	●			Generic	Generic	Yes
DeLone & McLean 2003		●	●	●	●						●			Generic	Generic (IS)	Yes

[7] The following abbreviations are used:
PQ = EA Process Quality
RQ = EA Product Quality
SQ = EA Service Quality
RU = EA Results Use
B = EA Benefits
SE = EA Social Environment
OC = Organizational Characteristics

EA Process Quality, referring to the day-to-day activities of the EA function and including dimensions related to EA methodologies, tools and organization, has extensive impact in the process. First, it has a direct impact on the quality of the results of EA processes namely, the EA Product and Service Quality constructs. Second, it also affects the use of EA products and services by EA stakeholders, conceptualized by the EA Results Use construct. Third, it directly impacts the realization of a number of benefits. Fourth, it has an effect on EA Social Environment referring to social, cultural and political factors that have an impact on EA benefit realization.

EA Results Use is impacted by EA Process and EA Results Quality, which also have mutual interrelationships. EA Results Use, in turn, directly results in EA Benefits. In addition to EA processes, this is a second way in which EA benefits are realized. There are also some benefits that are impacted by other benefits as well, in addition to one benefit that is only realized from another benefit. Finally, EA Social Environment has a significant mutual impact to most other constructs, as they influence and are influenced by EA Social Environment.

In addition to EA Process Quality, EA Results Use is the only construct contributing to EA Benefits in our model. This means that EA Benefits can only be realized by appropriate use of EA results and successful day-to-day functioning of the EA processes.

EA processes' role in the benefit realization process has been previously recognized in few models (Foorthuis, et al., 2015; Schmidt & Buxmann, 2011; Tamm, et al., 2011). Our findings emphasize the importance of high-quality EA processes for all parts of the EA benefit realization process, including realizing direct benefits. Contrary to many of the earlier models (Aier, 2014; Lange, 2012; Tamm, et al., 2011), we did not find EA Product Quality to directly impact on EA Benefits. However, we agree that EA Product (and Service) Quality have an indirect effect in benefit realization through the EA Results Use construct. While Lange (2012) identified EA cultural aspects as the only construct contributing to EA management use, we found also EA Process, Product and Service Quality to have a significant impact.

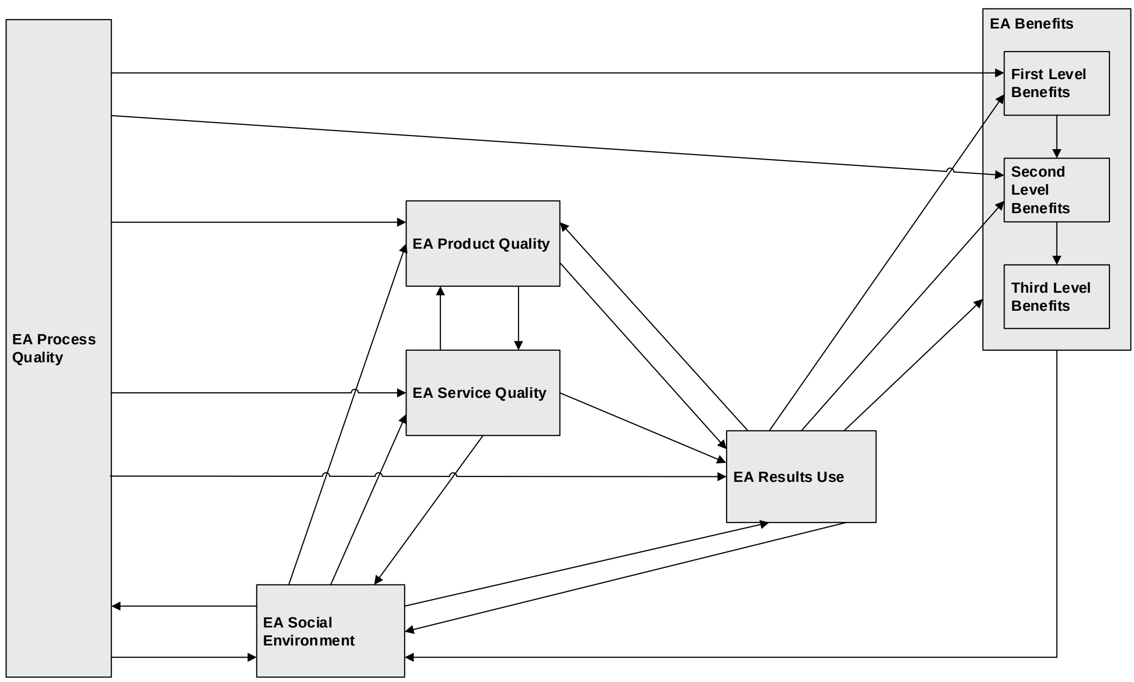

Figure 3. Constructs interacting in the EA benefit realization process

Some models also refer to EA implementation as a source of benefits (Foorthuis, et al., 2015; Schmidt & Buxmann, 2011; Tamm, et al., 2011). The organizational operating platform can be improved as EA guides the development initiatives, leading to better standardization and interoperability (Tamm, et al., 2011). These are more indirect, long-term benefits that are realized over time. EA implementation is also implicitly present in our results. Several First Level Benefits and EA Results Use contribute to Second Level Benefits related to the improved operating platform, including Increase standardization in the solution portfolio and Increase interoperability between solutions. However, EA Results Use also seems to impact these directly.

According to our results, EA Social Environment seems to have an extensive impact in the benefit realization process. Importance of EA's organizational grounding has been acknowledged before (Aier, 2014; Lange, 2012), but our findings highlight the extensiveness of this impact. In addition to being an important predictor of EA Results Use, we also suggest that it contributes to EA Process Quality and EA Product and Service Quality. This is understandable as EA Process Quality and EA Results Use are, to a large extent, organizational issues where the employees' participation in both the production and utilization of EA is essential. This is in line with Aier's (2014) effects of organizational culture on EA principle utilization and EA consistency. Our study is also parallel to that of Lange (2012) in the effect of EA Process and Service Quality on EA Social Environment, but adds a feedback loop from EA Results Use and EA Benefits. Successful EA use and benefit realization seem to create a more favorable environment for EA, further contributing to the benefit realization process.

Differences Between the Models

First of all, the differences between the models may be attributable to different contexts. Also, the different foci and levels of abstraction in the studies may account for some of the differences, especially regarding the EA Results Use construct. For example, Lange's (2012) generic approach to EA management may well have resulted in the overall EA management culture being the sole influencer of stakeholder engagement in the long term. As we have focused specifically on different dimensions of the use of EA products and services, it is not surprising that high-quality EA products and services, as well as EA process dimensions are emphasized.

The divergence in the utilization of different types of EA products may also account for a few discrepancies. For example, EA principles may actually have a double role: they are used as support documentation (part of the EA Process Quality construct) to guide the production of EA models; they are similar to EA products produced by the EA processes.

EA Social Environment as a distinct construct emerged from the data. This may explain the discrepancies regarding this construct. As there is little research on the subject in the EA context (Lange, 2012), it should be further studied whether these really form a distinct construct, or if they are part of the EA Process Quality construct, or even part of the overall organizational context, as in the IS field, where cultural aspects have been studied (Leidner & Kayworth, 2006). For example, the institutional factors studied by Aier & Weiss (2012) include both EA Process Quality and EA Social Environment dimensions.

The type of benefits may also have an effect on the findings. Most of the benefits identified in our model incurred directly from EA use (i.e. First Level Benefits). Also, some indirect benefits (i.e. benefits that may also be realized through other benefits) were referred. They include Increase standardization in the solution portfolio and Increase interoperability between solutions (Second Level Benefits). This could have resulted to the fact that some interviewees referred only to indirect benefits (without mentioning the impacting benefit), while the others disclosed the entire chain of benefits. One benefit that can only be realized indirectly was identified: Decrease IT costs (Third Level Benefit).

The direct benefits seem to have more impact on individual stakeholders while the indirect ones are more organizational in nature. For example, the interviewees may have been working in positions which did not give sufficient visibility on benefits having an organizational impact. This could have led to the situation where direct benefits are emphasized. Still, we argue that most organizational benefits from EA, such as cost savings and improved organizational alignment, are indirect and can thus only be realized through other EA benefits, such as deriving useful information from the EA products and implementing improved EA-guided practices. This is parallel to some others studies (Lux, et al., 2010; van Steenbergen & Brinkkemper, 2008; Tamm, et al., 2011), even though Lange (2012) argues that EA product quality also influences organizational benefits directly. In general, this resembles the IS domain where a large number of constructs, including system quality, information quality, service quality, IS use and user satisfaction, have been observed to directly influence organizational benefits (Petter, DeLone, & McLean, 2008).

In addition, the timeframe of benefit realization may have had an effect. For the above-mentioned indirect benefits, the exact timeframe in which they are incurred is not present in the data. Even though EA has been utilized for several years in the organization, other indirect benefits may not yet have been realized or may not yet be visible to the interviewees.

The reasons for the discrepancies could also be explained by the nature of our model which is both a process and a causal model (cf. DeLone & McLean, 2003). For example, causality between the dimensions of EA Product Quality and EA Benefits has been observed before (Lange, 2012; Petter, et al., 2008). However, from the process viewpoint, the EA results must be appropriately used to gain the outcomes since the benefits do not arise merely from the existence of the EA results. Further, EA Process Quality may contribute to some outcomes directly, not requiring any EA results and their use (cf. Tamm, et al., 2011). This might be the case when EA stakeholders' knowledge of interdependencies is increased by just participating in the EA processes (cf. also Foorthuis, et al., 2015). The model only considers the order of constructs in the benefit realization process and not exact time intervals (e.g. the time it takes for a specific EA outcome to emerge from EA processes); this may also account for discrepancies with earlier models.

Conclusion

In this study, we analyzed the explanatory power of the different EA benefit realization models. This was accomplished by establishing a set of criteria from a case study and reflecting other models to our EA benefit realization model.

Contributions

Our study makes several contributions to EA research and practice. Our results support earlier findings, thereby contributing to the enhancement of the relevance and generalizability of the constructs presented in earlier EA studies, and also identified in the IS domain (DeLone & McLean, 2003). However, in terms of some of the constructs, their mutual interrelationships and their impacts on EA benefits, there are substantial differences in the results. This indicates that no existing EA benefit realization model fully captures the complex phenomenon of EA benefit realization. A comprehensive EA benefit realization model is yet to be developed.

Our results also contribute to future EA research by proposing a potential framework for further research to validate, modify or extend the model of EA benefit realization. Also, since the benefit realization process seems to be very complex and intertwined, thorough reconsideration of EA management practices and processes might be needed. This leads to our contributions to EA practitioners. The study provides insights into what the potential benefits of EA are and where they result from. This is especially important because EA is often considered an expensive undertaking where the benefits are often difficult to observe (Rodrigues & Amaral, 2010).

Limitations

The main limitation of our study arises from the use of a single qualitative case study in a public organization. Thus, we by no means claim that the constructs, dimensions and interrelationships identified in our model are equally important or even existent everywhere (cf. Lee & Baskerville, 2003). Moreover, selecting a public organization may be perceived as a limitation as these organizations have not been much researched in previous studies. Although it has been suggested that demographic factors, such as organization size and industry, have no effect on stakeholder perceptions with regard to EA benefits (Kappelman, et al., 2008), other organizational characteristics may still have a notable effect on the realization process (cf. Aier, et al., 2011; Boucharas, et al., 2010). This may explain some discrepancies between our findings and earlier results. Also, the fact that only one indirect benefit—a benefit that is incurred through other benefits (i.e. Decrease IT costs)—was identified may result from the specifics of the case organization because this limited the focus on benefit sequences leading to cost savings. The findings give a fairly limited view on other possible benefit sequences (e.g. those leading to organizational innovation). In literature, many indirect benefits, such as increased innovation and agility, have been identified (Boucharas, et al., 2010; Lange, 2012; Niemi, 2006). These limitations obviously call for more research in other organizational contexts, with a variety of research methods.

Second, the fact that majority of the interviews were conducted by phone may have had an effect on the interpretation of the interviewees' statements, leaving out helpful visual cues. For example, it was difficult to assess the degree of confidence on the statements on interrelationships. Due to the foregoing, we took into account all statements including negative ones (e.g. "in situation X, A does not lead to B").

Third, due to the research design, the findings may have been influenced by the IS success model (DeLone & McLean, 2003). The IS success model was adapted as a basis for interview protocol which naturally, also provided a starting point for data analysis. Yet the iterative analysis soon diverged from the IS success model and its concepts, our model being significantly different from the IS success model. We thus argue that it provided a good starting point and vocabulary to understand the complex phenomena, but did not have a strong impact on the model.

Fourth, since we focused on EA benefits, the consideration of negative impacts was intentionally left superficial. This can be considered as another limitation.

Further Research

Several directions for further research can be identified. First, a comprehensive model of EA benefit realization is yet to be developed. The existing comprehensive models and our model can act as a starting point for further development and validation. For example, causal relationships can be further studied, e.g. by quantitative research methods in order to provide more extensive evidence. This is an important avenue for further research as there is still significant disparity in EA benefit realization models with regard to which constructs contribute to EA benefits and which are their mutual interrelationships.

Second, even though the relative importance of some dimensions and constructs was evident in our results, it needs to be further studied. This could be used in prioritizing the most influential factors in EA practice, potentially leading to more benefits with fewer resources. Third, even though the timeframe of benefit realization has been referred to and was also evident in our data, it has not been explicitly studied. This direction of research could lead to aligning expectations especially on when indirect benefits having an organizational impact can be expected. Fourth, investigating the effects of organizational characteristics might provide an entirely new course of research. It should be studied whether characteristics such as organization’s industry, size, complexity of the operating platform, and amount of experience in EA have an effect in benefit realization. These results could be used to guide the EA practice to take the specifics of certain context into account in day-to-day EA activities.

Finally, the extent to which the model is applicable in the IS context needs to be studied in detail as this would make it more useful also in the strategic planning of IS.

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Appendix A – Interview Protocol

The interview protocol translated from the original Finnish text includes sections that were addressed in that order. Regarding questions on concrete examples, additional sub-questions were used to dig out the details. If time allowed, additional examples were requested. The bulk of the target interview time (1 hour) was evenly divided for addressing sections 2-4. A few minutes were used for sections 1 and 5.

1 General questions

Please describe briefly your role related to architecture

Please describe briefly your experience in architecture (e.g. how long, what kind of architecture)

2.1 Architecture product use

Please give an example of a situation where you use an architecture product

- *What products do you use*
- *How are the products in practice*
- *For what/why/in what situations do you use the products*
- *How do you use the products in practice*
- *How necessary is the product*
- *How often do you use the products*
- *How long does the use of the products last*

2.2 Architecture service use

Please give an example of a situation where you used an architecture service

- *What services do you use*
- *How are the services in practice*
- *For what/why/in what situations do you use the services*
- *How do you use the services in practice*
- *How necessary is the service*
- *How often do you use the services*
- *How long does the use of the services last*

3.1 Architecture product user satisfaction and benefits

Please give an example of a situation where you have been satisfied with an architecture product

- *What product was it*
- *Why were you satisfied*
- *What was good/working about the product*
- *In what situation were you satisfied with the product*

Please give an example of a situation where an architecture product has been beneficial for you

- *What product was it*
- *Why was it beneficial / how did the benefit concretize*
- *In what situations is the product beneficial*
- *For whom is the product beneficial / for whom is it not*

Please give an example of an architecture product that would be beneficial to you

- *What kind of product would it be*
- *Why would it be beneficial / how would the benefit concretize*
- *In what situations would the product be beneficial*
- *For whom would the product be beneficial / for whom would it not be*

What other experiences do you have on architecture product use?

3.2 Architecture service user satisfaction and benefits

Please give an example of a situation where you have been satisfied with an architecture service

- *What service was it*
- *Why were you satisfied*
- *What was good/working about the service*
- *In what situation were you satisfied with the service*

Please give an example of a situation where an architecture service has been beneficial to you

- *What service was it*
- *Why was it beneficial / how did the benefit concretize*
- *In what situations is the service beneficial*
- *For whom is the service beneficial / for whom is it not*

Please give an example of an architecture service that would be beneficial to you

- *What kind of service would it be*
- *Why would it be beneficial / how would the benefit concretize*
- *In what situations would the service be beneficial*
- *For whom would the service be beneficial / for whom would it not be*

What other experiences do you have on architecture service use?

4.1 Architecture product quality

Please give an example of an architecture product of high quality

- What is the particular product in question
- Why are the products of high quality (what makes the product of high quality)

Please give an example of an architecture product that is not of high quality

- What is the particular product in question
- *Why are the products not of high quality (what makes the product not to be of high quality*

What other experiences do you have on architecture product quality?

4.2 Architecture service quality

Please give an example of an architecture service of high quality

- What is the particular service in question
- Why are the services of high quality (what makes the service of high quality)

Please give an example of an architecture service that is not of high quality

- What is the particular service in question
- *Why are the services not of high quality (what makes the service not to be of high quality*

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What other experiences do you have on architecture service quality?

5 Finalizing questions

Which two persons should I still interview (name and business unit)?

Is there still something that you would like to disclose?

Article

Quality Attributes for Enterprise Architecture Processes

By Eetu Niemi

Abstract

Enterprise Architecture (EA) is created, maintained, and managed through EA processes. While the quality of these processes is perceived to ultimately impact the realization of benefits from the EA approach, it has been considered in relatively few studies. Specific aspects of EA processes such as EA frameworks have been extensively studied, but there is no common understanding of the attributes that make up EA processes of high quality. In this exploratory case study, data from 14 themed interviews of EA stakeholders is utilized to identify 15 quality attributes for EA processes. These are then supplemented and validated by comparison to the hitherto existing state of research. The results provide a comprehensive framework for understanding EA process quality. They can be used to identify areas for development and define metrics for further improvement of the EA practice, and as a basis for further research.

Keywords

Enterprise Architecture, Quality, Process, Planning, Governance, Documentation, Management

INTRODUCTION

Enterprise Architecture (EA) processes comprise all of the processes and supporting infrastructure required for planning, documenting, and governing EA. Also conceptualized as EA Management (EAM), the processes enable setting the direction of the EA target state, creating and maintaining EA documentation, and ensuring the intended guiding effect of EA on the organization's development initiatives (Lange 2012; van der Raadt and van Vliet 2008). EA processes also encompass tools and methodologies required for supporting the processes, and are enabled by organizational factors such as human and financial resources (Lange 2012; van der Raadt and van Vliet 2008).

Even though the quality of EA processes is perceived to directly affect the quality of EA products such as architectural models (Tamm et al. 2011a), and even ultimately impact the realization of organizational benefits from the EA approach (Foorthuis et al. 2010; Tamm et al. 2011a), it has not been extensively studied. As yet, a comprehensive reference model for EA process quality does not exist (Lange 2012). Rather, researchers have either turned their attention to specific aspects of EA processes, such as EA frameworks and modeling technicalities (Schöenherr 2009; Ylimäki 2006), or studied EA quality on a high level (Lange 2012).

Within the latter, the focus has been on maturity models (e.g., Ylimäki 2007) and Critical Success Factors (CSFs) (e.g., Ylimäki 2006). Maturity models provide an approach developed especially for US government agencies for rating organizations' EA capabilities on a high level. Also, CSFs identify factors that are perceived to have an effect on EA quality and success. Even though both of these approaches suggest high-level factors argued to impact EA quality, they do not differentiate factors related to EA processes from ones related to the other aspects of EA, such as EA products, or even the organizational context (e.g., Ylimäki 2006). Also, other studies have exhibited similar challenges in clearly distinguishing the EA process quality dimension (e.g., Aier et al. 2011; Tamm et al. 2011b).

This gap in existing research motivates the study. Identifying the attributes that constitute high-quality EA processes is not only important for finding areas of improvement in the EA practice, but also in defining detailed performance metrics for EA operations (Hämäläinen and Kärkkäinen 2008). These in turn can be utilized to assure the quality, direction, and desired effects of EA (Lagerström et al. 2011; Ylimäki 2006).

This article aims to create a comprehensive picture of EA process quality by answering the following research question: What are the quality attributes of EA processes? By following the exploratory single case study approach and utilizing data from 14 themed interviews of EA stakeholders in a large Finnish public sector organization, it attempts to identify the attributes that make up high-quality EA processes. The findings are supplemented and validated by comparison to relevant literature.

BACKGROUND AND RELATED WORK

EA encompasses (1) products such as architecture models, principles, and other documentation, providing a high-level abstraction of the organization, and (2) processes for creating and maintaining these products and governing their use in the organization (Lange 2012; van der Raadt and van Vliet 2008; Tamm et al. 2011a). Also EA services such as architectural support and formal architecture reviews can be offered to facilitate EA product utilization (Lange 2012; van der Raadt and van Vliet 2008), referring to the interface of relevant EA processes towards recipient stakeholders. EA has myriad organizational stakeholders, ranging from architects to development projects and the top management (Niemi 2007).

EA Processes

The ongoing planning, documentation, and governance of EA is realized through EA processes. These support the following three activities:

- EA planning encompassing decision-making on the direction of the EA target state
- EA documentation by creating new EA products and maintaining the existing ones
- EA governance used to ensure the intended guiding effect of EA on development activities (Lange 2012; van der Raadt and van Vliet 2008)

EA processes also encompass the supporting infrastructure, including tools and methodologies, and required organizational factors (Lange 2012; van der Raadt and van Vliet 2008). These aspects of EA processes are depicted in Figure 1 and further described in Table 1.

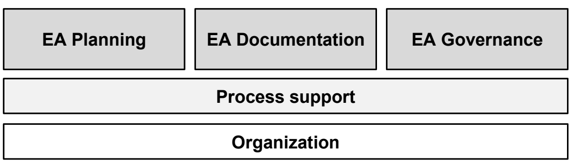

Figure 1: EA Process Aspects

The quality of EA processes has been suggested to have a profound effect on the success of EA. While quality management typically considers the quality of a process and its output as causally linked (ISO/IEC 2001), in the EA context the EA planning process quality not only determines EA product quality, but also directly contributes to the realization of benefits from EA (Aier et al. 2011; Tamm et al. 2011a). EA process quality also builds a culture favorable for EA use, ultimately also affecting the realization of benefits from EA (Lange 2012).

Table 1: EA Process Aspect Descriptions

Aspect	Description	Sources
EA Planning	An iterative process for decision-making on the direction of the EA target state, using EA products as source material. Planning is a participatory process between architects and other EA stakeholders across the organization. It is carried out on all abstraction levels of EA (such as EA, line-of-business architecture and project/program architecture).	Pulkkinen 2006; van der Raadt and van Vliet 2008; Tamm et al. 2011a
EA Document-ation	Process responsible for embedding the results of EA planning into new and existing EA products. It includes the creation of new products and the maintenance of existing ones.	van der Raadt and van Vliet 2008; Ylimäki 2006
EA Governance	Process responsible for ensuring that individual development projects adhere to relevant EA products. This includes guidance for projects in conforming to the EA products, and monitoring the conformance of the project to these products.	Lange 2012; van der Raadt and van Vliet 2008
Process Support	The tools, methodologies, and frameworks used to support EA processes. These include at least an EA framework and various modeling tools. The EA framework describes the conceptual structure of the EA description and provides guidelines for EA planning and governance.	Lange 2012; Lim et al. 2009
Organization	Supporting organizational structures, decision-making bodies, policies, and resources required for EA processes.	Lange 2012; van der Raadt and van Vliet 2008

EA Process Quality

Although quality is characterized by numerous definitions and models, these in general define quality as the ability of something to satisfy stakeholder needs or fitness for a specific purpose (e.g., Juran and Godfrey 2000). For example, the ISO 9000 set of standards defines quality as: "the degree to which a set of inherent characteristics fulfills requirements" (ISO 2005). To enable the management of quality, the concept of quality characteristics or attributes has been introduced to provide a basis for defining detailed process quality measures. These are to a large extent process-specific; for example, attributes or measures have been defined for software products (ISO/IEC 2001), systems development (Rai and Al-Hindi 2000), and IS services (Pitt et al. 1995). Only generic measures such as resource utilization, volume of output, cycle time, costs of operation, and number of errors characterize the quality of most processes. This calls for further defining EA processes and their quality attributes.

As yet, no frameworks for EA process quality have been proposed (Lange 2012). Prior conceptions of EA process quality are also somewhat indefinite: several authors mix EA process attributes with other EA quality attributes, such as those characterizing EA products and services, their utilization, or even the organizational context (e.g., Aier et al. 2011; Tamm et al. 2011b; Ylimäki 2006). To clearly distinguish the quality of EA processes from the other aspects of EA, EA process quality is defined as the extent EA processes satisfy the EA stakeholders' needs. EA process quality attributes then define the characteristics of EA processes that make up their overall quality.

Nonetheless, several authors have suggested attributes that are important for the proper functioning of the EA processes or the success of EA. Potential EA process quality attributes are included in both EA CSFs, referring to factors impacting EA quality and success (e.g., Ylimäki 2006), and EA maturity models, an approach attempting to assess the quality of the organization's EA capability on a high level (e.g., Ylimäki 2007). Also, measures proposed for different aspects of EA either include or consist of attributes indicating EA process quality or maturity. Especially business alignment, stakeholder involvement, adequate resources, clear definition of processes and roles, formalized project governance, and evaluation of EA processes and products have been identified as attributes having an impact on the success of EA (e.g., Aier et al. 2011; Foorthuis et al. 2010; Lagerström et al. 2011).

Most of the attributes identified in the literature can be categorized by the identified EA process aspects with regard to which process they especially relate. For example, taking into account the business strategies and requirements, and involving business stakeholders in the EA processes (i.e., business alignment) are especially important in the EA planning process (Tamm et al. 2011b; Ylimäki 2006). The EA process quality attributes identified in the literature and categorized by the EA process aspects are presented in Table 2.

Table 2: EA Process Quality Attributes Identified in the Literature

	Source					
Quality Attribute	Aier et al. 2011	Foorthuis et al. 2010	Lagerström et al. 2011	Lange 2012	Tamm et al. 2011b	Ylimäki 2006
Common to all Processes						
Clear scope and purpose				•		•
Appropriate management practices	•		•			•
Alignment with other governance and planning functions	•			•		•
EA Planning						
Alignment with business	•	•		•	•	•
EA Documentation						
Appropriate documentation practices	•		•	•	•	
EA Governance						
Appropriate governance mechanisms		•		•		
Effective program and project management					•	•
Process Support						
Adequate EA tool support	•			•		•
Adequate EA framework			•	•		•
Adequate support documentation				•	•	•
Organization						
Availability of human resources			•	•	•	•
Availability of monetary resources			•	•	•	•
Extent of skills and experience	•			•	•	•
Availability of training				•		•
Organizational culture					•	•

RESEARCH METHODOLOGY

The research problem was approached with an exploratory single case study approach (Yin 2009). The study took place in a large Finnish public sector organization, which has undertaken EA work for over five years. It has an established EA team, which is organized in a semi-centralized, federated manner. A proprietary EA tool and an established framework are also utilized. EA work is carried out on multiple levels, including EA, reference architecture, line-of-business architecture, project/program architecture, and implementation architecture.

The empirical data was collected in 14 semi-structured themed interviews. The interviewees were hand-picked from the centralized EA team, from all main business units, and from projects. Initially, five interviewees were identified as a part of a separate EA survey. Then snowball sampling was used to identify the rest of the respondents, and data collection continued until theoretical saturation was considered to have been reached (Paré 2004). Table 3 presents the interviewees and their characteristics. Each interviewee is classified in terms of the EA process aspect to which the interviewee predominantly relates.

Table 3: Interviewees and their Characteristics

Interviewee	Work Role	EA Process Aspect	Level	Team
Architect A	Technical-Functional Architect	EA Governance	LoB	Central
Architect B	Domain Architect	EA Governance	EA	Central
Specialist C	EA Framework Specialist	EA Governance	LoB	Central
Specialist D	Lifecycle Management Specialist	Process Support	LoB	Decentralized
Project Manager E	Project Manager	EA Planning	Project	N/A
Line Manager F	Line Manager, specialist in project	EA Planning	Project	Decentralized
CIO G	Head of Information Systems	Organization	LoB	Decentralized
Project Manager H	Project Manager	EA Planning	Project	N/A
Development Manager I	Development Manager	EA Planning/EA Governance	EA	Central
Architect J	Technical Architect	EA Governance	LoB	Central
Program Manager K	Program Manager	EA Planning	Project	N/A
Project Manager L	Project Manager	EA Planning	Project	N/A
Architect M	Functional Architect	EA Documentation	LoB	Central
Architect N	Architect	EA Documentation	LoB	Central

The themes included the quality, use, user satisfaction, and benefits of EA products and services (Niemi and Pekkola 2009). Following the narrative interview method (Jovchelovitch and Bauer 2000), each theme was approached by first requesting a concrete example and then breaking it down with clarifying questions. The interviews were conducted between October 2011 and January 2012, and lasted on average 57 minutes. The interviews were audio-recorded and transcribed, and during each interview detailed notes were taken. All interviews, except one, were conducted by phone.

The interviews were analyzed utilizing the grounded theory methodology (Urquhart et al. 2010). The data was first coded using the themes in the research instrument as dimensions. Next, the data referring to EA processes was identified and categorized on the basis of whether it described factors contributing to EA product quality or to EA benefits. After iteratively describing the identified factors and correlating them to relevant literature, a draft version of the paper was sent to a key individual from the case organization for review.

IDENTIFYING EA PROCESS QUALITY ATTRIBUTES

15 EA process quality attributes were identified from the interview data. These attributes are described and reflected to literature in the following. Each of the attributes is categorized by a specific EA process aspect. The categorization is based on the context in which the attribute was specifically referred to by the interviewee(s).

Common to all Processes

Clear Scope and Purpose: While the interviewees agreed that clear scope and goals should be set for EA, also literature suggests that the areas where EA is applied should be clearly defined, and cover both business and IT (Lange 2012; Ylimäki 2006). A domain architect stressed the importance of common approval of the scope and purpose [Architect B]. Also all EA products and services should have a defined purpose. The importance of long-term approach in EA planning was highlighted by a functional architect [Architect M]. Among others, clear goals are crucial for the measurement of EA (Hämäläinen and Kärkkäinen 2008).

Appropriate Management Practices: The appropriateness and effectiveness of management practices related to EA processes was perceived critical by the interviewees. Especially careful planning and clear definition of processes (Aier et al. 2011; Lagerström et al. 2011; Ylimäki 2006), and systematic EA-related communication covering all relevant channels and stakeholders (Ylimäki 2006) are emphasized. Additionally, the evaluation of the quality and the impacts of EA processes and products has been considered important (Hämäläinen and Kärkkäinen 2008; Ylimäki 2006). In the case organization, the importance of continuous benchmarking was stressed: "to compare if we really carry out [EA work] soundly … and how other organizations utilize their [EA] descriptions and what they have learned from it" [Architect N]. Ongoing improvement of the EA capability was also considered important.

Alignment with Other Governance and Planning Functions: Integrating EA planning and governance seamlessly with other organizational functions such as strategic planning, project planning, project steering, project portfolio management, and IT governance was seen as crucial, as also proposed in the literature (Aier et al. 2011; Lange 2012). A development manager suggested that the mechanisms should be integrated in parallel, and the overlap of different mechanisms should be minimized [Development Manager I].

Forcing projects and programs to produce similar information in different formats for different governance mechanisms was seen as especially problematic. As summed up by a project manager: "if for every [governance mechanism] you consider the same things over and over again, the motivation to do so may start to waver a little when you finally have reached EA governance" [Project Manager E].

Cooperation within the EA Team: Both formal and informal mutual cooperation of architects was perceived important by the interviewees. It was suggested that architects should form a close community, even above possible line and project responsibilities. This "on the one hand characterizes the working community, and on the other hand the existing work priorities" [Architect B]. Cooperation was also highlighted in the context of EA product and service cohesion and availability. The frequency of cooperation should be "daily, at least weekly" [Architect B].

Routinization of EA Work: EA planning, documentation, and governance should be perceived as part of day-to-day work, similar to the other overarching disciplines such as information security. This was highlighted by a functional architect, even suggesting that "EA should be perceived as an overarching capability embedded in all planning and management" [Architect M]. This was perceived to lower the perceived workload from EA governance, especially on the project level.

EA Planning

Alignment with Business: It was perceived that EA planning should be tightly aligned with organizational strategy and business plans to actually be usable in guiding organizational development, and ultimately enable the realization of desired benefits (Lange 2012; Ylimäki 2006). The participation of stakeholders, especially top management, in the EA processes has been considered important in ensuring this alignment (Foorthuis et al. 2010; Ylimäki 2006). The participation of business stakeholders across lines of business was highlighted also by the interviewees. A project manager suggested unifying the language of EA and business as a way to enhance this participation [Project Manager E].

Another project manager perceived EA-business alignment as a two-way relationship: while EA planning should not be conducted in an "ivory tower" (as also suggested numerous times in the literature), neither should business planning be carried out without consulting the EA team [Project Manager H]. Also the EA documentation process should support stakeholder participation by the production of intermediate deliverables for feedback and discussion (Tamm et al. 2011b).

EA-business alignment in the planning process was considered critical especially for the quality of resulting EA products. In an example disclosed by a line-of-business architect, a particular EA view was created utilizing mainly existing documentation as source, without consulting the business owners of the modeled objects [Architect A]. As a result, he considered the view to exhibit poor quality.

EA Documentation

Appropriate Documentation Practices: When working with a repository-based EA tool, it is important to maintain the coherence of the repository. According to a functional architect: "if one does not understand the vulnerability of elements, one can cause a lot of destruction in five minutes by inconsiderate use [of the EA tool]" [Architect M]. The architect even suggested centralizing EA tool use to the EA team if required modeling skills on the project level are insufficient. The same tool should also be consistently used for all EA modeling purposes. A domain architect considered that: "it is quite difficult to harmonize [newly created EA models] with the existing ones if they have been created with a different tool" [Architect B].

Maintaining repository coherence requires integrating new models to the existing ones, at the same time avoiding creating duplicate entities and unconnected models. To enable report-generation from the models, all required links should be modeled and metadata filled. In the literature, the clear definition of documentation processes (Lagerström et al. 2011), traceability of architectural decisions and requirements, clear ownership of products (Ylimäki 2006), and proper scope-detail-cost balance of EA products (Tamm et al. 2011b) have also been mentioned.

EA Governance

Appropriate governance mechanisms: While formalized project governance through project architecture reviews has been emphasized in the literature (Foorthuis et al. 2010; Lange 2012), it was not perceived particularly important by the interviewees. Instead, they emphasized the importance of providing support for project architecture planning (Foorthuis et al. 2010; Lange 2012), also contributing to the EA conformance of the project. A line-of-business architect even suggested providing a full-time project architect [Architect N].

Emphasizing formal architecture reviews in project governance was perceived to cause projects and programs to create the project architecture documentation just for the sake of passing the review, causing dissatisfaction towards EA, and not contributing to benefits on the project level. As summed up by an interviewee: "[EA planning] should be considered as a natural part of [project or program] planning. If it is considered as work carried out after the plans have already been put on paper, a specialist drawing the formal descriptions from them, it is quite hard to get benefits from it" [Specialist C].

Process Support

Adequate EA Tool Support: The availability of a repository-based EA modeling tool was perceived important by the interviewees. Also, literature highlights that tool support should be adequate for all EA planning, documentation, and governance needs (Lange 2012; Ylimäki 2006). Especially ease-of-use, functionality, and appearance of the models were mentioned as important EA tool quality factors by the interviewees.

Particularly modeling of inter-relationships, reporting functionalities, and meta-model customization features were suggested as preferred functionalities. The appearance of the models should be adequate for directly utilizing them in presentations. The tool should be available to everyone requiring its capabilities, and sufficient technical support services should be at hand. The tool capabilities offered to different user groups should also be customizable. While "… inexpert users should be kept as far as possible [from the EA tool], it should be able to produce content in report format for line users such as business users, and project and program managers" [Development Manager J].

Adequate EA Framework: It was perceived that EA work should be guided by a mutually accepted framework, as also suggested in the literature (e.g., Lagerström et al. 2011; Ylimäki 2006). While the framework should be sufficiently extensive to be able to meet stakeholder needs both in terms of covered domains (horizontal) and levels of detail (vertical), it should not be overly burdensome to use. This notion was emphasized by an architect: "we should have it clear in mind how we benefit from [the EA framework], what we are trying to achieve, so that we do not create EA descriptions just for their own sake" [Architect M]. Another interviewee suggested that: "[the EA team] should continuously evaluate the usability of the framework" [Specialist C] to reflect the latest academic and industry insight. This was perceived to increase stakeholder acceptance of the framework.

Adequate Support Documentation: Availability of clear guidelines, instructions, and templates for EA work was seen as important to the quality of EA work. This support documentation should encompass all hierarchy levels, including projects and external suppliers. According to a line-of-business architect, this is especially important in avoiding duplicate work associated with modifying supplier-created EA models to the required format: "in an optimal situation, we receive finished EA models from the supplier and only need to import them [to the EA tool]" [Architect M].

Organization

Availability of Human Resources: Availability of personnel was referred to numerous times in the interviews as a critical attribute. Not only should the EA team headcount be sufficient, but to allow the team members to concentrate on EA work their roles should be clearly distinguished from project and line-of-business roles, and be full-time. The possibility of using consultant resources was also seen important in particularly technical areas and carrying out EA modeling. While these views have also been disclosed in the literature (e.g., Tamm et al. 2011b; Ylimäki 2006), the discrepancy between role definitions and reality was especially highlighted by the interviewees. It is not sufficient to merely have clear role definitions, if these are not realized in practice.

Availability of Monetary Resources: Obviously, available funding was perceived to have a large impact on EA work, as also suggested in the literature (e.g., Lange

2012; Ylimäki 2006). Also, the typical one-year budgeting cycle was seen as problematic regarding EA, since EA was perceived to be a long-term initiative.

Extent of Skills and Experience: It was suggested that not only the skills of architects, but of all stakeholders utilizing EA and participating in the EA processes are important; especially those of the management and project personnel (Ylimäki 2006). According to an interviewee, this also has an effect on the quality of EA products, since stakeholders with EA-specific knowledge and experience participating in EA planning may better identify and bring out factors relevant to EA planning [Specialist D]. For maintaining the coherence of the EA repository, EA tools skills are crucial for stakeholders utilizing the tool. Architecture, communication and networking skills have been perceived as especially important in earlier studies (Aier et al. 2011; Lange 2012).

Availability of Training: Training possibilities were perceived as important as part of skills development. In addition to the training of architects, also training of other stakeholders, such as project and program personnel, was referred to. A project manager even suggested that: "passive architecture training for program personnel would be a very good idea" [Project Manager L]. While architects perceived training of architecture skills important (Lange 2012; Ylimäki 2006), some of them also suggested providing training on business substance.

DISCUSSION

Data from 14 EA stakeholder interviews was utilized to identify 15 EA process quality attributes. While there is support for nearly all of the attributes and their categorization in the literature, there is no single source that provides as comprehensive a view of EA process quality attributes as the interview data. Especially the importance of appropriate governance mechanisms, routinization of EA work, and cooperation within the EA team have been disregarded earlier.

The practicality of EA governance has been covered in the literature rather superficially. The findings indicate that EA governance should be steered more toward practical architecture support for projects than formal governance establishment (Foorthuis et al. 2010; Lange 2012). While some formality and enforcement is required for EA governance to actually work, EA governance should more emphasize the support of projects in architecture planning and utilizing the EA products. This can be achieved particularly by providing easily utilizable requirements, restrictions, and standards to projects, and facilitating the identification of inter-dependencies with the environment.

Another previously unidentified attribute linked to the practicality of governance is the routinization of EA work. While projects and programs should be supported in EA planning, they should also consider EA work as part of everyday project planning. This lowers the perceived workload of EA on the project level, potentially building up a culture favorable for EA.

Surprisingly, the importance of teaming-up and cooperation of the EA team has not before been explicitly referred to as an EA process quality attribute. Still, it was considered important that the EA team forms a tight-knit community and considers themselves as architects above possible line-of-business and project responsibilities. This contributes to prioritizing EA work above others, identifying the right support persons for EA work, and the recipients for the results of EA planning and governance. EA team meetings involving practical problem-solving as a team were suggested as one channel for improving cooperation.

The importance of program and project management was not especially emphasized in the data. Still, as EA is implemented in individual development projects, the effectiveness of program and project management practices has been perceived as important in the literature (Ylimäki 2006). Also organizational culture – encompassing factors such as attitude towards EA and changes, trusting environment, and open communication (Ylimäki 2006) – has been brought out to influence EA process quality (Tamm et al. 2011b; Ylimäki 2006). Still, in this article these are not considered as EA process quality attributes as such, since they rather characterize the context of the processes than the processes themselves. However, especially the importance of organizational culture should not be overlooked as it has been observed to facilitate EA use (Lange 2012). Also in the case organization, if EA was perceived to only cause extra work and confusion in projects, they tended to avoid requesting architectural support from the EA team, gearing the EA work in the project towards documentation instead of planning.

The results also provide insight on what quality attributes are important for each of the EA process types, including EA planning, documentation, and governance. While alignment with business is especially important in EA planning, the appropriateness of governance and documentation practices influence particularly EA governance and documentation, respectively. Several attributes also influence all types of EA processes. Clear scope and purpose, appropriate management practices, alignment with other governance and planning functions, cooperation within the EA team, and routinization of EA work are especially important as they have an effect on the EA processes comprehensively.

The main limitation of this study stems from the single case study approach. Since data from only a single case was utilized, contextual factors may have impacted stakeholder perceptions. Thus, further studies should validate the findings in different contexts. Still, the results provide a comprehensive view of EA process quality attributes, giving EA practitioners an idea where to focus improvement activities. The results can also be used as a starting point for further research.

As the perception of quality is dependent on the stakeholder in question, various stakeholders may prioritize quality attributes differently. Because the data provided limited justification for the weighting of the attributes, it is suggested as a direction for further research. For practitioners, the weighting could indicate on which areas improvement activities should be especially targeted. It also provides a possibility to investigate whether the weighting of the attributes varies in different contexts.

Detailed survey instruments can also be derived from the identified attributes, providing a tool for internal EA teams and EA consultants to benchmark the quality of EA processes in organizations. Additionally, they can be used in investigating the inter-relationships between the attributes, initially referred to in the interview data. The uncovered inter-relationships may then be used to pinpoint potential dependencies and other inter-relationships between the EA processes. Finally, the metrics can be used to measure EA process quality and its impact as part of a comprehensive EA measurement framework, encompassing all aspects of EA.

CONCLUSION

This study attempted to identify the quality attributes of EA processes. Through data from 14 themed interviews of EA stakeholders, 15 EA process quality attributes were identified, encompassing the aspects of EA planning, documentation, governance, process support, and organization. Even though the identified attributes are to a large extent supported by literature, several shortcomings in the existing theory base were identified. The comprehensive framework of EA process quality provided by the study is especially important since EA processes as a distinct dimension have been largely omitted in previous studies, with few exceptions. There also does not exist a single literary source that would cover all of the identified attributes.

As attributes that have previously received little attention, the results emphasize the importance of practical EA governance over formal governance mechanisms, and routinizing EA work on the project level. While some formal governance is presumably required, embedding EA planning into project planning was suggested as the preferred way of ensuring the EA conformance of projects. This also requires EA governance to be aligned with the other governance and planning functions, minimizing extra work required from projects. Also, the significance of internal cooperation and teaming-up within the EA team was highlighted. The results also emphasize the importance of several EA process quality attributes as they have an effect on all types of EA processes, including EA planning, documentation, and governance.

While the findings provide a basis for further research on EA process quality, the larger context of EA processes – realizing benefits from EA – should not be forgotten. As there are somewhat contradictory views on how EA process attributes interact in EA benefit realization (Foorthuis et al. 2010; Lange 2012; Tamm et al. 2011a), the impacts of EA process quality should be further studied. Only this allows us to understand how EA as a whole works in creating organizational value.

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Enterprise Architecture Quality Attributes: A Case Study

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Abstract

Enterprise Architecture (EA) is an approach for facilitating the integration of strategy, business, information systems and technology towards a common goal and mastering organizational complexity through the development and usage of architectural descriptions. The planning and modeling aspect of EA is already fairly well covered in the literature, while the attributes of EA quality have attracted less interest – even though EA quality has been perceived as a prerequisite for realizing its benefits. In this exploratory case study, we identify ten quality attributes for EA products and services, utilizing data collected from 14 EA practitioner interviews. We will fill in several gaps in the existing theory base, propose a list of attributes that increase EA quality, and call for more research.

1. Introduction

Enterprise Architecture (EA) is an approach to managing the complexity of an organization's structures, information technology (IT) and business environment, and facilitating the integration of strategy, personnel, business and IT towards a common goal through the production and use of structural models providing a holistic view of the organization [16,18,31].

Because of this scope, EA can be approached from a number of viewpoints [16,21,28]. First, EA contains *products*, especially structural models, needed in managing and developing the organization. The products typically encompass the domains of business, information, information systems (IS) and technology [8,26]. Products describe the current architecture of the organization, provide a vision for the future architecture, and include a transition plan describing how to reach it [16,26]. These products may also be supported by various *services*, such as architectural guidance and help for development projects [18,26]. Second, EA is a set of *processes* carried out by an EA function, more specifically a collection of planning, development and management processes for e.g. creating and updating EA products [18,26]. Using the EA products in turn generates various *outcomes* for the organization, for example for systems and processes implemented according to EA, and decisions supported by EA [26,28]. Lastly, EA can contribute to the realization of direct and indirect *benefits*, for example reducing cost and improving business-IT alignment [18,21,28]. Thus, EA products and accompanied services can be seen as prerequisites for EA processes, outcomes, and ultimately benefits.

The majority of EA research focuses on the planning and modeling aspect of EA [28,31]. Recently, however, more fundamental aspects, such as the use of EA in analysis [13,27] and the value of EA [18,21,28] have gained attention. Yet in the area of EA quality, significantly less research has been published. Especially empirical work in the area is lacking, with few exceptions [17,32]. This research gap is alarming since the quality of EA has been perceived as a prerequisite for the EA benefit realization [18,21,28].

In this exploratory study, we thus attempt to identify the quality attributes of EA products and services as prerequisites for EA benefit realization. We seek an answer to the question: *What are the attributes of high quality EA products and services?*

Following the exploratory case study approach, we conducted 14 semi-structured EA practitioner interviews in an organization using EA to gain understanding about EA quality attributes.

The paper is organized in the following way. First, related research on quality in general and EA quality in particular is reviewed. Second, the research methods are described. Third, the findings from the interview data are presented. Fourth, the findings are compared to literature in the discussion section. The paper ends with summary and conclusions.

2. Background literature

There are numerous definitions and models of quality. A widely used definition describes quality as *the* *set of features and characteristics of a product or service that have an effect on its ability to satisfy customer needs* [11,15]. In the field of EA, definitions are scarcer. Ylimäki [31] proposes that "*high-quality EA conforms to the agreed and fully understood business requirements, fits for its purpose, and satisfies the key stakeholders' expectations in a cost-effective way".* Tamm [28], on the other hand, states that "*high-quality EA is one that provides a vision for the future operating platform that is well-aligned with the organization's strategic goals, complemented by an optimal roadmap for moving towards that vision, based on an accurate understanding of the current operating platform".* Both definitions emphasize that EA should be aligned with business needs. The former focuses more on the traditional notion of quality as the fulfillment of stakeholder needs, while the latter defines quality through the types of information in EA products.

Consequently, in the context of EA products and services, we define quality as *the extent to which the EA products and services meet the EA stakeholders' needs*. These stakeholders include individuals and groups, ranging from top management and architects to project managers and business users both inside and outside the organization [20].

In the IS discipline, quality is often described and evaluated through a set of quality attributes or characteristics (also called non-functional requirements). For example, six quality characteristics: functionality, reliability, usability, efficiency, maintainability and portability, define the quality of a software [11]. These can further be evaluated by a myriad of methods [2]. Altogether, different attributes are always used as a basis for quality evaluation.

Considering the quality attributes in respect of architecture, one has to distinguish between the attributes of the description (e.g. architecture) and the attributes of the target of the description (e.g. a system) [16]. In this paper we consider EA quality attributes to describe *the non-functional characteristics of EA products, services and processes that comprise the overall quality of EA*, omitting the aspect of implemented EA (e.g. systems and infrastructure). This has been in focus in the IS field and has been addressed by a number of studies in the context of EA analysis [13,27].

In the IS domain, system quality and system output quality have been considered in numerous models that attempt to describe and measure IS success and its characteristics [5,7,24]. One of the most popular models is the IS success model [5,24]. It defines information systems´ success through attributes such as information quality, system quality, service quality, user satisfaction, intention to use (the system), and actual use (of the system). Altogether, these attributes characterize the benefits and quality of an IS.

The instruments for measuring the quality constructs in the IS success model have also been studied. For example, to measure information quality, items such as completeness, precision, accuracy, reliability, currency, and the format of output from end-user computing satisfaction instruments [3] have been used [7,24].

For service quality, the SERVQUAL instrument [22] has remained the most widely used model in the IS context [24]. Also it has been extensively validated [12,25]. The original SERVQUAL instrument includes 22 items divided into five dimensions, namely tangibles, reliability, responsiveness, assurance and empathy [22]. In the IS context, the tangibles dimension is largely omitted because of low reliability [12,25].

In the EA context, EA quality has been approached through EA maturity models, that origin from the field of quality management [32]. Maturity models are used to attain a high-level view of the quality of the EA capability in an organization [32]. However, the weakness of maturity models is that they are relatively simple quality management instruments, providing only a high level view of the EA quality [32].

Another approach to EA quality is the critical success factors (CSFs), which have been argued to lead to high-quality EA [32]. For example, Ylimäki [31] constructed a set of EA CSFs and concluded that EA models and artifacts are factors for EA product quality, while some aspects of program and project management, IT investment and acquisition strategies, and EA governance characterize EA services.

Besides EA maturity models and CSFs, EA quality attributes have been addressed. Razavi et al. [27] studied the concept of EA quality attributes and identified initial measures for EA maintainability in the context of EA scenario analysis. Their measures are mostly linked to EA product quality, even though they touch issues of EA function and processes, software architecture, and source code. Their results thus provide a narrow view of EA quality, focusing on one major quality attribute only, and having a fluctuating level of granularity from abstract (EA function) to detailed (source code).

Bernus [4] addressed the concern of documenting and sharing business process models required by the ISO9001:2000 standard. He identified and associated EA model quality measures to the sharing of the models, the measures being efficiency and completeness. However, the results are not validated or is the EA product quality thoroughly covered.

Lim et al. [19] defined a set of EA quality attributes by analyzing EA frameworks with regard to their stated objectives and benefits, arriving at a set of 14 attributes that define EA quality in terms of its impact on the organization. However, these attributes focus to a large extent on the quality of targets described by EA, not on EA product characteristics.

Hämäläinen and Markkula [9] took a practical view on quality evaluation and formulated a set of quality assessment questions for architecture descriptions. Those questions include the stakeholder and purpose orientation, quality of content, quality of presentation and visualization, and management of architectural descriptions. These results are again focusing on the EA product quality, and are subjected to limited validation.

Also IS success models have been expanded to the EA context. Dietzsch et al. [6] focused on service quality and use constructs, and reported initial results from two case studies discussing EA presentation and governance strategies and their effects on the value realization. Niemi and Pekkola [21] further tailored the success model by expanding each of the original constructs with four viewpoints, namely product, process, outcome and impact, attempting to capture the multi-faceted nature of EA. The results were initially validated [1], but a causal model of the introduced concepts was not developed. Lange et al. [18] aimed at identifying EA CSFs through an extensive literature review and coding them against the success model constructs. Then they introduced and validated an updated success model for the EA domain [17,18] where IS-specific quality constructs are replaced by EA-specific quality constructs They also introduced EA culture construct as a mediating factor between the quality factors and the realization of net benefits. In their validation for EA product quality, the measures were adapted from the IS field [7]. For EA service delivery, new measures were refined based on the originally identified CSFs [17], again providing a fluctuating level of detail.

Altogether, the studies focusing on EA quality attributes do not provide a comprehensive coverage of the quality of the EA products and services. The adaptation of the IS success model to the EA domain and the related quality measures provide a basis for further knowledge. However, CSFs describe more general level aspects and factors, while attributes are characteristics associated with certain factors. Thus, in order to understand the EA product and service quality thoroughly, the associated attributes need to be understood.

3. Research method

This study is based on 14 semi-structured interviews on EA product and service quality, use, user satisfaction and benefits in a large Finnish public sector organization. The first author had followed the situation for several years before the interviews took place. It was thus estimated that the maturity of the organization´s EA program was appropriate to provide adequate research data. A single case study approach [30] was utilized to gain in-depth understanding of their EA quality.

Table 1. Interviewees, their work roles and EA team membership types

Interviewee	Work role	Team
Architect A	Technical-Functional Architect, LoB level	Central
Architect B	Domain Architect, EA level	Central
Specialist C	EA Framework Specialist, LoB level	Central
Specialist D	Lifecycle Management Specialist	LoB
Project Manager E	Project Manager	N.A.
Line Manager F	Line Manager, specialist in project	LoB
CIO G	Head of Information Systems	LoB
Project Manager H	Project Manager	N.A.
Development Manager I	Development Manager, EA level	Central
Architect J	Technical Architect, LoB level	Central
Program Manager K	Program Manager	N.A.
Project Manager L	Project Manager	N.A.
Architect M	Functional Architect, LoB level	Central
Architect N	Architect, LoB level	Central

The organization, which has undertaken EA work for more than 5 years, has organized its EA work in a semi-centralized manner. A centralized EA team acts as an EA support organization, providing a number of services to the architects at individual business units, and projects and other stakeholders. Such services include architecture support for projects and programs, formal architecture reviews, regular architect meetings, training support, and external consultant support.

The organization utilizes an established EA framework and a proprietary repository-based EA tool. The framework defines a typical set of EA domains: business, service, system and technology, which are further divided into sub-domains and views. Similarly, architecture is segregated into levels, namely EA, reference architecture, line of business (LoB) architecture, project architecture and implementation architecture.

The interviewees were hand-picked from the centralized EA team, from all of the main business units, and from projects. In relation to the architectural level, most of the interviewees worked on the project/program or LoB level, while two respondents were mostly working on the EA level.

An initial set of five interviewees were identified as a part of a separate EA survey. Then chain (or snowball) sampling was utilized in identifying the rest of the respondents [23]. Data collection continued until theoretical saturation was considered to have been reached [23]. The interviewees, their work roles and whether they are members in the central EA team or in the decentralized architecture organization are described in Table 1.

Semi-structured theme-interviews were conducted according to the IS success model applied in the EA field [21]. The themes included the quality of EA products, the quality of EA services, the use of EA products, the use of EA services, user satisfaction and the benefits of EA products, and user satisfaction and the benefits of EA services.

The interviews were conducted by following the narrative interview method [14], focusing on concrete examples on the topics discussed as "stories". Each of the topics was approached by first requesting a concrete example and then deconstructing it by utilizing clarifying questions. Each interview followed the same order of topics and lasted from 35 to 82 minutes, the average duration being 57 minutes. The interviews were audio-recorded and transcribed. During each interview, detailed notes were taken as field notes to facilitate data analysis and to identify relevant factors to pin down in the subsequent interviews. All the interviews, except one, were conducted by phone.

Data analysis followed the principles of grounded theory methodology [29]. First, the data was coded by using the topics in the research instrument as dimensions. Subsequently, additional dimensions were identified from the data to further refine the coding system. Each fragment of data was also categorized according to whether it depicted the current state or (ideal) target state. Second, the researchers identified an initial set of EA product and service quality attributes from the coded data. Third, the data was categorized iteratively to the attributes and their formalized descriptions. Finally, the findings were reflected to the literature. In addition, a key informant from the case organization was requested to review the findings.

4. Findings

Data analysis revealed ten EA quality attributes: six related to EA product quality and four related to EA service quality. These are discussed in detail in the following sections.

4.1. EA product quality

Clarity and conciseness

An architect summed up the most important quality factors of EA products as follows: *"of course visibility, simplicity… and … well, there they pretty nearly are in short, visibility and simplicity"*[1] [Architect A]. In essence, as the EA definition suggests, it should provide a clear holistic view of the particular target area (e.g. a set of systems, processes, infrastructure or a combination of different types of objects), describe its various components and, basically at one glance, tell what it is all about. This suggests that EA descriptions should compress a fairly large amount of information into a set of models, at the same time maintaining clarity.

One way of promoting clarity is to use the top-down approach: starting from the high-level view and proceeding logically downwards by adding details level by level. Utilizing a formal EA framework was also identified as a means for the distribution of data to a number of architectural views forming an aggregate. *"A model constructed according to a framework is rather superior [as] it forms a consistent and unbroken aggregate, and the topic is also examined from a number of viewpoints; therefore, one can expect to find information for different needs, if one only knows which views to examine"* [Specialist D]. This quote illustrates the benefits of utilizing a framework from the EA user's point of view. An EA framework can be helpful in distributing the information both horizontally (to different domains such as processes and systems) and vertically (to different levels of detail).

Logical and coherent data distribution to a number of views significantly contributes to the clarity of models. As a functional architect put it: *"…clear and coherent, also other architects should be able to recognize the critical points from the model… architectural views should each have their own specific properties, which makes comparison easy"* [Architect M].

On the other hand, those EA descriptions that contain too much information or are structured in an illogical way are unclear. A project manager compared clear and unclear architectural documents as follows: *"…I got a feeling that if the architect has understood what he wants and then is able to guide it to a reason-*

[1] Translated from the original Finnish data by the authors

ably compact package ... in that case the architecture has served its purpose. That is to say it has brought uniformity, clarity and understandability instead of reducing them – which has also happened from time to time when you look at some architectural documents that only confuse you. They confuse you because everything under the sun has been included in every spot of the architecture document, resulting in a jumble of information ... some time ago I read one of the poorer architecture documents which had 100 pages. After reading it I did not understand what I had read, even though I thought that I understood the topic. After reading I thought that now I don't even know what the problem is" [Project Manager E].

Also, to facilitate the interpretation of the models, the models and accompanying textual descriptions should be concise. A functional architect simply said that usually *"the length does not increase quality"* [Architect M]. In graphical models, conciseness has to do with the number of objects included in each model. A technical architect recommended that a maximum 10-15 objects and connections should be included into a model. This would ensure conciseness. The same rule of thumb was related to architecture documents containing a set of connected models, for example project or program architecture.

Granularity

In principle, EA should be able to provide a high-level holistic view of the target area. This was seen crucial as the architectural descriptions should convey basic information about the target area to a random reader. This was seen as one of the most important uses of the architecture.

At the same time the description should give sufficiently detailed information to those parties that use the architecture on the subsequent levels of EA. For example, typically on the project level, the interest is on the technical details such as technical interface descriptions and standards, where a high level of detail is essential. It was seen to be beneficial if the architecture can be directly used as a basis for development.

The main challenge is to produce architectures that can provide both a holistic view and sufficient level of detail at the same time. This was expressed by an EA team member: *"usually one notices that people have struggled in choosing the right level of detail in their architecture models"* [Architect B]. How to produce architectural descriptions at different levels of detail from the same repository source is a challenge.

The level of detail requirement also applies to the models and their textual descriptions. A functional architect commented that textual, formalized information in the model properties is not quite enough. He requested more prose-style text to describe what the model is all about. However, the conciseness of the descriptions still has to be maintained.

Uniformity and cohesion

A certain amount of formality is essential in providing uniformity and forming a coherent aggregate. This is critical when EA models are developed by people both from a centralized EA team and from projects and programs. Obviously, lower level architectures should conform to the upper level architectures and unnecessary duplication should be avoided. For example, in LoB architectures, each element (e.g. system) should be associated with a specific LoB-level architecture to avoid duplication of the element. Cohesion has to also be considered in developing a set of models describing a certain target area from different viewpoints.

Utilizing a formal EA framework in an appropriate way is critical in achieving uniformity and cohesion in EA products. Conformity helps to add coherence and simplifies EA models by clearly defining which views are to be developed, the types of symbols and other content used in each view and the interrelationships between different views. The framework adds uniformity by defining a set of rules for EA modeling. It was mentioned that in a model conforming to a standard framework, more information can be included compared to textual descriptions.

It was typical that project/program architectures were not well aligned with the EA frameworks, whereas higher level architecture conformed to them better. To cope with the challenge of diversified project/program architecture descriptions, the EA team had introduced a standard program architecture template to be used for program/project level architecture descriptions. A development manager sums up the challenges of project architecture documentation as follows: *"...producing huge amounts of text instead of utilizing the EA framework… if one just does not understand the sequence and interdependencies of the views in the framework but adds 2-3 pages of text and a lot of different graphs that do not follow the notation of the EA meta-model for each view, it clearly indicates that the use, meaning and nature of EA as a planning tool has not been understood at all. Then the architecture document is produced just for its own sake"* [Development Manager I].

Project architecture descriptions developed by the suppliers also pose a uniformity challenge. If not requested, suppliers typically use *their* in-house methodologies and templates. Consequently, extra work is required to transform those models to ones conforming to the organization's own framework. Extra work is also required to record the models to the EA repository. There may also be discrepancies between the methodologies in the organization itself: for example, between EA and systems development methodologies, causing architecture descriptions to be incompatible.

Modeling a particular target (e.g. system) in a silo, without identifying and considering interfacing architectures is destructive to the uniformity and cohesion of EA models. For example, a project architect may design a model as if the environment is a completely green field, or as if everything depicted in the model will be implemented in the project – even though this is seldom the case in reality. The same problem may also arise if a certain part of EA is modeled without considering those models already made in the area, especially higher level ones. This not only lowers the quality of the models, but also corrupts the EA tool repository by adding duplicates: *"instead of searching the EA tool repository for existing system models, for example, the architecture owner constructs an own model of the system outright. When this is repeated a couple of times, it leads to a situation where we have four or five duplicates of the processes, services or systems in the repository*" [Development Manager I]. It was suggested that the EA repository reporting capabilities could be used to collect information about EA models related to a certain target area. This was asked to be offered out as an EA service.

A similar challenge may also arise if architectures are modeled from a narrow viewpoint, without considering the EA at large. This leads to cohesion issues and even erroneous models.

Finally, it can be somewhat challenging to distinguish the current state models and target state models from the central EA repository. Consequently, every model should clearly state whether it depicts the current or the target state, and whether target state has become the current state.

Availability

The availability of EA products is crucial to the usability of EA. EA product availability should consider all types of EA products: documents, models and reports. A great deal of architecture exists as documents, which are not necessarily easily accessible. For example, project architecture documents may only exist in the project workspace which is accessible only to key project personnel during the project. It is thus required to know the right persons in order to gain access to the documents. Even with models in the centralized EA repository, availability is a challenge as not all EA users have access there.

It was suggested that the time the architecture user spends in searching for a certain EA product should be minimized by the sharing of EA products, for example in the organization's intranet, and with regular notifications about new architecture material. It also came up that an easy-to-use web-based reporting capability utilizing the EA repository would be valuable to stakeholders who are not users of the EA tool.

Correctness

The interviewees emphasized that the information from the EA products should be correct. It should accurately depict the current state or desired future state of the part of the organization the architecture attempts to describe. Three potential reasons for erroneous products were brought out: the data sources used in the modeling of the architecture, the architecture being out dated, and the architecture being incomplete.

An architect [Architect A] argued that architecture can only be as good as its source material. To highlight his point, he provided an example: a specific architectural view was developed by an external consultant partner, deriving source material from several existing EA products. The owners of each view, however, did not participate in the development at all. In his opinion, the owners of the view should have been involved at least in reviewing the view, which would have to be updated accordingly.

If EA products are not updated regularly, they become erroneous when the organization and its plans change. According to a member of the EA team, the usability of outdated and erroneous EA products is very low: *"I don't know whether an erroneous product or a nonexistent product is of worse quality. It may be that a product that exists but is erroneous is actually more misleading"* [Architect B].

EA products should be iteratively developed and adequately finalized through a systematic development process. Incompleteness, in the sense that the EA product is not adequately finalized, was stated as a reason for a poor quality product. For example, there were EA products, especially architecture documents, containing only initial information from different sources to be worked upon later. The EA models were thus drafts. With some products, this situation seems to persist, making it threat to EA product quality.

Usefulness

EA products should be relevant and potentially beneficial to their users. The products should never be created only for their own sake, but every product should have a purpose. It was seen that to accomplish this goal, the EA team should not be a separate island in the organization but aligned with the business and other management and governance approaches. For individual architects, it was suggested that the "EA supply chain" should be clearly defined, describing the

EA products required, with their consumers and producers. It was seen important that architecture is used as a planning tool, not merely as documentation tool. By some of the interviewees, architecture was seen to be more focused on documenting already planned architecture, especially on the project level. As one interviewee put it: *"usually the planning is carried out by utilizing some freeform modeling methods, and when the system is already chosen or developed, EA models are then created to describe the current state ... this creates some benefits by facilitating the creation of the current state description, but I see EA more as a planning support tool"* [Specialist D]. To pass a formal architecture review was a typical reason for a project to document its architecture in the required format. This causes EA to be seen as burdensome and non-value adding on the project side.

The context and personal preferences of the EA user may also have an effect on the usability of EA products. For example, a project architecture description was seen to be of good quality partly because the area of the project was current and therefore relevant for the user at the time.

4.2. EA service quality

Availability and timing

Obviously, EA services should be available when they are requested. The services should also be available at the right time to yield the greatest benefits to the recipients. This was emphasized with the centralized architectural support for projects and programs. It was considered crucial that the support is given in the early phases of the project – either in the initial planning phase or at least before any acquisition decisions are made. Then the support organization can help the project in describing the target architecture influencing the major architectural decisions, i.e. to guide the project to comply with the overall EA. Moreover, architecture descriptions can then be utilized as a basis for the acquisition process. It was brought out that the EA support organization may help the project especially in integrating the project with the whole: identifying interfaces and other interrelationships, and EA products already existing in the area. Later on, after the project planning phase, architecture planning is more or less finished. Then the type of support is geared more towards documentation – converting the planning documents into a format that can pass the formal project architecture reviews.

The interviewees also identified several types of valuable services, which, however, are not currently appropriately available. For example, the importance of extending project architecture support, both for affecting more projects and for providing specialized support in the form of a dedicated project/program architect in each major project or program was missing. It was considered important that the same project architect should work in a number of projects full-time to have greater visibility and understanding of all development initiatives in the organization.

The seamless integration of separate EA models, for example LoB and project architectures, to a comprehensive EA was also underlined. The EA support organization should ensure the uniformity and compatibility between different models designed by different persons. This was claimed to be the responsibility of the central domain architects.

A need for EA related training was brought out by some interviewees. They felt that methodology and EA tool training would be valuable for helping them to utilize some of the more advanced features of the EA tool, for example how to link different models and objects. Also the need for training on the business issues to facilitate understanding of the modeled contents was recognized, in addition to general architectural training for program and project personnel.

Awareness

The EA service customers should obviously be aware of the services available, the conditions on which they are offered, and their best practices and potential benefits. The EA service organization should consequently actively promote their services to stakeholders. For example, it was seen that the service organization should bring all major programs and projects under the EA support umbrella. This issue was often mentioned, as some programs and projects consider EA work to be very complicated. They avoided requesting EA support, thus only slowing down the development.

The awareness of the services was also emphasized within the architect community. For example, in the words of a domain architect: *"...a person, that is new in the architect´s community should be able to gain sufficient visibility of the services available and the conditions and options with which the person can access them ... who is the person or organization offering that particular service, what kind of input is expected from the person himself, and what are the products received or produced by that service organization"* [Architect B].

Activeness

As with any service, activeness and a can-do service attitude from the service organization was perceived to be an important EA service quality factor. A technical architect said that: *"...activeness from the EA* *team, showing that they are interested in our matters is needed… they should ask how things are proceeding and whether they can help us… these are important factors, maybe even the most important factors … being allowed to ask stupid questions forces one to explain and rationalize one's own thinking. This could lead to more thorough thinking – whether these issues really make sense"* [Architect J].

Usefulness

EA services should be practical and useful for their recipients. The services should be motivating and beneficial to use, giving the EA function the possibility to have an effect on the architecture being developed. However, EA services should not only be beneficial for the EA governance as a whole, i.e. just forcing the projects to adhere to EA, but provide benefits for all parties. For example, formal project and program architecture reviews were often perceived to be burdensome, as they just increased workload and bureaucracy on the projects and programs side, without adding any value. This issue was particularly problematic if the project architecture model had to be converted to the required format for the sake of passing the review.

Also other factors having an impact on the usefulness of EA services were identified. For example, the possibility to utilize external consultant support was considered important. However, the consultants should focus on modeling and tool utilization, and on technical areas, while internal experts were perceived as better for producing the business contents.

Regular face-to-face architect meetings were seen as important to facilitate the consumption of services. Services development should be the centralized EA support organization's responsibility – their educational service to the community. Also, improving formal training should be their responsibility. The training should be personalized to the recipients' needs, and contain concrete examples and exercises. For example, a generic UML curriculum was seen to be insufficient for producing capabilities required in the data modeling.

Finally, the timing of the service has also an effect on its usefulness.

5. Discussion

From the EA practitioner interviews, we identified ten EA product and service quality attributes. In addition, a number of sub-factors for the attributes can be derived from the data. Table 2 presents the quality attributes and their sub-factors.

The list of attributes is somewhat different to the literature. As illustrated in Table 3, the literature covers only a subset of our identified EA quality attributes. We omitted some sources [4,27] as they narrowly focused only on one or two attributes. We considered a quality attribute to be covered if one or more of its sub-factors were referred to.

Table 3 illustrates that for all of the attributes for *EA product quality* (except availability), good or fair coverage in the literature already exists at the attribute level. For *EA service quality*, also references for all of the attributes can be found, though being scarcer than for EA product quality. It is also evident that there is no literature source that encompasses all of the attrib-

Table 2. EA product and service quality attributes and sub-factors

Quality attribute	Sub-factor
EA product	
Clarity and conciseness	Provides overall view
	Top-down approach used
	Logical data distribution
	Number of model elements
	Amount of textual information
Granularity	Conveys basic information
	Level of detail of models
	Level of detail of textual information
Uniformity and cohesion	Conformance to EA framework
	Conformance to existing architectures
	Avoidance of duplication
	Distinguishability of as-is and to-be architectures
Availability	Availability of appropriate EA products
Correctness	Correctness of source data
	Timeliness of description
	Completeness of description
Usefulness	Clear purpose
	Appropriateness to use context
EA service	
Availability and timing	Appropriate timing of service
	Availability of required service types
Awareness	Awareness of available services
	Awareness of service conditions
	Awareness of service benefits
Activeness	Willingness to help
	Showing of interest
Usefulness	Appropriateness to use context
	Benefits to service recipient

utes of either EA product or service quality, let alone both.

It seems that Lange's quality measures [17] provide the best overall coverage of our factors. However, they omit the aspects of uniformity and cohesion, and availability in EA product quality. With regard to EA service quality, Lange's measures more closely resemble EA CSFs (i.e. aspects, factors and tasks) than quality attributes (i.e. non-functional characteristics of factors). This is to a large extent because of Lange's explicit focus on EA management. Under the circumstances his measures are appropriate when the products and services already exist and can be offered to EA customers. The same challenge arises with other EA CSFs [31]. Even though CSFs provide an exhaustive set of factors related to EA product quality, they do not conceptualize EA services as an independent concept, offering only a mixed set of aspects that can be related to EA service quality. However, both Lange's measures and generic CSFs include factors that contribute to our EA service quality attributes. It can thus be argued that more work on conceptualizing the quality of both EA products and EA services is needed.

Table 3. Comparison of EA quality attributes with the literature.

Quality attribute	Literature source				
	[9]	[10]	[17]	[25]	[31]
EA product / domain:	EA	IS	EA	IS	EA
Clarity and conciseness	●	●	●		●
Granularity	●	●	●		●
Uniformity and cohesion	●	●			
Availability					
Correctness	●	●	●		●
Usefulness	●				●
EA service					
Availability and timing			●	●	●
Awareness			●		
Activeness			●	●	
Usefulness					●

The availability of EA products is, surprisingly, not considered a quality attribute in the literature. This may account for the fact that the models are designed for the evaluation of *already existing and available* EA products, taking the availability of products for granted. However, in reality the products stakeholders require may not be readily available, even though this would be an important condition for the fulfillment of the EA stakeholders' needs. On the other hand, EA product availability is considered in the literature in the sense that information contained in the EA product is unavailable in other types of documents [17]. However, this factor was not referred to in our case. Also, the alignment of EA products with business requirements, identified as a CSF in the literature [31], was not explicitly identified as an EA product quality factor, but was related to EA governance mechanisms as an important area of integration.

If one wants to apply these attributes to research and practice, the effect of the *context* should not be dismissed (c.f. [5,24]). For example, different EA stakeholders have different needs in regard to EA [20] so their perceptions of EA quality may vary. Moreover, the *type of the organization, type of EA products and services,* and the *maturity of their EA program* may have an effect on the quality perceptions, as suggested by some authors [17,24,27]. This emphasizes that these aspects should be considered in the choice of measures for EA quality attributes. Obviously, these items are limitations in our study.

6. Summary and Conclusions

In this study, we have defined the quality attributes for EA products and services. From the interviews with 14 EA practitioners, we identified a set of ten quality attributes, which were then compared against the literature for validation. It seems that even though all except one attribute have been identified in the literature (see Table 3 earlier), the coverage is limited. There are no reviews on EA quality attributes. The missing attribute, EA product availability, has not been identified. Altogether, there is a lack of research on EA quality attributes in general, and on EA service attributes in particular.

The study contributes to research by providing a set of EA quality attributes and sub-factors, to be further empirically validated in different contexts and organizations, and with different EA products and EA services. They can also be utilized as a basis for developing comprehensive measures for EA quality. For practitioners, the attributes have some kind of an effect on the overall quality of EA. By taking them into account, the organization's EA function could increase the quality of the EA products and services, consequently increasing stakeholder satisfaction towards EA.

Selecting only one case organization for data gathering is a self-explanatory limitation of this study. With the selection of multiple organizations, the results would have been stronger in respect to generalizability. We thus call for further research in this matter. We also urge more research on the attributes themselves to see whether all of their nuances are identified, and whether their importance varies between the cases and contexts. However, the list of EA quality attributes still provides a basis for understanding the quality of EA products and services. This further helps us to understand what constitutes the quality of EA as a whole, in terms of its processes, outcomes and overall benefits.

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ENTERPRISE ARCHITECTURE STAKEHOLDERS – A HOLISTIC VIEW

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Abstract

The importance of identifying and managing stakeholders and their needs has been emphasized in literature from various fields, including management, Information Systems (IS), Enterprise Architecture (EA) and Software Architecture (SA). The concept of stakeholder has been extensively discussed especially in management literature, but in the domain of EA, no comprehensive and generalizable view of stakeholders has yet been introduced. In this exploratory study, a holistic and generic view of EA stakeholders is constructed by identifying the stakeholders and their EA-related concerns through an extensive literature review, supplemented and validated by a focus group interview of EA practitioners. Moreover, a classification scheme for the stakeholders is suggested. The results are applicable by a wide range of academics and practitioners alike, potentially in other related contexts as well.

Keywords: Enterprise Architecture, EA work, stakeholder, concern, classification

Introduction

Recently, Enterprise Architecture (EA) has gained considerable attention in academia and industry alike. It is suggested to be an approach for supporting and improving communication, decision-making and change management in organizations (see e.g. de Boer et al. 2005). In brief, EA can be seen as a collection of all models needed in managing and developing an organization. It takes a holistic and consistent view of the organization rather than a view of a single application or information system (see e.g. Kaisler et al. 2005; Lankhorst 2005; Jonkers et al. 2006). Being a relatively new concept, research on EA has attempted to define the concept itself (see e.g. Kaisler et al. 2005; Lankhorst 2005). However, the research is still fragmented, predominately focusing on frameworks (see e.g. Sowa & Zachman 1992; The Open Group 2006), and modelling and development methods (see e.g. Lankhorst 2005). Recently, EA evaluation aspects, such as maturity evaluation (see e.g. Niemi 2006; OMB 2006) and critical success and failure factors (see e.g. van der Raadt et al. 2004; Rehkopf & Wybolt 2003; Ylimäki 2006) have gained increasing attention.

The commitment of key stakeholders, such as top management, is crucial to EA success (see e.g. Syntel 2005; Ylimäki 2006). As well as in the EA domain, the significance of identifying, involving and managing key stakeholders is emphasized in numerous other domains, such as software architecture (SA), information systems (IS), requirements engineering, and management (see e.g. Pouloudi 1999; Sharp et al. 1999; Boehm 1996; IEEE 2000; Mitchell et al. 1997). Stakeholders have different, sometimes even conflicting needs and perspectives (Kaisler et al. 2005; Morganwalp & Sage 2003; Jonkers et al. 2006), which should be identified and utilized in EA work. For example, communication is essential in EA work (see e.g. Ylimäki 2006; Lankhorst 2005), and thus the key stakeholders and their requirements for EA content and its representation need to be identified (see e.g. Armour et al. 1999; Lankhorst 2005).

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Although general stakeholder theory is extensively documented in management literature (see e.g. Mitchell et al. 1997), the view of stakeholders in the EA context is considerably more inconsistent, even with the great number of stakeholders identified in literature. Majority of the literature discusses EA stakeholders from the viewpoint of a particular stakeholder (such as the Architecture Group), a sub-area of EA (such as SA), or a specific organization, resulting in a distorted – non-holistic and not generalizable – view of stakeholders. Moreover, although a few models have been proposed particularly in the management (see e.g. Mitchell et al. 1997) and IS (see e.g. Preiss & Wegmann 2001) domains, there is no extensive, established model for classifying the variety of stakeholders in the EA context.

This paper presents an exploratory study which aims at constructing a holistic view of the stakeholders of EA and EA work, encompassing EA planning, development and management (see e.g. Ylimäki et al. 2005). Since the variety of stakeholders and their needs is organization-specific to some extent (see e.g. Clements et al. 2002; Pouloudi 1999), we also aim to provide a view generally applicable in the EA context by an extensive range of EA practitioners and researchers alike. This view provides researchers with a foundation for further research on EA stakeholders, and assists practitioners in identifying and managing 1) the key stakeholders of their EA programs, and 2) the stakeholders' needs, providing a vehicle for better informed EA work planning, and potential for increased stakeholder support. Moreover, because of the generic character of the results and the holistic nature of EA, the results could be applied in other related contexts as well.

Management literature proposes several definitions for a stakeholder (see e.g. Mitchell et al. 1997), including the substantially cited one by Freeman (1984): "A stakeholder in an organization is (by definition) any group or individual who can affect or is affected by the achievement of the organization's objectives". However, as we aim at a holistic, generalizable view of EA stakeholders, we adopt the following, even broader definition from the IEEE standard 1471-2000 (IEEE 2000, adapted):

> *Stakeholder is an individual, team, or organization with interests in, or concerns relative to, an* EA.

Although the standard originally describes a recommended practice for architectural descriptions of software-intensive systems, a system by definition encompasses information and communication technology (ICT) platforms, applications and systems, and even whole enterprises, making the definition appropriate in the EA context. Moreover, we adapt a definition for a concern from the standard (IEEE 2000, adapted):

> *Concerns are interests related to the development of EA, its use and any other aspects that are important to one or more stakeholders*.

The study was conducted in four stages and the paper is organized accordingly. First, a literature review was carried out to identify the stakeholders of EA and their typical EA-related concerns. Second, a focus group interview was organized to validate the literature review results and to supplement experience-based information. Third, the initial list of stakeholders from the literature review was supplemented and modified according to the information from the interview. Moreover, a potential classification for the stakeholders was proposed. Finally, the last section concludes the paper.

Literature review

This section describes the method and results of the literature review.

Method

Literature was charted for references of stakeholders using high-quality academic databases (Academic Search Elite, Electronic Journals Service, Science Direct and Web of Science), Google Scholar and Google. Since EA holistically encompasses an organization – involving architectures on various levels and relating to management activities and ICT development as well – the review was aimed to be extensive, including literature on architectural levels (e.g. EA, SA and system architecture), software and system development, requirements engineering, and management. In the search, the keyword "stakeholder" was used simultaneously with terms "enterprise architecture", "software architecture", "architecture" and "system". In addition to the initial literature provided by the search, additional literature was found by forward and backward search of references (see e.g. Levy & Ellis 2006). Literature by both academia and practitioners was included in the review for a more diverse perception.

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Results

The review identified 24 references including conference papers, journal and magazine articles, books, research reports, and white papers. The notion of stakeholder roles (such as Architect or Acquirer), that can be filled with various individuals, teams and organizations (IEEE 2000), was used as a basis for mapping synonymous or closely related stakeholders under representative initial roles (Table 1). Some of the stakeholders mentioned in the references could be mapped to initial roles in a fairly straightforward manner, as e.g. the stakeholder roles suggested by Armour et al. (1999). However, a number of them had to be derived by the discretion of the author. For example, Sowa & Zachman (1992) present five architectural perspectives, from which five roles were derived.

Subsequently, the initial roles were used as a starting point for defining stakeholder individuals, teams/groups and organizations. The stakeholder individuals were directly derived from the roles. Some of the team/group and organization-level stakeholders were also identified from other literature or added by the author. A preliminary list of stakeholders was constructed from the results, including the identified stakeholders, their brief descriptions and typical EA-related concerns. For clarity, a graphical representation of the results was composed for the next step, including the stakeholders and a suggestion of their hierarchy, adapted from literature (Syntel 2005; NASCIO 2004).

Table 1. Initial EA stakeholder roles, in alphabetical order

Stakeholder role	(Armour et al. 1999)	(Armour et al. 2003)	(Boehm 1996)	(Bot et al. 1996)	(Clements et al. 2001)	(Clements et al. 2002)	(Greefhorst et al. 2006)	(Hay 2003)	(IEEE 2000)	(Kazman et al. 2000)	(List et al. 2005)	(Lung et al. 1997)	(Lyytinen & Hirschheim 1987)	(May 2005)	(McBride 2004)	(Morganwalp & Sage 2003)	(Nightingale & Rhodes 2004)	(Robertson & Robertson 1999)	(Sharp et al. 1999)	(Smolander 2002)	(Sowa & Zachman 1992)	(Syntel 2005)	(The Open Group 2006)	(Zachman 1987)
Application Developer		●		●		●		●					●	●				●		●	●	●	●	●
Architect	●	●		●	●	●	●	●	●	●		●		●	●	●		●	●	●	●	●		●
Business User	●	●	●	●			●		●	●		●	●		●		●	●	●			●	●	
Enterprise Architect	●	●	●	●	●		●	●	●					●	●	●					●	●		●
Evaluator					●	●			●	●								●						
ICT Maintainer	●		●	●		●			●	●	●			●		●						●	●	
ICT Operator																●						●	●	
Legislator																	●	●	●					
Manager		●		●	●	●					●	●	●	●	●	●		●	●	●			●	
Project Manager					●	●				●	●				●			●	●	●				
Security Specialist																						●		
Sponsor		●	●	●	●	●	●		●	●					●		●	●			●	●		●
System Developer	●	●	●	●		●	●	●	●	●	●		●	●	●	●		●	●	●	●	●	●	●

Focus group interview

This section describes the focus group interview methods and results.

Method

A focus group interview (see e.g. Krueger & Casey 2000) of seven practitioners from five Finnish or international organizations was organized. All of the organizations were conducting EA work and thus employed specialists who could contribute to the study. The organizations were either 1) independent companies, or 2) divisions, subsidiaries or other parts of

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domestic or global enterprises. Moreover, they represented different industries and employed from 14 to several thousand people. The objectives of the interview were 1) to validate the literature review results, and 2) to collect additional, experience-based information. The interview was carried out by three researchers – the author acted as the moderator while the others took notes. The interview was also audio-recorded.

Results

While the focus group generally agreed with the literature review results, they did not see the proposed hierarchy of stakeholders feasible. According to the group, this is mainly because of the organization-specific nature of EA stakeholders and the relatively small size of Finnish businesses – the models for organizing EA stakeholders in enterprises (e.g. Syntel 2005; NASCIO 2004) are usually based on experiences in large US organizations (as measured by the number of employees), and are thus difficult to apply in smaller enterprises. Therefore, the relationships or hierarchy of the EA stakeholders and the organizational position of the entire EA-function are difficult to generalize. Moreover, the focus group suggested additional stakeholders (Research & Design and Internal Communications), as well as several additions to the stakeholder descriptions and concerns.

Classification of EA stakeholders

The results of the literature review and the focus group interview were combined into an extended list of EA stakeholders, included in the appendix. It describes the stakeholders, defines their type (individual, team/group or organization), and addresses their typical concerns related to EA. However, as the entire range of EA stakeholders is extensive, a classification scheme based on some of their common characteristics is needed. Although a small number of classification models are provided (e.g. Mitchell et al. 1997; Preiss & Wegmann 2001), none are validated in the EA context. To propose a simple, practically applicable classification, a model by Liimatainen and Koskinen (2007) was applied. The model originally classifies IS research into three contexts, including the viewpoints of 1) IS producers (e.g. software developers), 2) facilitators (e.g. information management and ICT maintenance) and 3) users. In the EA domain, these roles can be defined as follows:

- **Producers** are defined as the stakeholders carrying out EA planning and development. They differ from facilitators and end-users in the sense that they not usually manage or maintain EA, or use it for any other purpose than their primary work. However, some stakeholders such as architects can also be involved in management, maintenance, and even use of EA.
- **Facilitators** are the stakeholders performing EA governance, management and maintenance. The role also includes stakeholders that sponsor and support EA work by e.g. providing resources, requirements or ideas. This role differs from producers because it does not directly conduct EA planning or development. Facilitators are not EA end-users in the sense that their work directly affects EA.
- **Users** utilize EA work and its products (e.g. EA) in their daily work. The difference between the users and the other roles is that the users do not carry out EA work or directly affect EA. However, they can be involved in EA work by e.g. providing business requirements.

The stakeholders were classified accordingly by the discretion of the author, on the basis of the stakeholder descriptions and concerns. Several stakeholders were considered to have a more diverse role, and were therefore classified to have two or even three roles. Table 2 displays the classified stakeholders, with rationale for the classification.

Table 2. Classification of the stakeholders of EA, in alphabetical order

Stakeholder	P	F	U	Rationale
Applications Development	●		●	Use architectures in application development. Could also produce architectural descriptions from their work area.
Architect	●	●	●	Carries out planning and development of domain architectures, can also maintain and update them. Use architectures in assuring architectural consistency and completeness.
Architecture Board		●	●	Carries out strategic management and governance of EA and EA work. May also use the product and impacts of EA work in e.g. assessment of EA success.
Architecture Group	●	●	●	Carries out EA planning, development, maintenance and operational management. Use architectures in assuring consistency and completeness of EA.

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Stakeholder	P	F	U	Rationale
Board of Directors		●	●	Approves and has the business responsibility of EA work. Use EA work impacts in assessing the success of EA. In higher-maturity EA environments, could use the EA in e.g. decision-making.
Business User		●	●	Use the products of EA work in carrying out their daily work. Could also provide business requirements for EA work.
Competitor / Other Company			●	In special cases, may use the organization's EA and its impacts (if available) in their own EA work, for e.g. benchmarking.
Customer	●	●	●	Compliance between organization's and its customer's EA may be required. Therefore, a two-way relationship between their EA work processes might be needed. Moreover, customers could facilitate EA work with their needs and views, or even directly sponsor EA work.
Development Project Group	●		●	Either carry out architectural planning and development in the project area, or be guided by EA for assuring compliance between project results and EA.
Enterprise	●	●	●	In the enterprise, EA planning, development, management and maintenance are carried out, as well as the EA is used.
Enterprise Architect	●	●	●	Carries out EA planning and development, can also maintain and update domain architectures. Use architectures in assuring architectural consistency and completeness.
Evaluator			●	Use EA in assessment.
ICT Maintenance			●	Use architectures in ICT maintenance.
ICT Operations			●	Use architectures in ICT operations.
ICT Organization	●	●	●	Use architectures in e.g. ICT maintenance and operations. May also produce and maintain architectures. In some organizations, the whole EA-function may be situated under the ICT organization.
Internal Comms.			●	Use products and impacts of EA work in communication.
Investment Board		●	●	May approve investments related to EA work and use products of EA work in assessing investments.
Legislator	●	●	●	Carry out architectural planning, development and facilitation in the form of e.g. reference architectures and standards. Use products and impacts of EA work for feedback.
Manager / Management		●	●	May support and sponsor EA work in their areas of responsibility. In higher-maturity EA environments, could use the EA in e.g. decision-making.
Owner		●		Approves EA work via the board of directors.
Partner	●	●	●	Consultants and other partners may guide or carry out EA planning, development and maintenance in the organization. In the same sense, the organization may provide EA work or work products to partners.
Program Management Office		●	●	May carry out high-level management of projects related to EA, and use products of EA work in e.g. assuring EA compliance of project results.
Project Manager	●		●	Either manage architectural planning and development in the project area, or take into account EA for assuring compliance between project results and EA.
Project Steering Group		●		May require a project to produce architectural descriptions from the project area and thus facilitate EA work.
Public				Typically are not interrelated with EA or EA work.
Research & Design		●	●	Use EA work products for maintaining EA compliance in R&D. Could facilitate EA work with new ideas and research contacts.
Security			●	Use architectures in assuring security.
Sponsor		●	●	Sponsors and supports EA work by e.g. providing resources. Use EA work impacts in assessing the success of EA. Could also use EA in e.g. decision-making.
System Development	●		●	Use architectures in system development. Could also produce architectural descriptions from their work area.

Table key: P = Producer, F = Facilitator, U =User

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Conclusion

This study aimed at developing a holistic and generally applicable view of EA stakeholders by identifying the stakeholders and their EA-related concerns through an extensive literature review, supplemented and validated by a focus group interview of practitioners. Moreover, a classification scheme for the stakeholders was proposed. The classification provides a vehicle for deriving a number of potential shared stakeholder concerns:

- **Producers** could be concerned with carrying out EA planning and development in a way that (to a reasonable extent) satisfies facilitators' and users' requirements for 1) the content, presentation and quality of the work products (e.g. EA), and 2) the impacts (e.g. benefits) of the work or EA.
- **Facilitators** could be concerned with strategic or operational management, maintenance, or sponsorship of EA or EA work. In turn, they may require that 1) certain requirements are taken into account in EA planning and development, and/or 2) certain impacts are realized by EA or EA work.
- **Users** could be concerned with receiving EA work products and/or impacts that satisfy their requirements (e.g. enable or ease their work). In turn, they could be involved in EA work by e.g. disclosing requirements and feedback.

However, it should be noted that as several stakeholders have multiple roles related to EA, their concerns could also be diverse. Furthermore, the stakeholders could be classified differently depending on the organization and the phase of the EA program. For example, the top management and the board of directors may act as facilitators in the initial phases, but begin to use EA as its maturity and quality increases. Finally, the stakeholders and their concerns could be organization-specific. Thus, differences may exist depending on e.g. organizational size, type (e.g. hierarchical or matrix) and industry, and the scope and phase of the EA program. The focus group stated that the hierarchy and the organizational position of the EA-function vary across organizations, potentially affecting e.g. the influence and concerns of the stakeholders carrying out EA work. In organizations worldwide, the EA-function has been commonly situated under CIO or information management, but there seems to be a shift to top business management (Schekkerman 2005). Also the focus group expressed a need to bring the EA-function and business closer together, but still argued that the EA-function should not be situated outside the ICT organization because of the possibility of the EA becoming out of control.

This study contributes to research and practice in several ways. Firstly, it provides a preliminary list of EA stakeholders, their characteristics and concerns. Secondly, it proposes a classification scheme for the stakeholders, with potential for validation. These results can be used to analyze current EA work practices, frameworks and metrics for any deficiencies relating to e.g. stakeholder and concern identification and management. Moreover, practitioners can use the results to assure that all relevant stakeholders and concerns have been taken into account in EA work. Although a few most important stakeholders might already be identified, the results could help identifying other, more unapparent stakeholders potentially crucial to the EA program – according to the focus group, some stakeholders may not even be aware that they are stakeholders of EA. The classification scheme further assists in identifying and managing 1) stakeholders who should be involved in EA work or could provide other support, and 2) stakeholders' requirements for EA work products and impacts. Consequently, the requirements and other concerns of the stakeholders could be more comprehensively and extensively considered in EA work, potentially resulting in increased organizational satisfaction towards the EA program. In turn, this may facilitate the diffusion of the EA approach.

Even though the study resulted in an extensive, holistic perception of EA stakeholders, a few limitations can be found. Due to space limitations, the stakeholder descriptions and concerns had to be addressed concisely, and related important areas such as EA stakeholder management are left to be addressed in future research. Moreover, as the classification is for the most part based on the author's discretion, it still needs further validation. Generalizing the results of this study could also be impeded by the fact that the focus group included members of only one nationality and geographical area. Finally, due to the organization-specificity of EA stakeholders, the results are not exhaustive or in all circumstances valid.

As this is an exploratory study, it provides a multitude of themes for further research and discussion. Firstly, the classification scheme should be further validated, and other classification models applied if considered feasible. Secondly, interrelationships between stakeholders should be charted to discover any generic connections. Thirdly, further research on stakeholder characteristics and concerns should be carried out to discover new generic factors. Fourthly, the hierarchy and organizational position of the EA-function should be studied further – even though the focus group perceived that a generic solution may not even be created, it agreed that adaptable reference models could be constructed. Finally, the stakeholders should be prioritized on the account of e.g. their influence to the EA program or to EA success. Moreover, the stakeholders could be associated with certain phases or areas of EA work, or levels of EA maturity, where they have been discovered to be especially important.

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Appendix

Available: http://www.titu.jyu.fi/aisa/publications/appendix.htm

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Appendix

For conference paper
Niemi, E. Enterprise Architecture Stakeholders – a Holistic View. Proceedings of the Americas Conference on Information Systems, Keystone, Colorado, USA, Association for Information Systems, 2007.

Extended list of EA stakeholders, in alphabetical order

Stakeholder	Type	Description	Concerns
Applications Development	I/T	Responsible for constructing individual components of the ICT system (Syntel 2005). Use architectures as a reference for developing and testing system components (Boehm 1996; Clements et al. 2002).	To receive sufficiently detailed architectural descriptions (Boehm 1996; Armour et al. 1999).
Architect	I	Responsible for defining the logical structure of processes, data and applications. Architect positions include e.g. business, information, application, technology, and security architects. (Syntel 2005)	Completeness and consistency of architectural descriptions and requirements traceability (Boehm 1996; Armour et al. 1999).
Architecture Board	T	Includes the highest management level of the organization, and domain experts. Sets EA vision, goals and metrics, and monitors EA development. (Syntel 2005; Armour et al. 1999; The Open Group 2006).	Cost, progress, risks and business value of EA work (Boehm 1996; Clements et al. 2002; Van Grembergen & Saull 2001).
Architecture Group	T/O	Conceives, develops and maintains EA according to the policies set by the architecture board (Syntel 2005). Headed by the chief enterprise architect, and includes various domain architects (Syntel 2005; Armour et al. 1999).	Consistency between EA and business requirements, completeness and consistency of EA, requirements traceability (Boehm 1996; Armour et al. 1999).
Board of Directors	T	Represents the owners and financiers of the enterprise. Approves and has the business responsibility of EA work. However, EA in itself is not discussed in the board, but projects, business ideas, opportunities and such derived from EA and EA work are. The phase and status of the EA program affects the involvement of the board. (Focus Group)	The business value of EA (Van Grembergen & Saull 2001).
Business User	I/T/O	Responsible for daily business operations, and rely on ICT to perform their work (Syntel 2005). However, are not a homogenous organization since various individuals and groups of users might have different concerns related to EA, and can be identified by a number of factors (Armour et al. 1999; IEEE 2000; Sharp et al. 1999). Should be committed to and involved in EA work (Jonkers et al. 2006; Lankhorst 2005).	The business value of EA (Van Grembergen & Saull 2001, adapted), and consistency between EA and business requirements (Armour et al. 1999, adapted).
Competitor / Other company	O	Organization's competitors and other companies that have concerns related to the organization.	To receive various information about EA and the enterprise. The impacts of EA on competitors.
Customer	O	Various customers for the organization's products and / or services.	The impacts of EA on customer experience (Van Grembergen & Saull 2001).
Development Project Group	T	An EA project group, headed by a project manager. Projects could either develop EA or be guided by it. Various roles in the project might have personal views on e.g. the benefits of EA. However, the view of the entire project is more homogeneous. (Focus Group)	Commitment to resources and planned results (List et al. 2005). EA compliance and change management, production of architectural descriptions (Focus Group).
Enterprise	O	The whole enterprise, including all employees.	The business value of EA (Van Grembergen & Saull 2001, adapted).
Enterprise Architect	I	Responsible for planning and developing EA. Identifies the concerns and viewpoints of stakeholders and translates their requirements into EA. (Syntel 2005; IEEE 2000). Should also work as interpreters, creating various views of EA to satisfy various stakeholders (Ylimäki & Halttunen 2005). Usually lead by the chief enterprise architect (Syntel 2005).	Consistency between EA and business requirements, completeness and consistency of EA, requirements traceability (Boehm 1996; Armour et al. 1999).
Evaluator	I/T/O	Conducts EA or EA work evaluation by evaluating e.g. quality attributes. Using EA project or program members as evaluators is not recommended. (Clements et al. 2001)	To receive sufficient information for the evaluation (Clements et al. 2001).
ICT Maintenance	I/T	Responsible for the maintenance of ICT (Syntel 2005). Use architecture as a reference in ICT maintenance and modification (Clements et al. 2002; Armour et al. 1999).	Maintenance aspects of ICT, given its architecture (Boehm 1996).

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Stakeholder	Type	Description	Concerns
ICT Operations	I/T	Responsible for the day-to-day operation of ICT (Syntel 2005) and includes the roles of e.g. operators and system administrators (Kazman et al. 2000). If ICT services are produced to external customers as well, the function carrying out the work has its own concerns and is a distinct stakeholder as well (Focus Group).	Operational aspects of ICT, given its architecture (Boehm 1996, adapted).
ICT Organization	O	Situated under CIO or information management. Could include e.g. ICT maintenance and operation (Syntel 2005).	Quantity, quality and cost of ICT services (Lindström et al. 2006)
Internal Comms.	T	Could have communication on EA as a responsibility and therefore be an essential stakeholder. Present EA in an understandable form to various stakeholders. (Focus Group)	To receive accurate, clear and consistent information about EA and EA work.
Investment Board	T	Board of senior managers responsible for assessing investments. Used in some companies, but in some the assessment is done in the line organization. Moreover, the use could also depend on the size of the particular investment. (Focus Group)	To receive sufficient information for assessing investments.
Legislator	I/T/O	Provide guidelines and constraints for EA and EA work (Sharp et al. 1999). Include e.g. legal representatives, safety and quality executives, auditors, government, trade unions, producers of standards, and researchers (IEEE 2000; Sharp et al. 1999).	To receive various information about EA and the enterprise.
Manager / Management	I/T/O	Encompasses individual managers, groups of management, and the entire management of the enterprise. The support of the CEO and the top management is crucial to EA success (see e.g. Syntel 2005), and the CIO is also an influential stakeholder (Lindström et al. 2006). Also, managers committed in enterprise, business and strategy planning and development, and product, product line and portfolio management should be involved in EA work (Focus Group).	The support of EA for business goal achievement (Van Grembergen & Saull 2001)
Owner	I/O	Owners and investors of the organization.	The business value of EA (Van Grembergen & Saull 2001)
Partner	O	External service providers and collaborators, e.g. consultants, software vendors, outsourcing partners and other suppliers.	The support of EA for collaboration.
Program Management Office	T	Guides projects to ensure that they are carried out consistently and successfully in alliance with strategy (NASCIO 2004). Usually situated under the ICT organization (Focus Group).	Completion of projects (NASCIO 2004).
Project Manager	I	As EA work is commonly executed as projects, the project manager of such a project is an important stakeholder. The project manager's view is rather project-specific, so EA compliance, management of changes in EA, and production of architectural descriptions should be required in and from the project area. (Focus Group)	Commitment to resources and planned results (List et al. 2005). EA compliance and change management, production of architectural descriptions (Focus Group).
Project Steering Group	T	The production of comprehensive architectural descriptions of the project area and its external connections could be challenging in practice. Therefore, the project steering group could require these descriptions from projects (Focus Group)	To receive architectural descriptions of the project area and its external connections (Focus Group).
Public	O	Includes the public impacted by the enterprise, media and other commentators. However, the public does not yet recognize EA work (Strano & Rhemani 2005).	The impacts of the enterprise and EA on the public.
Research & Design	T/O	Need support and approval from the architecture group for maintaining EA compliance in R&D (Focus Group).	EA support and constraints (Focus Group).
Security	I/T	Responsible for protecting organization's operations, systems and data (Syntel 2005).	Security aspects of the organization and ICT, given their architecture (Boehm 1996, adapted).
Sponsor	I/T	The executive-level acquirer, customer, sponsor or owner of EA. Helps to determine EA scope, acceptance criteria, risks, feasibility, budget and schedule (Armour et al. 1999). The drive for EA work should come from the board of directors or the top management to ensure commitment (Syntel 2005).	Cost, progress, risks and business value of EA work (Boehm 1996; Clements et al. 2002; Van Grembergen & Saull 2001).
System Development	I/T	Responsible for building the ICT system (Syntel 2005; IEEE 2000). Use architectures as a reference for e.g. compatibility checks, component interoperability and testing (Boehm 1996; Clements et al. 2002).	To receive sufficiently detailed architectural descriptions (Boehm 1996; Armour et al. 1999).

Table key: I = individual, T = team or group, O = organization

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Using Enterprise Architecture Artifacts in an Organization

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As a tool for management and planning, Enterprise Architecture (EA) can potentially align organizations´ business processes, information, information systems and technology towards a common goal, and supply the information required within this journey. However, an explicit view on why, how, when and by whom EA artifacts are used in order to realize its full potential is not defined. Utilizing the features of information systems use studies and data from a case study with fourteen EA stakeholder interviews, we identify and describe fifteen EA artifact use situations that are then reflected in related literature. Their analysis enriches understanding of what are EA artifacts, how and why are they used, and when are they used, and results in a theoretical framework for understanding their use in general.

Keywords: enterprise architecture; use situation; artifact; utilization; case study

1. Introduction

Enterprise Architecture (EA) is a comprehensive approach for business development. In its essence, it involves the alignment of organizations' business capabilities, information, and information technology (IT) to a common goal through the production and utilization of architectural models (Ylimäki 2006; Tamm et al. 2011; van der Raadt 2011). Despite this promising approach and increasing interest by practitioners, high-quality EA research has been scarce (Tamm et al. 2011). It also focuses, to a large extent, on the definition aspect of EA, such as frameworks and modeling (Tamm et al. 2011; Ylimäki 2006; Schönherr 2009; Nogueira et al. 2013). Only recently have more fundamental issues such as the value of EA (Tamm et al. 2011), realized benefits (van der Raadt 2011; Lange, Mendling, and Recker 2012) and organizational implementation of the EA function (Aier and Schelp 2010; Hjort-Madsen 2006) gained attention in empirical inquiry.

The use of different kinds of EA artifacts has been said to be the most vital antecedent for EA benefit realization (Tamm et al. 2011, 149–150). Yet the topic has not been studied extensively or in detail (Winter et al. 2007; Purao, Martin, and Robertson 2011). Previous studies have either described EA use situations very narrowly, with only a few aspects of use, or focused on a single or a limited set of use situations. Consequently, a comprehensive view on why, how, when and by whom EA artifacts should actually be used to realize its benefits is missing (Sidorova and Kappelman 2011; Winter et al. 2007; Purao, Martin, and Robertson 2011). This makes it difficult to study, describe, explain, and manage EA practitioner work. It is very easy

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to fall into the trap of merely producing EA artifacts (cf. Lange 2012, 232), without considering their use situations and stakeholders (cf. Lankhorst 2005), let alone the motivation and objectives for EA in the organization.

In this paper, we study the use of different EA artifacts. These artifacts include, for example, current and future-state architectural models, roadmap, EA principles and standards (Tamm et al. 2011; Lange 2012; Boh and Yellin 2007) and EA services such as support for project architecture planning (Lange 2012; van der Raadt 2011). As we want to gain comprehensive understanding of the different EA artifact use situations, we chose the following generic research questions to guide our study:

Why are EA artifacts used?

Who are the stakeholders using the EA artifacts?

What actually are the EA artifacts?

When are the EA artifacts used?

In order to answer these questions, we conducted a qualitative, interpretive case study (Yin 2009) with fourteen semi-structured EA stakeholder interviews to identify and analyze real, concrete EA artifact use situations and to gain understanding of their distinctive characteristics. The use situations are analyzed and interpreted by utilizing the items from the information system (IS) use framework (Burton-Jones and Straub 2006). This result in insights into what EA is and how it is used building a shared understanding among various EA stakeholders on EA goals (cf. Armour and Miller 2000). This ultimately helps to ensure that EA is used in an appropriate manner to create business value (cf. Bittner and Spence 2003).

Next, related research is discussed. Then a theoretical framework is formed. This is followed by research settings and methods, and presentation of the findings. The paper ends with a discussion and concluding section.

2. Related research

EA is defined as "*the definition and representation of a high-level view of an enterprise's business processes and IT systems, their interrelationships, and the extent to which these processes and systems are shared by different parts of the enterprise*" (Tamm et al. 2011). This emphasizes EA being both a process and the results of this process. EA processes encompass a set of planning, delivery and governance processes used in EA management (Lange 2012; van der Raadt 2011). These are mostly concerned in producing and updating EA artifacts, and facilitating and directing their use.

When EA work (e.g. modeling) is carried out, it results different types of artifacts, such as concrete EA products and abstract EA services. EA products consist of models, principles, standards and other documentation that provide a representation (or model) of the organization and guidelines for its development (Tamm et al. 2011; Lange 2012; Boucharas et al. 2010; Boh and Yellin 2007; Liu et al. 2008). Generally, EA models describe the structure of the organization, its resources and their flows, and the functions accomplished by the flow and use of resources (Liu et al. 2008). There are different frameworks, tools and approaches the organization can use to focus and scope its modeling activities (see e.g. Liu et al. 2008).

EA products cover different domain architectures, such as business, information,

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systems and technology architectures on several abstraction levels (Pulkkinen 2006; van der Raadt 2011), ranging from general overview architectures and lines of business (LoB) descriptions to individual projects and solution implementations. Recently, modeling of goals and requirements behind EA has also been added to some EA frameworks (Engelsman et al. 2011; Nogueira et al. 2013). EA products are also related to different time orientations, including current and a target state, and transition from the current state to the target state (Kaisler, Armour, and Valivullah 2005; Lange 2012).

EA products may also be supported with various services (van der Raadt 2011, 48). Those services are abstract EA artifacts, being particularly concerned with enabling EA to direct planning, development and decision-making, i.e. realizing the EA target state. For example, architects can offer training and coaching to development projects in modeling the project architecture, and conforming the project architecture to relevant existing architectural documents (artifacts) in the process (Lange 2012; van der Raadt 2011).

Ultimately, different kinds of EA benefits, for example reduced costs and improved IT-business alignment, can be gained from the use of EA artifacts (Lange 2012; Tamm et al. 2011). This underlines the importance of someone actually using the results of the EA processes. It is thus not sufficient to merely have high-quality EA processes and artifacts if they are not utilized in an appropriate way. This is similar to the IS context, where the system use has been identified to a significantly impacting on the IS benefits (Petter, DeLone, and McLean 2008).

Yet EA artifact use situations have not been extensively studied (Sidorova and Kappelman 2011; Winter et al. 2007; Purao, Martin, and Robertson 2011). In general, these studies have had either very abstract, or highly detailed but very narrow focus. Previous studies have addressed, for instance, high-level use contexts (e.g. project portfolio or risk management), or potential outcomes from such use (e.g. business-IT alignment) (e.g. Winter et al. 2007; Boucharas et al. 2010).

Within the detailed studies, the use of EA artifacts in IT acquisition management (Boyd and Geiger 2010) and IT portfolio management (Quartel, Steen, and Lankhorst 2012) have been studied. However, the majority of the earlier research has focused on different types of formal EA model analysis methods for either analyzing the current state (e.g. Winter et al. 2007; Purao, Martin, and Robertson 2011; Närman et al. 2011; Närman et al. 2014) or facilitating decision-making on the optimal target state (e.g. Niu, Xu, and Bi 2013; Babar, Zhu, and Jeffery 2004). Currently, there is no comprehensive model for describing EA artifact use.

One rare example of a comprehensive model of architectural uses originates from the software engineering field. Software architecture metaphors characterize the ways in which software architecture is perceived by stakeholders, suggesting various uses for software architecture descriptions (Smolander, Rossi, and Purao 2008) (see Table 1). A few authors have also addressed software architecture use situations (e.g. Clerc, Lago, and van Vliet 2007). However, there are mixed conceptions on their applicability to the EA context. While they have been adapted to the EA context (Lange 2012), it has also been suggested that the use of EA fundamentally differs from software architecture (Purao, Martin, and Robertson 2011). Therefore, there is a need to thoroughly understand the EA artifact use.

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Table 1. Software architecture metaphors (Smolander, Rossi, and Purao 2008)

Metaphor	Definition
Blueprint	Specification of the system to be implemented.
Language	Medium of communication for achieving common understanding.
Decision	Choices about the system to be implemented and rationale.
Literature	Documentation for current and future generations of users and developers.

3. Theoretical framework

IS use is often defined as the "*an individual user's employment of one or more features of a system to perform a task*" (Burton-Jones and Straub 2006). The employment and use compromises a number of characteristics and measures (DeLone and McLean 2003; Burton-Jones and Straub 2006), ranging from very lean (i.e. presence of use) to very rich (i.e. extent to which a user employs an IS to carry out a specific task) (Burton-Jones and Straub 2006).

EA use resembles IS use in many ways. While IS is defined as being an organized collection of IT, data and information, processes and people (Hirschheim, Klein, and Lyytinen 1995), EA is similarly seen as a collection of principles, methods and models that describe the entire organization (Lankhorst 2005). EA thus includes the components of IS as it (in IS) refers to systems architecture in EA, data and information to information architecture, and processes and people to business architecture, respectively. Also, EA is used to accomplish some tasks in an organization. Similarly it can be regarded as a function to mediate a certain activity (Hirschheim, Klein, and Lyytinen 1995). From this perspective, IS functionality resembles the EA process viewpoint.

EA artifact use can thus be defined as *an individual user's employment of EA products and services to perform a task*. In order to understand EA artifact use, we adopt the items of the rich IS use measures, namely *system*, *user* and *task* (Burton-Jones and Straub 2006). These form the basis for our analysis: motives (i.e. task), stakeholders (i.e. user), and EA artifacts (i.e. system). As EA is also used in some IS development endeavors, we add the development phase of a project where those artifacts are utilized. Each of these items answers a specific research question. Next, these items are discussed in detail.

Motives

The *task* describes the goals (i.e. motives) for IS use (cf. Burton-Jones and Straub 2006). The motive is similar in EA artifact use: to accomplish a task and achieve a goal.

Although architecture has been traditionally perceived as a (technical) blueprint of a system which is used as a specification of a system to be implemented, also other kinds of uses have been considered (Smolander, Rossi, and Purao 2008). In the EA context, there are several motives for use. They include the support for *decision-making on the EA target state*, the *guidance for implementation and feedback to be taken into account in EA products* (Pulkkinen 2006; van der Raadt 2011; Lange 2012), and the *use of EA in other IT and business planning activities* (Boyd and Geiger 2010; Boucharas et al. 2010; Winter et al. 2007; Aier, Gleichauf, and Winter 2011; Närman et al. 2011).

For example, EA products can be used to support decision-making by facilitating the analysis of organizational attributes such as data accuracy (Närman et al. 2011) or IS availability (Närman et al. 2014). In the software architecture domain, different architecture trade-off methods have been suggested for selecting the optimal architecture option (scenario) for the target state (e.g. Babar, Zhu, and Jeffery 2004). Particularly non-functional architecture requirements can be used as a basis in selecting the optimal target architecture (Niu, Xu, and Bi 2013).

Within other IT and business planning domains, EA artifacts can be particularly used to support the IT acquisition process, for example by providing a description of the organization and its requirements for vendors (Boyd and Geiger 2010). EA models can also be used to valuate IT and project portfolios in terms of their contribution to business goals (Quartel, Steen, and Lankhorst 2012).

EA can also be used as a *communication* tool with a more generic purpose, for instance in business-IT or organizational alignment (van der Raadt 2011; Winter et al. 2007; Tamm et al. 2011), or for conveying an overview of the organization and its objectives across the whole organization (Kappelman et al. 2008; Sasa and Krisper 2011). EA artifacts can also be used for *quality evaluation* purposes (Ylimäki 2006).

As a high-level description, EA is not a specification for implementation *per se*. Instead, EA artifacts provide high-level guidance for individual development projects. This encompasses two activities: guiding the projects so that their architecture description conforms to relevant EA products, and validating the conformance of the finished architecture description to applicable EA artifacts (Foorthuis and Brinkkemper 2008; Lange 2012; van der Raadt 2011). EA helps especially in defining project scope and interrelationships with the environment (Winter et al. 2007).

Stakeholders

A *user* is a person who employs an IS in a task (Burton-Jones and Straub 2006). However, we take a more comprehensive view on the users of EA and consider the user being any stakeholder interacting with EA. This includes both individuals and groups (cf. Freeman 1984).

EA has several different stakeholders (Niemi 2007). They can be roughly classified as those *producing* EA artifacts (e.g. architects and projects), those *using* them (e.g. architects, projects, IT organization, and management), and those *facilitating* EA artifact production and usage (i.e. management) (Niemi 2007).

EA artifacts

An IS can be described as an artifact that provides representations of one or more task domains (Burton-Jones and Straub 2006). Similarly, EA artifacts (products and services) can represent task domains such as decision-making or communication.

EA products are characterized by their *domain*, *level of abstraction*, and *time orientation* (Pulkkinen 2006; Kaisler, Armour, and Valivullah 2005; Smolander, Rossi, and Purao 2008). These factors impact use, especially in decision-making on the EA target state. Architectural decisions on each level of abstraction should consider other EA products from both preceding and subsequent levels (Pulkkinen 2006; van der Raadt 2011). Within a particular level, the products of each EA domain also guide decision-making on several other domains (Pulkkinen 2006). EA products of all time orientations are utilized in decision-making (van der Raadt 2011).

EA services are generally considered as support vehicles for the creation and use of EA products (e.g. van der Raadt 2011). Both decision-making on EA target state (van der Raadt 2011) and guiding projects to adhere to EA can be facilitated by services (Lux, Riempp, and Urbach 2010).

Development phase

As EA artifacts are utilized to guide implementations (Foorthuis and Brinkkemper

2008; Lange 2012; van der Raadt 2011), the phase when the results are introduced to the development project may be critical. Therefore, the phase of the development project in which the EA artifacts are (mainly) used offers a basis for understanding their usage. Potential candidates include project initiation, analysis, design, implementation and testing phases (e.g. Armour and Miller 2000).

4. Research setting and methodology

An explanatory single case study method (Yin 2009) was utilized. It was chosen because EA artifact use is lacking an established theory and knowledge base, as discussed earlier. Under the circumstances an explanatory case study allows one to gain in-depth understanding about EA artifact use. As the first author had followed the case organization as an external consultant for several years before the study took place, it was estimated that the maturity of the organization's EA was appropriate to provide research data of adequate depth and extent.

The study took place in a large Finnish public sector organization, which has undertaken EA work for more than five years. The organization is governed by a centralized group administration, and has several fairly independent LoBs. It uses EA to concretize strategic plans, set architectural guidelines for development initiatives, and guide individual projects in conforming to EA. During a given period, the organization has underway a multitude of development initiatives, which are governed by typical corporate governance processes such as portfolio management, project and program management, procurement and IT governance, in addition to EA.

The organization has organized its EA work in a federated, semi-centralized manner. A centralized EA team acts as an EA support organization. Its domain architects provide a number of services to architects at business units, and all other stakeholders. Such services include, for example, architectural support for projects and programs, formal architecture reviews, regular architect meetings, training, and external consultant support.

In its EA work, the organization utilizes an established EA framework and a repository-based EA modeling tool. The framework defines a set of EA domains: business, information, system and technology. EA is also segregated into levels, namely EA, reference architecture (RA), LoB architecture, project architecture and implementation architecture. While the EA level presents a high-level overview of the entire organization, RA gives architectural guidelines for the several groups of operational units, clustered according to the business areas. LoB architecture then describes each business unit in more detail. Project architecture is a detailed view of a solution developed in a specific project or program. Finally, implementation architecture contains the detail level required for the implementation of the solution.

Research data was collected through fourteen dedicated semi-structured theme-interviews. The interviewees were hand-picked from the centralized EA team, all of the main business units, and individual development projects. All EA abstraction levels were covered. An initial set of five interviewees was identified as part of a separate EA survey, and then snowball sampling (Paré 2004) was exploited to identify the other respondents. Data collection continued until theoretical saturation was considered to be reached (Paré 2004). Table 2 presents the interviewees and their characteristics.

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Table 2. Interviewees and their characteristics

Interviewee	Work role	Level	EA team
Architect A	Technical-Functional Architect	LoB	Central
Architect B	Domain Architect	EA	Central
Specialist C	EA Framework Specialist	LoB	Central
Specialist D	Lifecycle Management Specialist	LoB	Decentralized
Project Manager E	Project Manager	Project	N.A.
Line Manager F	Line Manager, Specialist in Project	Project	Decentralized
CIO G	Head of Information Systems	LoB	Decentralized
Project Manager H	Project Manager	Project	N.A.
Development Manager I	Development Manager	EA	Central
Architect J	Technical Architect	LoB	Central
Program Manager K	Program Manager	Project	N.A.
Project Manager L	Project Manager	Project	N.A.
Architect M	Functional Architect	LoB	Central
Architect N	Architect	LoB	Central

The interview themes were defined according to the IS success model applied in the EA field (Niemi and Pekkola 2009). The model covers the issues of quality, use, user satisfaction and benefits of EA products and EA services, making it suitable to identify the issues related to use. In particular, as the interviews were conducted by following the narrative interview method (Jovchelovitch and Bauer 2000), focusing on concrete examples as "stories", different EA artifact use situations were evidently revealed. Each theme was approached by requesting an example and then breaking it down by utilizing clarifying questions. The interviews took place during October 2011 – January 2012, and lasted from 35 to 82 minutes (on average 57 minutes). They were audio-recorded and transcribed. Detailed field notes were also taken to facilitate data analysis and to identify relevant factors on which to focus later. All interviews, except one, were conducted by phone.

Data analysis, carried out by the first author, followed interpretive research approach and the instructions by Klein and Myers (2001) and Walsham (2006). First, the transcripts were coded by using the interview themes as initial coding categories. Second, the data referring to EA artifact use was iteratively reanalyzed over and over again, and coded according to the motives, stakeholders, EA artifacts, and development phase (see Section 3). This approach was chosen to supplement the IS success model in order to facilitate more in-depth analysis of the data, and to find examples and evidence on EA artifact use. From this sub-set of data, a set of use situations were identified and iteratively defined. Identical data was grouped together and descriptive names were given to every use situation. Then the codes were used to structure the descriptions. Third, the findings were reflected against the theory base. Finally, a key informant from the case organization reviewed the findings, with no changes. Table 3 illustrates the coding process by providing examples of the coding categories.

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Table 3. Examples of coding categories

Framework item	**Use situation**	**Example from the interviews**
Motives, Stakeholders	Train and instruct	*"Getting to know a system, architecture descriptions are a pretty good means for getting to know a new area."* [Architect A]
Motives, Stakeholders, EA artifacts, Development phase	Support management	*"The steering, ownership and governance responsibilities [of the service architecture] can be quite well tied to the life cycle definitions [used in the service architecture]."* [Development Manager I]
Motives, Stakeholders, EA artifacts, Development phase	Define and plan solution	*"[In the program] there is this IT architecture description that has around twenty IT requirements derived from the current EA version… it is essential that [EA] can affect the program or project in its early stages through requirements."* [Architect J]
Motives, Stakeholders, EA artifacts, Development phase	Create EA product, Provide support for projects	*"…the program planning results should be immediately packaged into the [program] architecture, so it would be created alongside [program planning]… so there should be an architect involved in the program initiation phase…"* [Project Manager L]
Motives, Stakeholders	Present content	*"EA descriptions [in the EA tool] get better and better; it is very good to show things from there, when I present situations or our systems…"* [Architect N]

5. Findings

Fifteen EA use situations were identified. This suggests a variety of different EA uses. Tables 4 and 5 provide illustrative examples of the identified use situations. The use situation in Table 4 emphasizes the EA product creation and the differences in the use situation items. They depend on the level on which the product is created. The use situation in Table 5 features a typical EA service production and consumption situation. All fifteen use situations are listed in the Appendix. The quotations are translated from the original Finnish data by the authors.

Table 6 presents a summary of all identified EA use situations. *Motives* map the situation to the EA use motives. *Primary stakeholder(s)* are those stakeholders interacting with EA products and/or producing EA services, and *secondary stakeholder(s)* ones acting as service recipients (if applicable). Regarding EA results, *product domains* and *levels* identify the types of EA products applied, and the *service* field indicates whether the use situation involves the use of an EA service. Product *time orientation* (current state, target state and transition plan) is omitted since it was not explicitly referred to in the data. *The development phase* (e.g. Armour and Miller 2000) states in which phase of a development project the use typically takes place.

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Table 4. Example of EA artifact use situation (Use situation 1)

Name	Create EA product
Motives	Support target state decision-making *(EA, RA and LoB levels)* Guide implementation *(project level)*
Stakeholders	EA team *(product producer; EA, RA and LoB levels)* Project *(product producer; project level)*
EA artifacts	All levels and domains *(EA and RA levels)* EA, RA and LoB level; all domains *(LoB level)* EA, RA and LoB level; all domains *(project level)*
Development phase	N.A. *(varied update cycle for EA, RA and LoB levels)* Initiation *(project level)*
Description	This use situation involves the creation of new and revised EA products. For EA products above the project level (i.e. EA, RA and LoB level), this use mostly has to do with supporting decision-making on the EA target state. On the project level, the motives are more geared towards guiding implementation by assuring that the project architecture conforms to relevant EA products. As EA products are created on different levels of EA, products of multiple levels are used as source material. To facilitate this, each *“[EA product] should provide adequate source data for stakeholders fining it down”* [Architect B]. The levels of products used as source material depend on whether the product being created is on the project or LoB level or on the EA or RA level. Products of all domains are used. Also the stakeholders involved in EA are similarly dependent upon the product level. Levels above project are typically modelled by centralized architects, while project architecture is created by a designated project architect (usually the project manager or technical representative), with the help of EA support services. EA products above the project level are typically created and updated as needed, leading to a varied creation and update cycle. Project architecture creation was seen to be most useful in the initiation phase, as parallel activity to project planning.

In the following, the findings on EA use situations are summarized. The analysis terms; motives, stakeholders, EA artifacts, and development phase (see Section 3) are used to describe the findings. The findings are then discussed in the next section.

Motives

The motives of use fell into four categories: supporting target state decision-making; guiding the implementation; supporting other planning activities; and supporting communication. While most use situations staged only a single motive, some had two. For instance, when new or updated EA products are created, the motive depends on the level on which the product is created (the project level, or the EA, RA or LoB levels). Interestingly, utilizing EA for quality evaluation purposes was not explicitly mentioned.

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Table 5. Example of EA artifact use situation (Use situation 4)

Name	Provide support for projects
Motives	Guide implementation
Stakeholders	EA team *(service producer and product user)* Project *(service user)*
EA artifacts	All levels and domains
Development phase	Initiation
Description	This use situation involves the use and production of architectural support for a development project to facilitate the creation of the project architecture description, and ultimately to pass the formal project architecture review(s). While the project may be the active party in requesting support, proactive offering of the service was preferred: *"when a project is initiated, someone should immediately be guiding it… to package the results of project planning right away into the required architecture format"* [Project Manager L]. The support is initiated with a kick-off meeting to identify the support need, provide requirements, guidelines and templates, and agree on timetables. All types of existing EA products may be provided for the project as references and examples. Follow-up meetings are also typically held, occasional questions answered and ad-hoc coaching and training given. Typically, a senior central architect is responsible for offering the service, while the named project architect and possibly other subject-matter experts participate from the project side. Support should be focused on the initial planning phase of the project.

Stakeholders

Most of the use situations involved numerous stakeholders. These included both EA artifact producers and users. Most often EA teams and development projects exploited the EA artifacts. Also management and IT maintenance organization were acting as users. The only stakeholders acting as EA producers included the EA team, projects and the consultant partner. While they were involved in EA product creation, only the EA team and the consultant partner acted as EA service providers. The projects just utilized the services provided by these stakeholders in creating the EA products. Although facilitator-type stakeholders were not explicitly associated with individual use situations, top management support was perceived as critical for EA creation and utilization in general.

EA artifacts

While all of the use situations involved the creation and/or the use of EA products, only about half of the situations considered EA services. In those situations, the services were mainly produced to facilitate either the use or production of EA products.

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Table 6. Summary of identified EA artifact use situations

Use situation	**Mo-tives**[a]	**Stakeholders**		**EA artifacts**			**Dev. phase**
		Primary	**Secondary**	**Product domain**	**Product level**	**Service**	
Create EA product	TS/IM	EA team, Project	N.A.	All	All	No	N.A./ Initiation
Provide support for architects	TS/IM	EA team (central)	EA team	All	All	Yes	N.A.
Provide support for projects	IM	EA team / Consultant partner	Project	All	All	Yes	Initiation
Provide modelling support	TS/IM	Consultant partner	Project	All	Project	Yes	N.A./ Initiation
Review project architecture	IM	EA team (central)	Project	All	Project	Yes	All
Define and plan solution	IM	Project	N.A.	All	All	No	Initiation /Analysis
Design and implement solution	IM/ CM	Project	N.A.	All	Project	No	Design/ Impl.
Execute solution acquisition	IM/ CM	Project, Supplier	N.A.	All	Project	No	Analysis
Maintain solution	CM	IT maintenance	N.A.	System, Tech.	Project, Impl.	No	N.A.
Plan solutions update	IM/ CM	Project	N.A.	All	EA, LoB, Project, Impl.	No	Initiation
Support management	OP	Mgmt./ EA team	Mgmt.	Busines s, System	EA	Yes	N.A.
Support strategic planning	OP	Top mgmt./ EA team	Top mgmt.	Busines s	EA	Yes	N.A.
Train and instruct	CM	All	All	All	All	Yes	N.A.
Present content	CM	All	All	All	All	No	N.A.
Take part in EA team meetings	CM	EA team (central)	EA team	N.A	EA, RA, LoB	Yes	N.A.

[a] TS = Support target state decision-making; IM = Guide implementations; OP = Support other planning activities; CM = Support communication

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Although in most use situations EA products of all abstraction levels and domains were used, some situations turned out to be specific only to some levels and/or domains. For example, project-level products were favored in projects and primarily used in project-related use situations such as providing modeling support, reviewing project architecture, or supporting solution acquisition, design or implementation.

In EA product creation situations, the level of the abstraction of the source products obviously depends on the level on which that product was created, as discussed earlier. For example, on the EA and RA levels, EA products of all levels were used. On the project and LoB levels, all levels of products except the project level were used.

In a few use situations concerning EA products, the stakeholders also favored domain specific products. While management utilized mostly business and high-level system blueprints, IT maintenance expected detailed descriptions and products from system and technology domains. Surprisingly, it was not explicitly mentioned which time orientation (current state, target state, transition plan) the products were used. The data does not reveal which time orientations were favored in which use situations, whether there are differences between the use situations, or whether this is after all a significant factor in terms of use.

Development phase

A specific phase in which use occurs could be defined for all of the use situations which involved project stakeholders. Most often the use seems to occur in the projects' initiation phase.

6. Discussion

EA vs. software architecture use

EA artifacts seem to be used in various ways, more than analyzed earlier, or for example studied in the context of software architectures (cf. Smolander, Rossi, and Purao 2008). For example, EA seems to be more comprehensive than software architecture metaphors as most of the EA artifact use situations seem to cover multiple metaphors and include significantly more varied use. This emphasizes the diversity of EA use over software architecture use. In Table 7, the identified EA artifact use situations are compared to the software architecture metaphors (see Table 1 and Smolander, Rossi, and Purao 2008). For example, in *creating new EA products*, EA artifacts can be used as *blueprint* (as the resulting target state EA artifacts specify a certain implementation or give guidelines for an implementation on a higher level), *language* (i.e. resulting EA artifacts can be used as a communication medium in many situations, and existing EA artifacts can be used to guide the creation of the new ones), *decision* **(**resulting target state EA artifacts document design choices related to the areas the artifacts describe), and *literature* (as both current and target state EA artifacts can be used now and in the future as documentation on the state of the architecture and its improvement plans).

In our case, EA artifacts seems to be used to the largest extent as *literature*, i.e. as source material and reference in creating new EA products, and as *language*, contributing to EA communication. EA artifacts also provide guidance and direction for

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implementation. Early development phases seem to emphasize use in implementation, while in later phases the use orientates towards literature. The *decision* viewpoint is emphasized in creating EA products and making informed decisions. EA artifacts are also used in areas traditionally considered for software architecture use, such as solution design, implementation and maintenance (cf. Smolander, Rossi, and Purao 2008). However, the use of EA products and services seems to be more multifaceted, covering many of these issues at once. This indicates more extensive complexity of EA over software architectures.

Reflection to literature on EA use

The findings are to a large extent in line with the earlier suggestions on EA use motives (e.g. Pulkkinen 2006; van der Raadt 2011; Lange 2012; Winter et al. 2007). However, although formal analysis methods, such as influence diagrams for EA product analysis (cf. Johnson et al. 2007; Winter et al. 2007; Sasa and Krisper 2011) have been suggested, in our case this analysis was technically much simpler as it was based on basic EA tool functionality (e.g. dependency modeling) and expert opinion. The evaluation of EA products, architecture trade-off methods, or the role for EA products in the IT acquisition and portfolio management processes were not brought up in the case (cf. Babar, Zhu, and Jeffery 2004; Ylimäki 2006; Boyd and Geiger 2010; Clerc, Lago, and van Vliet 2007; Quartel, Steen, and Lankhorst 2012). Generally, the analysis of EA products was much simpler in practice than suggested by the myriad of complex technical analysis methods presented in the literature. For example, in IT acquisition EA products were purely regarded as background material.

Table 7. EA artifact use situations and related software architecture metaphors

	Metaphor[a]			
Use situation	**Blueprint**	**Literature**	**Language**	**Decision**
Create EA product	●	●	●	●
Provide support for architects	●	●	●	●
Provide support for projects	●	●	●	
Provide modelling support	●	●	●	
Review project architecture		●		●
Define and plan solution	●	●	●	●
Design and implement solution	●	●	●	
Execute solution acquisition	●		●	
Maintain solution		●		
Plan solutions update		●	●	●
Support management		●	●	●
Support strategic planning		●	●	●
Train and instruct		●	●	
Present content			●	
Take part in EA team meetings		●	●	

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Also the myriad of EA stakeholders was evident. The classification of EA stakeholders into EA users and producers is feasible for describing EA artifact use, even though facilitator-type stakeholders directly involved in use situations were not explicitly identified (cf. Niemi 2007). In the case most EA artifact use took place at the project level. The main actors were project architects and EA team members, with relatively few references to management and IT line organization. The use of EA products by the non-architect stakeholders was usually facilitated by the architects through coaching and training. This parallels to the literature (Lange 2012; van der Raadt 2011).

However, EA artifacts usage varied between the stakeholders. For example, the format and appearance of EA products was considered crucial for non-architects attempting to reuse them in presentations and training. Yet they did not necessarily have appropriate skills to utilize the artifacts, as they are often designed for dedicated EA specialists.

Project architectures were geared towards passing the architecture reviews, and not for providing valuable insight on requirements, restrictions and dependencies as a basis of project planning and solution definition. In other words, EA artifacts were actually not used for ensuring the compliance of different solutions to EA. Instead, the review focused more on compliance to the EA framework and whether sufficient project architecture documentation exists. This contradicts the literature (cf. Ren and Lyytinen 2008). These insights emphasize that EA artifacts should provide practical value for each and every stakeholder involved in their use and creation, and not only exist for their own sake or be important only for a single stakeholder (such as the central EA team).

Despite the EA products were not used for ensuring the compliance between EA and other solutions, they were used in some EA work. Even though EA products were not used in EA work between different domains, i.e. using information architecture to create system architecture, they were used for creating or updating EA artifacts *within* the domains. For example, when the projects used the architectures of other projects as examples and as inputs in creating their own architecture (cf. Pulkkinen 2006; Kaisler, Armour, and Valivullah 2005). In fact, EA products with varying abstraction levels and domains were utilized in many use situations. This underlines the importance of choosing the EA framework that sufficiently covers appropriate dimensions and abstraction levels. For example, omitting RA or LoB architecture may be disastrous for the EA products use on the project level since high-level EA products are often lacking the adequate level of detail.

Whether the EA products used represented the current state, the target state or the transition plan, was not explicitly articulated. Either the EA stakeholders took the time orientation for granted, or it was not considered as a significant factor in the EA product use (cf. Lemmetti and Pekkola 2012). For example, different stakeholders might intuitively use EA products either on several time orientations, or on only a single time orientation (e.g. the target state) in some specific use situation.

The EA value for development projects is dependent on the time the EA artifacts are taken advantage of in the project. According to the data, most EA use should occur in the project initiation phase. This allows the consideration of EA artifacts, such as existing requirements, restrictions and interdependencies, already in the project planning phase. However, this was not always the case as EA work in projects was heavily focused on translating the already rather complete plans to EA models in order to pass the architecture review, instead of actual planning that creates unique insight.

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Consequently architecture planning should be started as early as possible in the projects, even parallel to project planning. Later on in the project, EA use should be heavily intertwined with solution definition to allow the maximum utilization of standards and requirements described by EA artifacts.

Limitations

Deriving the results from a single case is an obvious limitation and may have caused bias in the results. If the data had covered a diverse set multiple of organizations, the results would have been stronger in generalizability. Also potential differences in EA artifact use between different types of organizations remain unknown. We call for further research in these respects.

Also utilizing different frameworks in the interviews and the data analysis may be considered a limitation. Although (IS) use is in the core of the IS success model making it suitable for discussing issues related to use in the interviews, neither the IS success model nor its adaptation to the EA domain (Niemi and Pekkola 2009) explicitly focus on stakeholders and motives. Therefore, we had to widen our view in the data analysis by using the theoretical framework constructed in Section 3. An apparent limitation related to the research method is also the possibility for subjective interpretations from the interview data.

7. Conclusion

To understand EA artifact use situations, we have adapted the IS use framework (Burton-Jones and Straub 2006) to answer our research questions:

Why are EA artifacts used?

Who are the stakeholders using the EA artifacts?

What actually are the EA artifacts?

When are EA artifacts used?

Those helped us to discover and scrutinize fifteen unique EA artifact use situations. These situations emphasize that EA artifact use is a very complex phenomenon that should be considered comprehensively, including its motivation, involved stakeholders and EA results, and the phase of the project where EA artifacts are used. All of these items seemed to have an impact on EA artifact use. Thus, they should be considered both in analyzing EA artifact use in research, and in planning EA utilization in organizations. Currently a theoretical model of EA artifact use does not exist as only individual characteristics of EA use have been studied (e.g. Pulkkinen 2006; van der Raadt 2011; Lange 2012). Our findings are consequently a step toward a theory for EA usage. The findings can also be used as a basis for developing EA use measures.

Although the findings support some of the earlier views on possible EA artifact use situations (e.g. Pulkkinen 2006; van der Raadt 2011; Lange 2012; Winter et al. 2007; Niemi 2007), the coverage of the situations identified in the literature is limited in both extent and level of detail. The findings suggest a multitude of uses of EA artifacts. There are several EA stakeholders participating in the use situations. Those include also a number of non-architect stakeholders such as managers. This study has thus equipped

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us with understanding why, how, when and by whom different EA artifacts are used in an organization. That understanding can be directly utilized in future studies. Also practitioners can utilize the findings, especially Table 5, to understand EA objectives, stakeholders and scope, and coherently plan EA utilization with stakeholders (cf. Cockburn 2001; Armour and Miller 2000). Ultimately, it can help to ensure that EA is used in the right way to create value (cf. Bittner and Spence 2003).

EA use also seems to be more complex and diverse than, for example, the use of software architecture, which has been studied more thoroughly before. In the software architecture context, the conceptions and uses can be categorized into four metaphors (Smolander, Rossi, and Purao 2008) while in the EA context, the use situations are affiliated to three or four of the software architecture metaphors at the same time. No comparison between EA and software architecture has been done earlier.

Several suggestions for the EA practice can be derived from the identified use situations and the associated challenges. First, it is critical to consider EA utilization in every part of the EA processes, starting from the initiation of EA work. To effectively plan the EA utilization process, the organization needs to have clear objectives and goals for EA. Second, the findings indicate many potential uses for EA artifacts. Those uses can be beneficial to a multitude of different stakeholders. Thus, there also has to be an understanding of the EA stakeholders and their needs and goals with regard to EA (cf. Armour and Miller 2000; Niemi 2007). For example, technical architects in a project may require different EA products and services than the IT management.

The EA use framework (see Section 3) provides a starting point for the EA utilization plan: for what, by whom and when EA artifacts have to be used to meet the goals of the organization and the stakeholders – and what EA artifacts are actually needed. In practice the EA architects may adopt the attitude of dwelling into an “ivory tower” (cf. Lange 2012, 232). Under the circumstances they are producing different EA artifacts without fully considering their utilization, or paying attention to varying requirements from several different stakeholders. Another pitfall is creating too much or overly detailed EA artifacts. Hence, as resources for EA work are often scarce, only as much architecture should be created as absolutely necessary. In addition to meticulous EA use planning, EA frameworks appended with objectives and goals (Engelsman et al. 2011; Nogueira et al. 2013) can be used for setting objectives for EA.

With regard to EA’s role in guiding implementations, a balance between control and guidance has to be reached. Naturally EA has to be able to have some control over implementation projects to have the necessary guiding effect towards the target state. At the same time, the projects have to benefit from EA. Overlap between different project governance processes was also seen destructive for the EA stakeholder’s motivation to utilize EA. Therefore, the roles of EA (an organizational development function) and other development functions (such as strategic planning, IT governance and project governance) should be carefully planned. Producing project architecture should be more tightly tied to the project planning process and started in the project initiation phase to minimize extra work required from the project because of EA governance and to actually contribute to the project planning process. Easy to use EA artifacts should be available to guide project (architecture) planning. For example, organizational technology standards were seen by projects as a very useful EA artifact.

With regard to EA use itself, the findings emphasize that producing and utilizing only EA products is not sufficient, but EA services should be provided concurrently by the EA team to facilitate the utilization of EA products. EA products and services are mutually intertwined entities that should be utilized together to thoroughly fulfill the needs of different EA stakeholders.

EA artifact utilization is somewhat organization-specific. Organizational attributes, such as industry, size, age, management structure, decision-making and organizational culture, and IT environment and its complexity can have an effect on how EA can be used and what can be its possible benefits. This emphasizes thorough consideration of the EA artifact use situation and its dependency on the organizational issues – which evidently differ between the organizations. Nevertheless, bearing this dependency in our mind, we argue that our findings still provide some generic guidelines and ideas how the EA artifacts can be utilized. For example, in manufacturing organizations, EA artifacts can be used for planning and implementing enterprise application integration (EAI; cf. Liu et al. 2008). The EA team can model EAI patterns and technology standards. Those models can then be used in guiding individual integration and application architects. Another area where EA artifacts can be generalized to different organizations is by providing data models, derived from the actual business concept models. These could be used for application databases, reporting and analysis repositories and information flows in application integration.

Several areas for further research can be identified. First, the identified EA artifact use situations should be further scrutinized. Especially the interrelationships between the use situations and the effect of EA product time orientation on EA artifact use should be clarified. We also call for further research to investigate the actual coverage and benefits of formal EA analysis in organizations. While formal EA analysis has been studied quite extensively (e.g. Winter et al. 2007; Purao, Martin, and Robertson 2011; Närman et al. 2011), it did not have a significant role in our case. Third, further research should also address the factors having an effect on EA utilization by management, especially on the business side. Fourth, as we did not include EA process support tools and documentation in our consideration of EA artifact use, their effect on its success should not be overlooked. These aspects should be considered in future studies. Finally, as we have focused on where EA is used, it should also be clarified as to where the EA artifact use is not feasible.

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Appendix – EA Artifact Use Situations

The fifteen identified EA artifact use situations are described in the following tables. The quotations are translated from the original Finnish data by the authors.

Table A1-1. Use situation 1

Name	Create EA product
Motives	Support target state decision-making *(EA, RA and LoB levels)* Guide implementation *(project level)*
Stakeholders	EA team *(product producer; EA, RA and LoB levels)* Project *(product producer; project level)*
EA artifacts	All levels and domains *(EA and RA levels)* EA, RA and LoB level; all domains *(LoB level)* EA, RA and LoB level; all domains *(project level)*
Development phase	N.A. *(varied update cycle for EA, RA and LoB levels)* Initiation *(project level)*
Description	This use situation involves the creation of new and revised EA products. For EA products above the project level (i.e. EA, RA and LoB level), this use mostly has to do with supporting decision-making on the EA target state. On the project level, the motives are more geared towards guiding implementation by assuring that the project architecture conforms to relevant EA products. As EA products are created on different levels of EA, products of multiple levels are used as source material. To facilitate this, each *"[EA product] should provide adequate source data for stakeholders fining it down"* [Architect B]. The levels of products used as source material depend on whether the product being created is on the project or LoB level or on the EA or RA level. Products of all domains are used. Also the stakeholders involved in EA are similarly dependent upon the product level. Levels above project are typically modelled by centralized architects, while project architecture is created by a designated project architect (usually the project manager or technical representative), with the help of EA support services. EA products above the project level are typically created and updated as needed, leading to a varied creation and update cycle. Project architecture creation was seen to be most useful in the initiation phase, as a parallel activity to project planning.

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Table A1-2. Use situation 2

Name	Provide support for architects
Motives	Support target state decision-making
Stakeholders	EA team, central *(service producer)* EA team *(service user)*
EA artifacts	All levels and domains
Development phase	N.A.
Description	This use situation involves providing support for architects working above the project level (i.e. on EA, RA or LoB level). Architects can also request support in EA planning from the support organization or a certain central architect personally. The service is especially used by LoB architects. A kick-off meeting is held to provide guidance and existing EA products as references and examples, and follow-up is agreed on. Ad-hoc peer coaching and answering occasional questions were also seen as important parts of this service. The support occasionally produces new EA modelling principles, for example on which level of EA a certain service belongs to.

Table A1-3. Use situation 3

Name	Provide support for projects
Motives	Guide implementation
Stakeholders	EA team *(service producer and product user)* Consultant partner (*service producer and product user* – if required) Project *(service user)*
EA artifacts	All levels and domains
Development phase	Initiation
Description	This use situation involves the use and production of architectural support for a development project to facilitate the creation of the project architecture description, and ultimately to pass the formal project architecture review(s). While the project may be the active party in requesting support, proactive offering of the service was preferred: *"when a project is initiated, someone should be immediately be guiding it… to package the results of project planning right away into the required architecture format"* [Project Manager L]. The support is initiated with a kick-off meeting for identifying the support need, providing requirements, guidelines and templates, and agreeing on timetables. All types of existing EA products may be provided for the project as references and examples. Follow-up meetings are also typically held, occasional questions answered and ad-hoc coaching and training given. Typically, a senior central architect is responsible for offering the service, while the named project architect and possibly other subject-matter experts participate from the project side. Support should be focused on the initial planning phase of the project.

Table A1-4. Use situation 4

Name	Provide modeling support
Motives	Support target state decision-making *(EA, RA and LoB levels)* Guide implementation *(project level)*
Stakeholders	Consultant partner *(service and product producer and product user)* Project *(service user)*
EA artifacts	All levels and domains
Development phase	N.A. *(varied update cycle for EA, RA and LoB levels)* Initiation *(project level)*
Description	This use situation involves outsourcing the modelling of a specific architecture to a consultant partner as a service. Although the service has typically been used on the project level, it has also been utilized for modelling higher level views, especially LoB level. It was seen as a useful service, especially if the project in question does not have sufficient EA planning and/or EA tool experience and skills. However, some saw the lack of domain knowledge a challenge in utilizing external partners. The planning required for modelling is typically carried out in a series of workshops with the project personnel, typically including the project manager among others. The service also uses source materials similarly to the project support service. Similarly to project support, it should be focused in the initiation phase.

Table A1-5. Use situation 5

Name	Review project architecture
Motives	Guide implementation
Stakeholders	EA team, central *(service producer and product user)* Project *(service user)*
EA artifacts	Project level; all domains
Development phase	All
Description	This use situation involves reviewing the project architecture description against a set of norms, offered as a service by the EA team. This ensures, for example, that the description complies with the EA framework. Projects must take part in the review or reviews in certain phases, each requiring a particular set of architecture views to be finished. It was brought out that preparing for the review typically initiates architecture work in the project. The review process is intertwined with the project support service. The requirements and guidance for preparing for the review are introduced in a kick-off meeting. The review itself typically consists of a short presentation of the architecture description by the project representative and a review of the project architecture document by the EA team representatives. Also a feedback meeting may be involved.

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Table A1-6. Use situation 6

Name	Define and plan solution
Motives	Guide implementation
Stakeholders	Project (*product user*)
EA artifacts	All levels and domains
Development phase	Initiation/Analysis
Description	This use situation involves the use of EA products in the definition and planning of technical and non-technical solutions to assure that the solution conforms to EA. This planning should be intertwined with the creation of the project architecture. The project is responsible for adhering to EA in solution analysis. EA products above the project level (i.e. EA, reference architecture and LoB level) are used to tie the project to the EA by defining what parts (e.g. services) of the EA it realizes, and to derive high-level requirements for the solution, covering especially technologies and interfaces. This was emphasized by an interviewee: *"useful architecture is one that enables identifying reasons and requirements for initiating a system acquisition project"* [Architect A]. Architecture products from parallel projects can also be used to identify integration needs. EA products also provide the project with a set of standards. This was considered important *"... so it would be not necessary to consider everything in the project, but the products would provide ready answers to certain concerns"* [Architect J]. Standards were seen as important especially for selecting appropriate IT products. Mainly technical views were seen adequate for this use, but also high-level business views and conceptual data models were considered valuable.

Table A1-7. Use situation 7

Name	Design and implement solution
Motives	Guide implementation Support communication
Stakeholders	Project (*product user*)
EA artifacts	All levels and domains
Development phase	Design Implementation
Description	This use situation involves the use of EA products for re-checking solution design and providing new stakeholders with an overview of the solution later in the project. According to Program Manager K, the products can bring out new, unforeseen issues and dependencies that can be taken into account in implementation planning. Project architecture can also be used in defining functional utilization model and detailed user instructions.

Table A1-8. Use situation 8

Name	Execute solutions acquisition
Motives	Guide implementation Support communication
Stakeholders	Project (*product user*) Supplier (*product user*)
EA artifacts	Project level; all domains
Development phase	Analysis
Description	This use situation involves the use of EA products in the solution acquisition process. They were suggested to be used as background material, for giving potential suppliers an overview of the solution and its purpose. Project level architecture was seen to be the most useful for this purpose.

Table A1-9. Use situation 9

Name	Maintain solution
Motives	Support communication
Stakeholders	IT maintenance (*product user*)
EA artifacts	Project and implementation levels; system and technical domains
Development phase	N.A.
Description	This use situation involves the use of EA products by solution maintenance personnel in familiarizing themselves with the solutions under their responsibility.

Table A1-10. Use situation 10

Name	Plan solutions update
Motives	Guide implementation Support communication
Stakeholders	Project (*product user*)
EA artifacts	All levels; EA, LoB, project, implementation domains
Development phase	Initiation
Description	This use situation involves the use of EA products in solution update situations for communicating with users, gaining an overview of the solution and obtaining required technical details, especially on interfaces. These situations include extending the user base or functionality of the solution, and integrating with other solutions, typically carried out in a dedicated project. While business views are used in communicating with users and to comprehend the overall picture, technical views are considered crucial since they *"…depict all interfaces to other systems… help to identify the parts that need attention in the development"* [Architect N].

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Table A1-11. Use situation 11

Name	Support management
Motives	Support other planning activities
Stakeholders	Management *(product user or service user)* EA team *(product user and service provider)*
EA artifacts	EA level; business and system domains
Development phase	N.A.
Description	This use situation involves the use of EA in business and IT management activities, such as portfolio, change, program and requirements management. For example, IT service architecture can be used as a means for governing the ownership and management responsibilities of services. The required analysis of EA products relies on the functionality of the EA tool and EA skills of the user, and appropriate support services.

Table A1-12. Use situation 12

Name	Support strategic planning
Motives	Support other planning activities
Stakeholders	Senior management *(product user or service user)* EA team *(product user, service provider)*
EA artifacts	EA level; business domain
Development phase	N.A.
Description	This use situation involves the use of EA in strategic planning and decision-making by senior management. Development Manager I even considered EA to be *"…at the highest level one of the management and decision making tools for senior management"*. This use was usually facilitated by architects. Architect J brought out an example on facilitating strategic planning with EA products in the context of the planned outsourcing of a large subset of LoB systems. When utilizing high-level EA descriptions mainly from the business domain, it was fairly quickly discovered that the systems in question have myriad dependencies with each other and with the overall business processes. After discussions with the senior management, it was soon decided to abandon the outsourcing plan. Architect M also referred to the use of EA products by management in the context of large-scale transformation planning.

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Table A1-13. Use situation 13

Name	Train and instruct
Motives	Support communication
Stakeholders	Consultant partner *(service provider in training EA team)* EA team *(service user and service provider)* Project (*service user)* End-users (*service user)* All *(self-motivated training)*
EA artifacts	All levels and domains
Development phase	N.A.
Description	This use situation involves the use of EA product content (usually individual models) in training different stakeholders. As suggested by Architect M, "*[EA models] could be utilized anywhere where something needs to be instructed"*. Even though not the only one, training users to use a specific system is a typical use situation. Architects also walk project management and other stakeholders through relevant EA products, contributing to their overall understanding of the environment. Architecture training is mostly provided for architects, but it was suggested that passive training should be provided to projects on the side of day-to-day work by a dedicated project architect. Training can also be self-motivated, driven by curiosity and refreshing ones memory on a particular part of EA.

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Table A1-14. Use situation 14

Name	Present content
Motives	Support communication
Stakeholders	All (*product user*)
EA artifacts	All levels and domains
Development phase	N.A.
Description	This use situation involves the use of EA product content (usually individual models) as presentation material. Although all types of stakeholders may use this content, most often these were project presentations. Program Manager K considered that *"we received rather good presentation material from [the project architecture description], a variety of models, that provide a rather good concrete overview of the program objectives"*. EA products are also used in presentations on system details, statuses and lifecycle events by system leads and other similar stakeholders. The centralized EA team also presents newly finished EA products. While higher-level business domain views are preferred in presenting to the management, more detailed views such as concept and process models are preferred internally. Also potential suppliers are a target group for project presentations. As the EA models are copied from the EA tool to the presentation as-is, the appearance of the models may be an issue to some. As brought out by Project Manager L, *"[the EA tool] makes rather unsightly models, so they cannot be used anywhere before they are redrawn prettier"*.

Table A1-15. Use situation 15

Name	Take part in EA team meetings
Motives	Support communication
Stakeholders	EA team (*service provider and user*)
EA artifacts	EA, RA and LoB levels; all domains
Development phase	N.A.
Description	This use situation involves regular EA team meetings, held for providing updates and solving architectural problems. The meetings were seen particularly as a presentation forum, but they should also act as a vehicle for further improving the cooperation and teaming-up of architects.

Adapting the DeLone and McLean Model for the Enterprise Architecture Benefit Realization Process

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Abstract

Enterprise Architecture (EA) approach has been widely used for managing the complexities and changes in organizations and their business environments. However, research on potential benefits of the approach is rare and lacks strong empirical evidence. In this paper, we adapt the DeLone and McLean Model of Information Systems Success for describing the EA benefit realization process. Accordingly, we scrutinize seven constructs contributing to EA benefit realization. Each constructs is approached from four viewpoints namely process, product, outcome and impact. Perceptions on describing the constructs in the EA context are presented with an example of how our adapted model can be used in organizations. The results form a basis for further research and discussion, and are also a step toward cumulative tradition in EA research.

1. Introduction

Organizations today are applying Enterprise Architectures (EA) for managing the complexity of organizations' structures, information technology (IT) and business environments, and facilitating the integration of strategy, personnel, business and IT [12, 14, 19, 23]. EA includes architectural models needed in managing and developing the organization, encompassing the viewpoints of business, information, information systems (IS) and technology [17, 18, 21]. It describes the current architecture of the organization, provides a vision of a future architecture and a transition plan describing how to reach it [3, 21].

However, as with any organizational initiative, also EA has to be justified by demonstrating its positive impacts to the organization [23]. This is emphasized as EA initiatives typically require substantial investments [18]. Even though it is claimed that EA has the potential to produce significant benefits [17, 18, 23], strong empirical evidence has yet to be presented [24]. This lack of data might be caused not only by the novelty of the topic but also by its constant change – making the measurement of EA effects extensively difficult [23]. Furthermore, no generic, validated theory or model for describing the realization of benefits from EA has been introduced.

In this exploratory study, we scrutinize how the DeLone and McLean model of IS success [8] can be used to describe the EA benefit realization process. Such a process is defined as a *sequence of constructs that contribute to the realization of benefits from EA*. First, we define each of the DeLone and McLean model constructs in the EA domain and second, demonstrate how the model can be used by describing a real-life EA initialization case. Consequently we aim at identifying the first steps in tailoring the model to the EA domain so that they form a basis for formalizing the model and depict some issues to consider when assessing the EA benefits and establishing such initiatives. Our approach helps the benefit realization by illustrating the scope of EA and providing tools to narrow it down to meaningful range.

Our approach is based on the fact that the DeLone and McLean model originates from generic communication and information influence theories [22, 31], being validated in several domains [e.g. 9, 15, 20, 30], consequently making it sufficiently versatile to be used in the EA context as well. However, since the concept of EA is extensive and somewhat ambiguous, we consider the original model in its current form to be insufficient and incomplete to accommodate the whole concept of EA. Therefore, we approach each of the constructs from four different viewpoints; *process*, *product*, *outcome* and *impact*, that are described in details later in chapter 2.

- *Processes* comprise a set of EA planning, development and management processes [3, 21, 26].
- *Products* include models and principles depicting the current and future state of an organization, complemented by certain services [2, 21, 33].
- *Outcomes* (implementations) result directly from the use of EA products and services, featuring e.g. information systems constructed according to EA products.
- *Impacts* from EA, such as benefits, may arise directly from EA processes, products and services, implementations, or indirectly through the applicability of direct benefits.

The paper is organized in the following way. First, theoretical background is presented. Second, the DeLone and McLean model is described. Third, the model is brought into the EA context. Fourth, an example to clarify the use of the adapted model is portrayed. The paper ends with discussion and conclusion chapters.

2. Theoretical Background

Currently a large amount of EA research focuses on the *planning and development* aspect of EA: frameworks [e.g. 32, 33], planning and developing methods and tools [e.g. 5, 21], and development processes [e.g. 3, 26, 33]. Critical success factors and maturity models have gained less attention [c.f. 34, 35, 36]. Typically, maturity models can be used to attain a high-level view of the quality of the process and product viewpoints of EA in an organization, i.e. what success factors have been taken into account in EA development and management and how comprehensively. They do not include comprehensive instruments for evaluating EA benefits.

There are only a few studies addressing the *potential* benefits or the value of EA [e.g. 19, 23], i.e. the situations before EA development initiatives have started. Although some studies have been conducted [e.g. 14, 28], they are often theoretical, lacking strong empirical evidence [24]. Studies on the *theoretical foundations* of EA, including comprehensively defining the different viewpoints of EA, i.e. processes, products, services, implementations, impacts and their interrelations, and the use of EA products are rare. Yet the importance of EA has been emphasized [23, 34] also in industry where a great number of anecdotal evidence on the practical business value and utilization of EA exists.

The domain of EA is not extraordinary when attempting to display benefits. Historically, the same issues have been encountered in the IS domain [7, 8, 11]. A multitude of models have been developed in order to describe and measure the IS success – the realization of benefits or value of IS [7, 8, 10]. Especially the DeLone and McLean models (both original and updated) [7, 8] have been widely used and validated (e.g. Google Scholar finds over 1300 citations).

The DeLone and McLean model is designed for the IS domain. It is based on generic communication and information influence theories [see 22, 31]. This generality suggests the model to be usable in characterizing any process, making it applicable to other contexts. In fact, in addition to IS context, the model has already been adapted and validated in e-business [9], knowledge management [20], e-learning [15], business processes [30], and websites [29]. Also the definitions of IS and EA indicate that the model can be used in the EA domain. Information systems are defined as being an organized collection of IT, data and information, processes and people [13] while EA is seen as a collection of principles, methods and models that holistically describe the entire organization [21]. The EA description includes the abovementioned components of IS.

The EA domain would benefit from the success model when trying to unify the concept of EA benefit realization. So far only some ideas of components of the realization process have been suggested [e.g. 19, 21, 23]. To gain an overview of and understanding about the process, the nature of EA has first to be understood and defined. First, *EA is a product* including principles and models depicting the current and future state of an organization [3, 21]. The products may be complemented with various services, for instance EA guidance [2, 33]. Second, *EA is a process* [3, 17, 21, 26], more specifically a collection of planning, development and management processes.

EA generates various *impacts* to and within the organization [e.g. 17, 23]. Yet the studies do not differentiate from where the impacts actually arise. Alternatives include direct impacts from EA processes, or indirectly through the resulting products and services. However, DeLone and McLean [7, 8] suggested that benefits from information systems are generated through their use only. This argues for similar kind of approach in the EA domain. Indeed, as any architecture EA is used for implementing, for instance, organizational structures, processes, systems, applications, and services. The transformation towards the target EA is carried out through a set of development projects [18, 33]. This adds another potential source of *EA outcomes*: implemented EA.

There are also a variety of other uses for EA products and services. For instance, they can be used to support decision-making processes, change management, business process design, system development, and project planning and steering [6, 17, 33]. We consider also these to be the *outcomes or implementations of EA* as they involve the use of EA products and services.

Kluge et al. [19] adapted the DeLone and McLean model to the EA context. They used two case studies to provide an overview of the EA value realization process. However, their study reports only preliminary results discussing EA presentation and governance strategies and their effects on the value realization process. The problem, in our view, is the narrow consideration of the original success model: only the effects of presentation and governance strategies are discussed while the other constructs have been left intact.

3. The DeLone and McLean Model

The original DeLone and McLean IS Success Model [7] aims at examining and structuring the "dependent variable" in IS research – IS success. At the time the article was written, already a considerable amount of literature had been published on IS success and IS success measures. This myriad of different measures was (and still is) caused by the multidimensional nature of information: it can be measured on different levels, such as the technical, the semantic, and the effectiveness level [31]. Therefore, a need for a comprehensive view of IS success was highly appreciated.

The DeLone and McLean model is based on two complementary theories: theory on communication [31] and information influence theory [22]. Communication theory considers information to be serial – it passes through a series of stages from its creation to the potential impact on the recipient [31]. Furthermore, for each stage different success measures may be applied [22]. By adding the additional information influence level to the levels of information, DeLone and McLean derived six categories of IS success, namely System Quality, Information Quality, Use, User Satisfaction, Individual Impact, and Organizational Impact. Subsequently, they used the categories to organize the research on IS success, identified potential variables (measures) for each category and for interdependencies between them, and finally, developed a descriptive model of IS success.

As the model shows, IS success is a multidimensional construct. DeLone and McLean (1992) thus suggested that individual measures should be selected from the IS success categories to create a comprehensive measurement instrument. All the constructs should be measured, or at least controlled, and any possible causal relationships between them should be taken into account. The measures and constructs should be selected according to the objectives of the measurement and its context, emphasizing tested and established measures. The number of measures should then be reduced to enable the comparison and validation of the results.

The model was not validated through empirical studies in the original article. However, since then considerable amount of research have been conducted to validate, criticize and develop the model. Later DeLone and McLean [8] produced an updated version utilizing the findings and critique. For example, a Service Quality construct was added and the Use construct divided into Intention to Use and Use constructs. Also Individual Impact and Organizational Impact constructs were combined into a simpler Net Benefits construct. Figure 1 illustrates the updated version of the model.

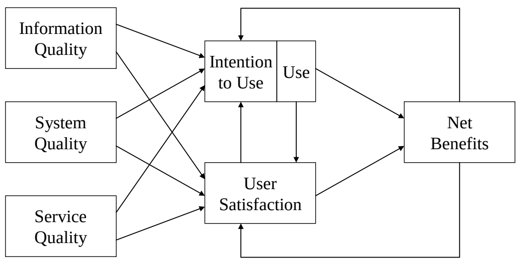

Figure 1. Updated version of the DeLone and McLean IS Success Model [8]

4. The DeLone and McLean Model in the EA Context

Next the adaptation of the DeLone and McLean model to the EA context is discussed.

4.1. Information Quality

The Information Quality construct measures the output of an IS [7]. Typically this is the information produced by the system. Attributes such as accuracy, timeliness, completeness, relevance and consistency of information are found to be relevant measures [8].

- *Product*. In the EA context, the closest equivalent for information produced by an IS is the information produced by EA processes, i.e. EA artifacts. The construct measures the quality of EA artifacts, meaning EA principles and models [21]. The quality of EA artifacts can be defined, for instance, by four characteristics: stakeholder and purpose orientation, quality of content, quality of presentation, and the management of documentation [16]. This emphasizes the EA product viewpoint rather than the process viewpoint since EA artifacts are products.

- *Process*. This viewpoint connotes the quality of information used in the EA processes, such as information extracted from documents and interviews.
- *Outcome*. The construct refers to the quality of information produced by a specific implementation of EA. For example, if an IS is implemented according to EA, the construct can be defined and measured as presented by DeLone and McLean [7, 8]. Similarly, the output of an implemented process producing information is evaluated correspondingly.
- *Impact*. A direct equivalent for this construct would be the quality of information related to the EA impacts, i.e. the information that describes the impacts themselves. However, such a definition complicates the model by creating an extra construct referring to EA benefits, which, according to the original definition rather follows the ideology of the Net Benefits. Hence, from this viewpoint the measures of Information Quality construct rather refer to the Net Benefits construct.

4.2. System Quality

The System Quality construct measures the system, i.e. IS itself [7]. It can be evaluated through functionality, flexibility, reliability, response time, integration or usability of the system [8].

- *Process*. The closest equivalent is the quality of the EA processes themselves. The process quality characteristics include effectiveness, efficiency and adaptability [27]. Also a number of process measurement methodologies have been constructed and applied.
- *Product*. From this viewpoint there is no direct equivalent apart from the EA implementation itself. EA products are typically documents, referring to the Information Quality construct. Systems are produced according to or in compliance with EA thus referring to the Use construct. Similarly, EA products are also more closely associated with the Net Benefits construct as high-quality systems can be produced according to EA, or other benefits may arise in systems development because of EA.
- *Outcome*. The construct refers to the quality of a specific EA implementation. It can be measured e.g. by the system quality criteria [e.g. 7, 8] or by the process quality criteria [e.g. 27], depending on the type of implementation.
- *Impacts*. From this viewpoint the construct refers to the quality of impacts themselves, and can thus also be conceptualized as the Net Benefits construct.

4.3. Service Quality

The Service Quality construct draws from the notion that IS organizations work in a dual role both as information providers and service providers [8]. This suggests that the IS organization's service quality should also be measured with traditional measures such as Information and System Quality. In regard to the overall success of the IS organization (and not the success of a single system), DeLone and McLean [8] suggested that the service quality construct may be the most important quality component.

Work on EA produces both products and services, where the services might be crucial in facilitating the diffusion of the EA approach in the organization. Therefore, measuring merely the quality of EA artifacts is insufficient. Kluge et al. [19] suggested, opposed to the original Service Quality construct definition, that the construct could represent EA presentation strategies. That is; who is allowed to read EA content, which contents can be read, and how the content is presented. However, in our view, these dimensions are about EA artifact quality [16] being as a part of the Information Quality construct. Also the weaknesses related to the presentation strategies (e.g. the lack of understandability and the lack of timeliness) point towards information quality criteria. We argue that the Service Quality construct should be defined according to its original definition.

- *Product*. The construct represents the quality of various services (as products) provided by the EA function; that is, the stakeholders carrying out work on EA in the organization [e.g. 3, 25]. Services are typically communication-oriented requiring cooperation between the different stakeholders. Hence, measuring different characteristics of the quality of communication is emphasized [e.g. 21, 35]. These characteristics can be used to derive EA-oriented communication metrics and further, EA service quality metrics. Typical EA services include both EA reviews and EA guidance to ensure alignment of EA principles in the project and in between the projects,

- *Process*. The process refers both to the quality of support services (e.g. access and availability of experts and documents), and the organizational IS services necessary for the functioning of the EA processes [c.f. 18, 35].
- *Outcome*. The viewpoint represents the quality of services implemented according to or in compliance with EA. These services also include EA services if they are created according to or in compliance with EA.
- *Impact*. From the EA impacts viewpoint there is no equivalent counterpart for this construct.

4.4. Use

Originally the Use construct presented the consumption of the output of an IS by various recipients [7]. Although the IS use as a success variable has been criticized, it is still widely utilized [8]. However, "especially informed and effective use" remains an important indication of IS success although the frequency of use alone is insufficient measure. Instead, IS use should be approached and measured more extensively, including metrics related to the nature, extent, quality and appropriateness of use [8].

Kluge et al. [19] defined the EA governance strategy to be related to the Use construct. They stated that EA governance should act as an interface between various stakeholders, taking into account their specific needs. This definition does not correspond to the original definition. The more appropriate equivalents would be the use of EA products and services, and the use of EA implementations. EA governance is a part of other constructs, namely Information Quality from the viewpoint of EA products (e.g. how well the needs of various stakeholders are considered in the documentation and its representation) and Service Quality from the point of view of EA products (e.g. how well the needs of stakeholders are addressed when providing EA services).

- *Product*. The construct represents the consumption of EA products and services that are the output of the EA processes. This ranges from the implementation of elements (organizational structures, processes, systems, applications, and services) [3, 18] to supporting decision-making processes, change management and business process design, system development, and project planning and steering [6, 17, 33]. Measuring the EA product and service use should be targeted to these processes and functions. Yet the complex nature of the construct should be taken into account [c.f. 8].
- *Process*. The definition of using EA processes is ambiguous as the processes are "used" indirectly through their output, i.e. through products. Rather, from this viewpoint, the Use construct refers to the extent in which the processes are carried out according to their descriptions, guidelines or best practices, i.e. according to specifications.
- *Outcome*. The construct represents the consumption of the output of various implementations of EA, i.e. their use.
- *Impact*. The construct refers to the consumption of the EA impacts, which, again, refers to the Net Benefits construct.

4.5. Intention to Use

Because the Use construct can be interpreted in various ways, e.g. as either a behavior or an attitude, DeLone and McLean [8] suggested that in some contexts, the Intention to Use construct could be used as an alternative. They acknowledged that because intention is an attitude, it is difficult to measure and even more difficult to link it with behavior (use). Hence, the Use construct might still be more feasible alternative [8]. We follow this suggestion and assume that the Use construct, with its multitude of dimensions, could be more feasible construct in most cases as intentions arise from business needs and strategies rather than from individuals and their perceptions.

4.5. User Satisfaction

In the IS domain, the User Satisfaction construct represents the user's response to the use (or consumption) of the output of the system [7]. Both single-item and multi-item measures for the construct have been used to measure the users' satisfaction. Hence the selection of stakeholders is emphasized [7].

- *Product*. The construct represents the stakeholders' response to the consumption of the output of the EA processes, i.e. to EA products and services. Satisfaction metrics could therefore measure, for example, the satisfaction towards EA products and services, or towards individual products and services.

- *Process*. The construct can be conceptualized as stakeholder's response to the activities in the EA processes, i.e. to what extent the actors operating in the processes are satisfied.
- *Outcome*. The construct follows the original definition and represents stakeholders' response to the use of the output of the specific implementation of EA, e.g. an IS.
- *Impact*. With regard to EA impacts, the construct refers to the stakeholders' response regarding the consumption of EA impacts, i.e. to what extent the stakeholders are satisfied with the realized impacts.

4.6. Net Benefits

As IS impacts range from the individual user level to the whole economy and business environment, DeLone and McLean [8] chose to keep the model simple. The Net Benefits construct correspondingly presents all kinds of IS impacts, leaving the choice of granularity to the researcher.

In the EA domain, the construct should also take into account a wide range of EA benefits on different levels of granularity. As EA encompasses the whole organization, it may consequently produce a great number of impacts which are difficult to disentangle. Because of this it has been difficult to define the benefits in concrete terms, developing metrics for them, and defining causalities between various benefits [23, 24]. Benefits achievable by EA identified in literature include, for instance, reduced costs, improved business-IT alignment, improved change and risk management, and shortened cycle times [24]. Also, when EA is implemented into an organization, it generates benefits that can be measured through its impact on business operations, e.g. bottlenecks identified from EA models. As EA consists of models for managing and developing the organization [18] the benefits above may arise from both models and their usage. This implies they may arise not only from using EA models for managing the architecture, but already from their development.

- *Process, product* and *outcome*. EA benefits might be realized directly from EA processes, resulting products and services, or from specific EA implementations. They can thus be conceptualized from the respective viewpoints.
- *Impact*. Indirect benefits, on the other hand, can be realized through direct ones and be conceptualized from the point of view of EA impacts, including all potential sources of impacts.

5. Illustration of the Model in a Real-Life Case

To illustrate the use of the DeLone and McLean model in the EA context, we use the case description by Andersin and Hämäläinen [1] and discuss how some of the components are concretized in a real-life case. The case is chosen because it is one of the rare documented examples. It illustrates the initialization of the EA process in a Finnish telecommunication company, aiming to identify the factors that should be taken into account in the EA process initialization phase. Because of the early stage of the EA process, we have excluded the Intention to Use construct, and the outcome and impact viewpoints from every construct.

- *Information Quality*. EA work has produced several types of documentation in the company, e.g. EA models and principles. To measure the quality of information in these documents, architectural documentation quality criteria [16] can be selected according to the needs of the organization. Obtainability, understandability, availability, and ability to inform different stakeholders about the EA approach were considered important. Because of the early state of the EA process, not all of the quality criteria were applicable, e.g. documentation was not mature enough to enable measuring all dimensions of the content quality. From the process viewpoint, the quality of information could be measured with a few selected generic quality attributes [e.g. 8], timeliness and reliability.
- *System Quality*. Because of the early stage of the EA process, the quality of the process was needed to be measured to be able to observe and guide its improvement. The process was measurable as other processes in the organization. Generic quality criteria include cycle time (e.g. the time to give architectural guidance to a project), throughput (e.g. the number of project that received architectural guidance), and costs (e.g. average cost of a certain service produced).
- *Service Quality*. The company's EA process is connected to strategy management, investment management, and project definition and support. The EA team offered EA services to these areas. A customized SERVQUAL in-

strument and adapted communication audit metrics can be exploited when developing service quality metrics to the viewpoint of EA products. Again, as the stakeholders might need EA guidance, it becomes the first candidate to measure. In this respect, project managers may act as data sources. General EA-related communication is also a measurement target as it indicates whether the stakeholders are aware of the EA products and services and whether they can utilize them. From the viewpoint of EA process, similar kind of instruments can be constructed. Feasible quality criteria includes stakeholder satisfaction toward EA guidance, EA models and principles, and the their knowledge how to obtain EA products and services in the organization.

- *Use*. Measuring EA product use indicates whether the EA approach has been adopted in the organization. EA products can be used at least in the areas that are connected to the company's EA process. The attributes by DeLone and McLean [8] provide a starting point for developing appropriate metrics. The process viewpoint, on the other hand, is not yet important as the process is in an early stage. However, a customized "EA process description compliance maturity" instrument, similar to EA compliance metrics [c.f. 33] could be developed. Feasible quality criteria include the distribution of projects that received EA guidance, that used EA models or principles; that received EA review, or that comply/do not comply with the results of EA review.
- *User Satisfaction*. From the viewpoint of EA product, the User Satisfaction construct can be measured with a single-item metric, adapted from the IS domain. From the process point of view similar kind of measures can be developed. The metrics include, e.g. the stakeholders' satisfaction toward EA or EA functions in general.
- *Net Benefits*. The company's EA goals include complexity management, and increasing knowledge, flexibility and customer orientation. These goals are used as a starting point for development if e.g. the Goal Question Metric approach [4] is adopted. However, the goals need to be concretized significantly before they can be measured. One feasible alternative is to chart the concrete EA-related needs of the most important stakeholders and derive a set of benefit measures from them. Benefits could be measured from all of the viewpoints, but due to the stage of the EA process, they may remain exiguous and be thus difficult to quantify. It is also very challenging to link the benefits to a specific EA viewpoint or evidence that indirect benefits even result from EA. Also, the benefits need to be measured on a regular basis to enable later comparison, and to make it possible to draw conclusions about the EA benefits. In the initial phases of the EA process, selected metrics may not show any positive change and even if they do, conclusions should be drawn carefully since a number of other factors affect the metrics as well. Realized benefits may also need to be derived from indirect metrics. In this case, some criteria for measuring EA benefits include the number of systems (management of complexity), the number of point-to-point interfaces (management of complexity), the time to implement a new business requirement to systems/processes (increased flexibility), the number of proactive/reactive change projects (increased flexibility/knowledge), the level of stakeholder satisfaction toward EA's or EA function's support to decision making (increased knowledge), the number of new improvements, features, services or products (increased knowledge), customer satisfaction (increased customer orientation), and the level of customer acquisition/retention (increased customer orientation)

6. Discussion

As seen, the DeLone and McLean IS Success Model seems to be usable in the EA context and in the EA benefit realization process. Our adapted model tailors the original model by expanding it with the four different viewpoints. Consequently, it can be used in describing the state of the EA benefit realization process. In this manner, causalities between different constructs can be examined and different factors facilitating the benefit realization can be recognized. This helps the identification of areas of improvement in EA processes, in product and implementation quality, and in the use of EA and its implementations. This way the maximum benefits are achievable with the minimum use of resources. Table 1 summarizes the constructs and EA viewpoints.

DeLone and McLean [7, 8] emphasized the significance of the context in utilizing their model. This is especially important in the EA context, because of the organization-dependent nature of EA. The exam-

Table 1. The DeLone and McLean model constructs and EA viewpoints

	Process	**Product**	**Outcome**	**Impact**
Information Quality	Quality of information used in EA processes	Quality of EA artifacts	Quality of information produced by implemented EA	No direct equivalent
System Quality	Quality of EA processes	No direct equivalent	Quality of implemented EA	No direct equivalent
Service Quality	Quality of support services to the EA function	Quality of EA services	Quality of organizational services constructed according to EA	No direct equivalent
Intention to Use	No direct equivalent	Potential alternative to the Use construct	Potential alternative to the Use construct	No direct equivalent
Use	Functioning of the processes according to specifications	Consumption of EA products by stakeholders	Consumption of the output of implemented EA by stakeholders	No direct equivalent
User Satisfaction	Stakeholder's response to the functioning of EA processes	Stakeholder's response to the use of EA products	Stakeholder's response to the use of implemented EA	Stakeholder's response to the consumption of EA impacts
Net Benefits	Direct benefits from EA processes	Direct benefits from EA products	Direct benefits from implemented EA	Indirect benefits

ple above points out that at least following factors should be defined for guiding the development of metrics for the constructs:

- *EA components available for use*. What EA process descriptions, EA products (including services) and EA implementations are available and measurable?
- *Purposes of use*. For what purposes are the EA products and implementation used? Explicit definition of purposes is required in order to develop metrics for the quality of these components and their use.
- *Users and their needs*. Who are the stakeholders using the EA components and what are their actual EA-related needs? The stakeholders are potential data sources, and their needs can provide clues on what could be the most important factors to be measured.
- *Benefits of use*. What benefits could potentially be achieved by the usage of the different EA components? These can be used as a starting point for measuring the overall EA benefits.

Perhaps the most important aspect to be considered when planning an EA benefit evaluation is its scope. Since our adapted model covers four EA viewpoints and would thus require an extensive measurement system, there is a definite need to delimit the benefit evaluation process by carefully considering the most relevant viewpoints and constructs for evaluation. One way to do this is to consider the level of EA maturity or the phase of the EA initiative in the organization. For instance, if the EA process is at its initialization phase, as was the case in the example above, it is not feasible to measure the constructs from the EA implementation viewpoint, simply because no implementations exist. Moreover, as EA benefits may take a long time to unfold their measurement could sometimes be postponed until a certain level of EA maturity has been achieved. Also, measuring the quality attributes of the EA processes might not always be sensible particularly when the EA maturity is low. In such a situation the product quality might be more relevant target. EA product use, on the other hand, is a construct not to be disregarded. This is because it indicates whether the products are actually utilized. It also gives an indication whether any benefits might ever be realized. However, as it is difficult to directly link realized benefits to EA, it is eventually important to measure all of the constructs to establish the causal relationships and use them as evidence of EA's impact.

It should be noted that beside EA benefits, the adapted DeLone and McLean model includes constructs related to the quality of EA processes, products and implementations. In this sense, the adapted model also encompasses areas included in EA maturity models. Yet our model adopts more holistic and comprehensive view of EA quality and its contribution to EA benefits. It can be used as a framework to plan EA measurement and eventually to establish the causal relationships between EA benefit metrics and factors contributing them. In contrast, maturity models only give a general idea of the overall quality of EA products and processes without strong, objective empirical evidence as proven causalities.

The original DeLone and McLean model is limited in the sense that it does not consider the quality of development processes. Our adapted model takes this into account through the process viewpoint. Although this complicates the model and makes the measurement system more complex, it provides a basis to decide the most relevant factors for any particular context at any moment of time. Another weakness in our model is that it does not consider different types of EA processes separately but treats them as one construct. This raises the question whether the causal relationships can be identified and measured. However, the constructs we have defined provide a starting point for EA benefit evaluation, and for developing a detailed benefit evaluation model to any particular context. Yet this remains to be confirmed by further research because of the limited validation of the ideas presented. In this respect, this paper provides a conceptual basis for adapting, tailoring and validating the DeLone and McLean model for the EA benefit realization process.

7. Conclusions

This exploratory study aimed to adapt the DeLone and McLean IS Success Model [8] for describing the EA benefit realization process. Consequently, the study scrutinized the seven constructs contributing to EA benefit realization from four different viewpoints, namely process, product, outcome and impact. Ideas on describing the constructs and their related metrics in the EA context were presented. Subsequently an example of how the adapted model can be used in real organizations was described.

This study contributes primarily to the research domain by clarifying the EA benefits realization process, and the concepts of EA processes, products, outcomes and impacts, for initiating further research and discussion. This guides and structures the future research efforts, similarly to the original DeLone and McLean paper, potentially building towards cumulative tradition of EA research. Also, as the phenomenon is very complex, we have not even attempted to define a new EA success model but rely on the original DeLone and McLean version which could serve as a basis on such an endeavor. Practitioners can utilize the arguments from this paper when clarifying the use of EA concepts and when initiating discussion on EA measurement and improvement. More generally, the adaptation of DeLone and McLean model to EA context reveals and concretizes some challenges and issues that need to be considered when planning the EA assessment activities. Particularly the scope and focus need to be decided before proper evaluation is sensible and possible. Also, our analysis helps one to identify appropriate stakeholders both as data sources and as being swayed by future EA activities.

As with the original DeLone and McLean model, also our adapted model needs for further validation through empirical studies. Especially the interrelationships between the constructs should be studied to discover how each construct contributes to the realization of EA benefits in reality. Preceding this, the constructs should be examined further and feasible metrics developed. Further research efforts could also focus on prioritizing the viewpoints to be covered by a generic EA measurement system.

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