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 multifaceted 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.

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” [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 reasonably 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
... 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 as 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 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 outdated, 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 attributes 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

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<th>Quality attribute</th>
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<td>EA product</td>
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<td>Clarity and conciseness</td>
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<td>Availability</td>
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<td>Appropriateness to use context</td>
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<tr>
<td></td>
<td>Benefits to service recipient</td>
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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.

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.

### 7. Acknowledgements

We would like to thank the Finnish Cultural Foundation, Central Finland Regional fund and Oskar Öflund’s Foundation for funding this research.

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<table>
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<tr>
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<td></td>
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</tr>
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<td>Usefulness</td>
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Table 3. Comparison of EA quality attributes with the literature.
8. References


