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Mediterranean Conference on Information Systems (MCIS)

Summer 9-4-2014

ENTERPRISE ARCHITECTURE EVALUATION: A SYSTEMATIC LITERATURE REVIEW

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Completed Research

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Abstract

By being holistically preoccupied with coherency among organizational elements such as organizational strategy, business needs and the IT functions role in supporting the business, enterprise architecture (EA) has grown to become a core competitive advantage. Though EA is a maturing research area, little has been done to understand how e.g. projects, application or other organizational elements contribute to the overall EA. The current paper presents a literature review on EA evaluation. Different types of evaluation are a necessity in order to ensure that EA demands are being met by disparate IT initiatives. Still, EA evaluation has attracted little attention within academic literature. Thus, the aim of the current review is to get an overview of the topic, which can serve as a foundation for further development of the field. Overall, the study shows that while little research has been done within this area, research is especially lacking regarding empirical studies of how EA evaluation unfolds in practice, while holistic views on EA evaluation is almost non-existing.

Keywords: Enterprise architecture, evaluation, literature review, measurements

1 Introduction

In a world more and more driven by information technologies, and where increased efficiency through IT and enhanced decision-making through the use of data has become pivotal in order to obtain, or sustain, competitive advantages, EA, and related fields, have become more important than ever (Zachman 1997). Owing to the fact that EA, at its core, facilitates: "The analysis and documentation of an enterprise in its current and future states from an integrated strategy, business, and technology perspective" (Bernard 2012), EA enables coherence across the business – between business units, strategy, management and IT.

Traditionally, EA has been concerned with understanding and representing the fundamental component of the enterprise through modelling methods and notations. Meanwhile, little attention has been paid to the set-up and implementation of EA concepts in organizations (Löhe and Legner 2012). As also pointed out by Löhe and Legner (2012), EA management (EAM) suffers from not being properly embedded into the organization and existing IT management practices. Thus, while EA research and practice has mainly been preoccupied with the overall analysis and documentation of the enterprise, knowledge is lacking when it comes to how the ideas and architectural plans are realized through everyday projects, system implementations etc. and how these elements contribute to the architecture. As a result of this lacking operationalization of EA, architectural teams in businesses and the field in general, have often been criticized for acting as an ivory tower (Koch 2005), whose models and theoretical discussions are disconnected from the practical concerns of businesses – thus not adding any value to the organization.

Since EA is a rather new field, its attention to the conceptual levels seems like a natural point of departure. On the other hand, it also seems timely – more than 25 years after Zachman's seminal paper (1987) –now to consider how the goals and benefits defined through EA can be ensured through the operational activities that shape and transform today's enterprises. Furthermore, by moving from being a predominantly technical discipline focused on narrow technological problems and solutions towards being a business discipline, EA needs to provide more clear indications that IT initiatives are moving the business in the right direction (Fonstad and Subramani 2009).

How to link both individual projects objectives with enterprise-wide objectives has been explored by Fonstad and Robertson (2006), who stress the importance of ensuring alignment between the three levels of the business: company level, business level and project team level. This is done through for example company-wide governance and linking mechanism (Fonstad and Robertson 2006). Though these general guidelines exist, both practice and theory seems to lacks actual indications on how each project contributes to the overall architecture. This motivated the research behind the current paper, with the aim to address the lacking knowledge on how EA can be implemented by seeking to understand the ways to evaluate how different elements contribute to a given architecture. The outset of the paper was the following research question: *"What is the current knowledge and research on EA evaluation?"* and *"What are the research gaps that need to be addresses within this topic?"*

The paper is organized as follows. The next section further conceptualizes EA and EA evaluation in order to give the reader an overview of the studied field. This conceptualization of EA was additionally intended to guide the further analysis of the reviewed literature by identifying common ways to evaluate the contribution to EA. The conceptualization is followed by an elaboration of the methodology of the review, and successively the analysis of the contributions identified through the search process. Hereafter, current research on evaluating EA is discussed. Based on the analysis and discussion, a conclusion is made on the state of current research and directions for possible further research – hereby addressing the two research questions.

In order to better understand how EA can be evaluated, an overall understanding of EA and its main concepts is necessary. Accordingly, the following paragraph will provide a conceptualization of EA as a foundation for the further review.

2 Conceptualizing enterprise architecture evaluation

Since EA emerged as a field in the beginning of the 1980s with IBMs 'Business System Planning method' (Ahlemann et al. 2012; Zachman 1987) and the later development of the Zachman framework (Zachman 1987), EA has developed both within academia and practice. Still, EA as a concept is associated with a great deal of ambiguity (Kappelman 2010 p. 1). Nonetheless, finding types of evaluation relevant to EA requires an understanding and conceptualization of the topic. The following definitions of EA are used in this paper as outset for the further conceptualization.

	Definition	Main concepts
CISR (2014)	"the organizing logic for business process and IT capabilities reflecting the integration and standardization requirements of the firm's operating model."	Integration and standardization of core processes
Lankhorst (2005 p. 3)	"a coherent whole of principles, methods, and models that are used in the design and realisation of an enterprise's organisational structure, business processes, information systems, and infrastructure"	Design and realization of organizational structure, business processes, information systems and infrastructure.
Bernard (2012 p. 31)	"The analysis and documentation of an enterprise in its current and future states from an integrated strategy, business, and technology perspective"	Integrated view of strategy, business and technology.

Table 1. Common enterprise architecture definitions

From the above definitions, it is evident that EA is a broad concept. For this reason, it can be challenging to grasp all the elements of EA and how they relate to each other. Because of this, a number of EA frameworks exists which describe the key elements of the EA. These frameworks are often divided into different subdomains which in some cases can be further subdivided (Kappelman 2010 p. 247). For example business architecture, information architecture, and technical architecture (Kappelman 2010 p. 247), or data architecture, application architecture, and technology architecture (Spewak and Hill 1993). This allows a level of abstraction for the EA architects. However, the definitions above (Table 1) also stress how EA is concerned with not only the different technical levels of the organization, but also the tactical and strategic levels of the organization. By being involved in e.g. organizational policy and strategic coherence, the contribution of EA is often related to non-quantifiable elements, and is often valuated in other ways than financial measurements, but instead through evaluation of realized benefits (Plessius et al. 2012a). Some of the benefits identified in literature by Tamm et al. (2011) are reduced risk, improved integration, stability, improved business processes, and increased responsiveness and guidance to change.

Accordingly, EA on the one hand focuses on technological solutions and how technology can help support standardizing existing processes. Thus EA enables alignment between IT and the rest of the business. Through this alignment EA is seen as a driver for enhanced business execution by digitizing routine processes and capabilities (Ross et al. 2006 p. 3-4; Weill and Ross 2009 p. 1-20). But, on the other hand, in order to not only drive efficiency of current processes, but also drive ongoing effectiveness, EA also needs to consider the organizational strategy, and the future state of the organization. For this reason, EA is both concerned with the as-is and the envisioned to-be architecture of the enterprise.

To get an overview of both the current state of the organisation's EA and the envisioned future state, enterprise architects often describe and view their architecture as going through a number of different architectural stages or maturity levels (Open-Group 2009; Ross et al. 2006; Weill and Ross 2009). As enterprises shift from one maturity stage to another, they also shift their investments in IT and business process redesign (Ross et al. 2006 p. 71-72), and with this, their architectural goals and priorities.

Having established a general conceptualization of EA, sufficient to use as an outset to structure the search process for EA evaluation and select the most fitting contributions, the following subsection is intended to give the reader an overall understanding of the plurality of EA evaluation as it is seen in this study.

2.1 Types of evaluation for enterprise architecture

As it has been described in the above paragraph, EA is a broad concept. For this reason, evaluation in relation to EA can take a number of different forms, and can be difficult to conceptualize. In this study, evaluation is understood as it has been defined in the Oxford Dictionary of English which is to: *"form an idea of the amount, number or value of"* (Stevenson 2012). This implies that this study considers types of evaluation of both qualitative and quantitative character. Additionally, evaluations of EA can have a technology focus, but can also focus on strategic or business aspects. All these aspects are, according to the above conceptualization, included in the holistic view on EA. On the one hand, the technology focused evaluations are mainly concerned with systems properties, for example data accuracy (Narman et al. 2011), modifiability (Lagerström et al. 2010), and usage (Närman et al. 2012). These evaluations are usually done using tangible, quantitative measurements. On the other hand, the strategically focused evaluations are mainly concerned with the level of achievements of for example different strategic/business goals (Doumi et al. 2013; Quartel et al. 2012), benefits (Niemi and Pekkola 2009) and the more qualitative aspects. Furthermore, EA evaluations can be considered at a number of different levels. Interoperability, for example, can be viewed from a business, process, service or data level (Elmir et al. 2011). Evidently, one cannot evaluate this concept the same way at the different levels as data interoperability is concerned with semantic properties while other aspects would be relevant in relation to service interoperability. The same holds true for concepts such as agility, which is often considered a strategic goal, but can come from a number of different providers such as technology, people, innovation etc. while covering a number of different capabilities such as responsiveness, competency, flexibility and speed (Sharifi and Zhang 1999; Sherehiy et al. 2007).

Seemingly, evaluating EA is no simple task and requires a range of different evaluation types. However, this gets even more complex if one starts to consider how dissimilarities between organizations can affect which elements should be evaluated and how. As already described, different enterprises can operate at different architectural maturity levels. For this reason, evaluating enterprise agility might not be equally relevant for a low maturity level enterprise – trying to build up their fundamental capabilities, as it might be to a high maturity level enterprise which has already sufficiently standardized their technology, integrated their processes and achieved operational efficiency (Ross et al. 2006). At the same time, other factors such as the size of the enterprise, its current sector, strategy etc. additionally influence which types of evaluation is relevant and how the evaluation can be done. Moreover, evaluations that are done in relation to EA are often not measuring the architecture itself, but elements that are related to EA. For example, services (Närman et al. 2013a), applications (Närman et al. 2012), processes, enterprise systems (Lagerström et al. 2010), architectural candidates (Razavi et al. 2010; Razavi et al. 2009) or projects (Quartel et al. 2012). By covering so many aspects of the business, it is also possible that literature relevant in relation to evaluating delimited EA elements such as process modelling (vom Brocke et al. 2010), might not be explicitly linked to the concept of EA in the written contribution.

Another important distinction for evaluation is whether it is intended for an evaluation of the current situation – through for example service performance (Närman et al. 2013b) or existing processes (Setiawan 2013) – or whether one is trying to evaluate for example project business cases or scenarios representing a future to-be architecture (Gammelgård et al. 2007; Lange and Mendling 2011). Evidently, types of evaluation used to assess the current situation can be quite different from the ones used to evaluate a future state.

Looking at types of evaluation in relation to EA from a broad perspective, the literature search was conducted on the topic with the aim to identify current research approaches, methods and existing measurements for EA in order to get an overview of how the concept of EA can be evaluated, and in which areas

knowledge is lacking concerning the evaluation of EA. This research process will be further elaborated in the following paragraph.

3 Methodology

Overall, this study followed a process similar to the one described through the framework by vom Brocke et al. (2009). Accordingly, the outset of the study was a definition of the review scope by considering the focus, goals, perspective, coverage, organization and audience of the review (vom Brocke et al. 2009). Regarding scope, it was decided to look after contributions concerned with evaluating elements related to EA, for example, by identifying measurements or methods for evaluation.

The definition of scope was followed by a conceptualization of the topic and the subsequent literature search and analysis. As illustrated in Figure 1, this happened in an iterative fashion where search and analysis in some cases revealed insights that resulted in changes to the initial decisions about review scope and conceptualization of the topic.

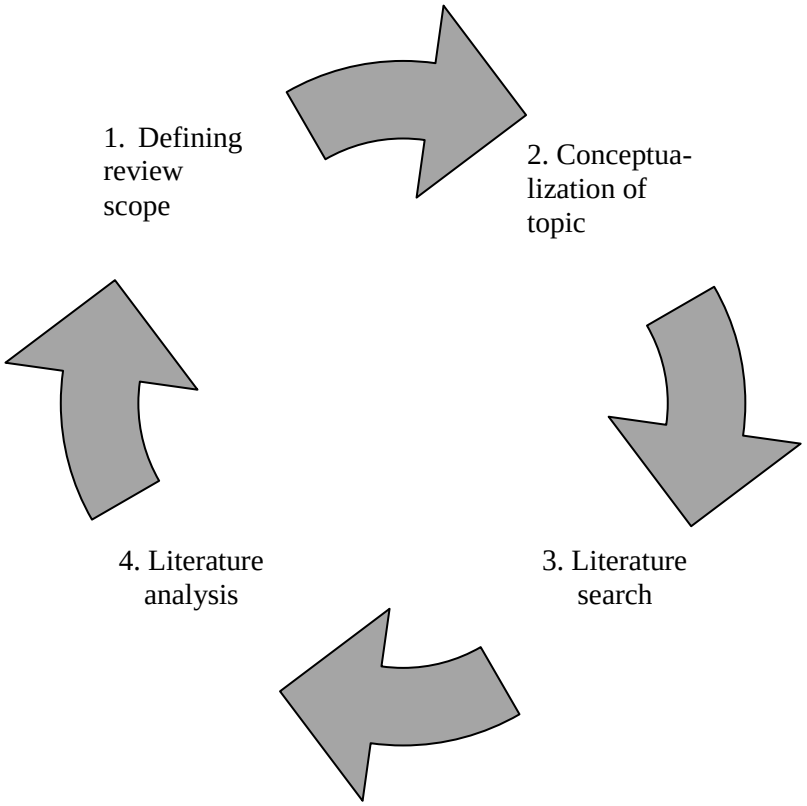

Figure 1. The research process adapted from (Andersen and Svejvig 2013)

Though the conceptualization of the topic did change as new insights were gained through the process depicted above (Figure 1), the initial conceptualization served as an important overall direction and structure through the process. Having established the review scope and conceptualization of the topic, the following step was to conduct the literature search as described in the following.

3.1 Literature search

The outset of the literature search was an exploratory analysis and review process on EA evaluation. During the first part of this phase, literature was sought by consulting other experts within the field (Papaioannou et al. 2010) i.e. other scholars and practitioners, and by exploring different keyword searches on Google Scholar and the Association for Information Systems elibrary. The literature found through this exploratory process was used in a pearl growing approach (Papaioannou et al. 2010) where the most interesting journals and conference proceedings related to the topic were identified. Keywords and index terms were taken from this initial literature, which were to be used in the later, structured database searches.

The main journals within the field of IS as defined by the Association for Information Systems Senior Scholar's Basket of Journals (Consortium 2011) were identified as key due to their importance to the field. However, since the goal was to do an exhaustive and selective coverage of relevant literature (vom Brocke et al. 2009) – not only limited to top journals or the field of IS – the search was not limited to these journals. Instead, the search was done across selected databases covering a wide range of different journals within the field of IS, computer science, engineering etc. Rather than being used as an exclusive list, these main journals and conferences were used to select which databases to use for the structured search. The reason for this broad review scope is that EA as a field is driven by practitioners as well as academics (Langenberg and Wegmann 2004). For this reason, only looking at peer reviewed journals within the field of IS might result in the exclusion of highly relevant insights either from practice-oriented or non-peer reviewed literature. The chosen databases were Scopus, Business Source Complete, ScienceDirect and the Association of Information Systems library.

Though ScienceDirect only covered Journal of Strategic Information Systems from the list of central journals and conferences – which was already covered by Scopus – a search was still conducted within ScienceDirect. This was done partly because the list of important journals and conferences was not seen as exclusive, but mainly because ScienceDirect also indexes a large number of book chapters that could prove to be relevant to the study.

The exploratory study was followed by a second phase where literature was sought in a structured manner in the databases chosen through part one of the search process. First, EA was used as a keyword in a broad search within the AIS eLibrary and ScienceDirect (Table 3). Since this resulted in an extensive amount of literature – 1399 contributions in total – the final search string developed through part one of the study was used for the subsequent searches within Business Source Complete and Scopus. The logical search string and its keyword terms can be seen below (table 2).

TITLE-ABS-KEY("enterprise architecture*" OR "domain architecture*" OR "business architecture*" OR "solution architecture*" OR "IT alignment*" OR "IT governance")
AND TITLE-ABS-KEY(measur* OR metric* OR assess* OR evaluate* OR KPI* OR "Key performance indicator*" OR "key goal indicator*" OR "KGI*" OR "critical success factor*" OR CSF*)

Table 2. Logical search string

In total 2192 contributions were found (not excluding duplications) through this second phase. Table 3 shows how the 2192 contributions were distributed across the different databases.

Databases	Science Direct	AIS Library	Scopus	Business source Complete
Total contributions	856	543	606	187

Table 3. Database overview

Afterwards, a forward and backward search was conducted (Webster and Watson 2002) on selected contributions, based on the degree to which they were related to the concept of EA and by looking at the general quality of the paper, for example proper methodology and number of citations. In total a net list of 45 contributions were deemed relevant in relation to measuring EA. 39 was found through the structured database search, while 6 was found through the early exploratory search and subsequent forward and backward analysis. The relevance of the different papers was judged using the approach described below.

3.2 Judging relevance

In order to determine the individual paper's relevance to the study, each paper was analyzed by first looking at the title of each paper. If in doubt, the papers were further analyzed by looking at keywords and abstracts. In some cases it was necessary to further analyze the text body of certain contributions. Each paper was evaluated according to its perceived usefulness in either evaluating an EA directly or evaluating different elements that contribute to an EA. As noted by Papaioannou et al (2010): "Terms within social sciences are often ambiguous, poorly defined and constantly changing". Therefore, the study did not limit itself to articles using the term EA due to its broad definition and the fact that the term is not necessarily used by the authors. Instead, relevance was judged according to the earlier conceptualization of EA.

Through the earlier conceptualization of EA, contributions concerning very technical details – for example use of software languages, wireless networks etc. – were disregarded since this level of technical detail is unnecessary and usually abstracted from by enterprise architects and IT management.

4 Analysis

This section presents the analysis of the contributions identified through the search process. The focus of the analysis was on identifying how each contribution is concerned with evaluating EA or related concepts, what is being evaluated and how. Also, the research approach (inductive versus deductive) was identified for each paper, together with an analysis of whether the approach would be applicable to an evaluation of just the current situation, or also a future state.

Figure 2 below depicts what is being evaluated in the different papers. For example, if the paper is evaluating individual IT projects contribution to a given architecture, if the architecture itself is being evaluated etc.

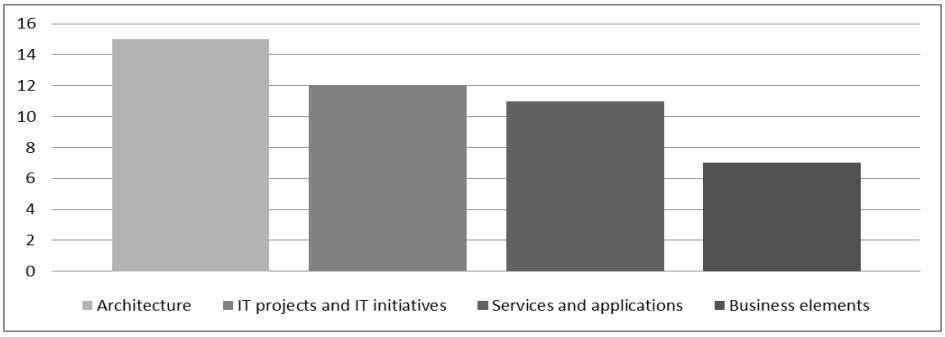

Figure 2. Different elements being evaluated

As the above chart illustrates, evaluation in relation to EA is often done by evaluating the architecture itself or by looking at projects and IT initiatives and investments. Since projects and the individual solutions are often the units of delivery regarding the realization of an EA (Klein and Gagliardi 2010), it makes sense that this has gotten some research attention. Meanwhile, the evaluation of services and running applications has received less attention. Seven contributions were concerned with business elements such as process integration. Surprisingly, the business elements category was identified as the least touched upon category. This suggests that EA is still regarded as a highly technical discipline, even though the discipline is closely linked to organizational issues, and is often referred to as a strategic, rather than technical, exercise (CISR 2014).

After having established which elements are typically evaluated in relation to EA, each contribution was analyzed regarding what these different EA elements were evaluated against. While the different types of evaluation varied greatly – for example, evaluation of granularity, flexibility, response-time, value, usage and financial types of evaluation – some overall types of evaluation focuses emerged. Overall, these concern financial focus, business contribution focus or technical focus. This distribution has been depicted in the chart below (Figure 3).

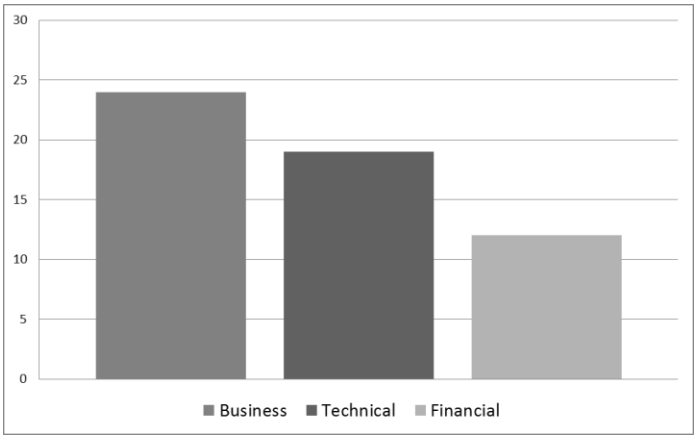

Figure 3. Distribution of overall types of evaluation focus

While the business centric evaluation was identified as the largest category with a total of 24 contributions, this was also a broad category encompassing elements related to for example EA goals (Lange and Mendling 2011), strategic alignment (Doumi et al. 2013), benefits (Niemi and Pekkola 2009; Plessius et al. 2012b), key performance indicators (Ganesan and Paturi 2009) etc. Also, many of the papers were concerned with technical properties relevant to the concept of EA. These concern among others the evaluation of service granularity and its relation to reuse (Krammer et al. 2011), measurement of architecture complexity (Schütz et al. 2013), and interoperability of services to improve integration (Elmir et al.

2011). Finally – and to a lesser degree – some papers were concerned with evaluating financial properties. For example Rico (2006) describe different methods and models for measuring return on investment (ROI) in relation to EA, while Kuiper et al. (2011) describe different methods for IS and IT valuation. Note that some contributions were attributed to more than one category since some contributions were concerned with e.g. both evaluating financial contribution and business contribution.

Overall, the different papers contributed to EA evaluation in three different ways: measurements, methods and models. Of these three, measurements for EA evaluation was most represented. Some papers identified existing measurements for EA evaluation or developed their own measurements. These quantitative approaches have been applied broadly to different EA concepts, and are related to all of the three different evaluation focuses i.e. business, technical and financial. Some example of contributions concerned with quantitative measurement approaches are depicted in the table below (Table 4).

Measurements	**Contribution**
Financial value of EA	(Rico 2006)
Granularity of services	(Krammer et al. 2011)
Flexibility and efficiency	(Kim et al. 2000)
Response time of services	(Närman et al. 2013a)
Usage of applications	(Närman et al. 2012)
Data accuracy	(Narman et al. 2011)
Modifiability of systems	(Lagerström et al. 2010)
Interoperability of services	(Elmir et al. 2011)
Valuation of IS/IT	(Kuiper et al. 2011)
Complexity of EA	(Schütz et al. 2013)

Table 4. Examples of measurements

On the other hand, a smaller number of contributions – a total number of five papers – employ a qualitative, empirical research approach to EA evaluation. Out of these five contributions, only one paper was identified as having an inductive, qualitative research approach – studying how EA evaluation unfolds in practice rather than for example employing predefined measurements. The one paper with an inductive approach studies how IS/IT evaluation is done in different ways using a single case study (Kuiper et al. 2011). This approach is very different from the more deductive approaches employed for example in the quantitative and technically focused papers, wherein methods derived from e.g. mathematical formulas might be empirically tested at a later stage. While inductive case studies were not used – apart from (Kuiper et al. 2011) – many of the contributions identified used a deductive research approach, departing from a theoretical point of view that in some cases are applied to an empirical setting at a later stage. These contributions used a case as minor part of the paper for illustrational purposes, or for arguing for validity of for example a measurement approach (e.g. De Vries and Van Rensburg 2008; Franke et al. 2012; Widjaja et al. 2012; Zellner and Laumann 2013).

Apart from papers focusing on measurements, the contributions were either focused on methods for evaluation or models. Here, both methods and models are understood broadly. A method could for example be an approach to develop measurements or a step-by-step process for EA evaluation. Model as a category covers both theoretical models, frameworks, theoretical frameworks and other conceptualizations of EA evaluation that are not measurements or methods. This is done partly due to inconsistencies between the ways the different papers define their work as for example frameworks, models, theories, approaches etc. The distribution of the papers between the three different they contribute to EA evaluation is shown below.

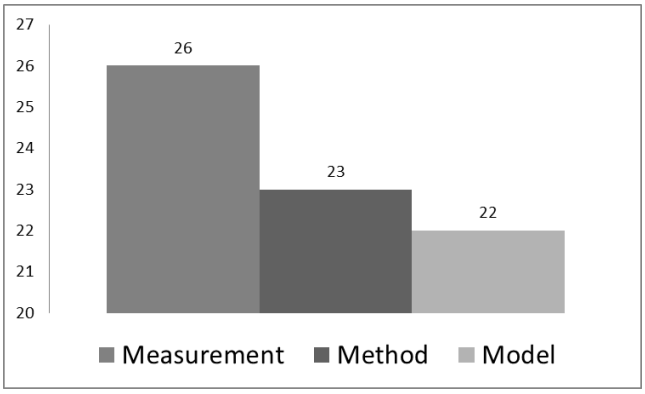

Figure 4. Outcomes of the different papers

These categories shown in Figure 4 were somewhat overlapping, for which reason some papers have been counted multiple times. Naturally, the scientific contribution of a paper is not monolithic to any of the three categories. Hence, many contributions were e.g. identifying both tangible measurements, but also methods and useful models for EA evaluation in the same contribution.

As a next step, each contribution was analyzed looking at whether they were concerned with elements related to assessing the current situation or a future state, or whether the used approaches or measurements were applicable to both assessments. A total of 26 contributions developed measurements, methods or models applicable to the evaluation of a future state. E.g. EA management benefits (Lange et al. 2012), the value of process redesign projects (vom Brocke et al. 2010) and future value of IT investments (Cumps et al. 2006). Four out of the five papers with an inductive, qualitative and empirical research approach present findings in relation to evaluating a future state.

5 Discussion

Regarding the research methods employed, the review showed that while a lot of research on EA employs deductive and quantitative methods for EA evaluation, pure empirical studies for example studying how organizations actually work with EA evaluation, are almost non-existing. This might be due to predominantly objectivistic underlying philosophical assumptions concerning EA research due to its connection to the field of engineering and computer science. However, from a utilitarian point of view one cannot deny that much can be learned from practical studies of EA, and that systematic collection of knowledge on the topic from different organizations has been unexplored by researchers thus far. While the deductively developed measurements and methods might be of good use in organizations, the literature has been ignorant to the practical problems, barriers and approaches used by practitioners, and how a throughout understanding of the phenomenon in its context might benefit both practice and research.

Another findings from this study is that most research on EA evaluation take a very monolithic approach to EA evaluation rather than holistic. This is contradicting the very nature of EA cf. the earlier conceptualization that clearly shows that EA can only be understood holistically. For example from an integrated strategy, business, and technology perspective (Bernard 2012). Thus, evaluating delimited elements such as system heterogeneity is not sufficient to say if an EA is adequate or moving in the right direction. Accordingly, it is not uncommon that EA literature for example employs a system of systems perspective to EA (e.g. Armour et al. 1999; Morganwalp and Sage 2003). This has potential for coupling systems engineering activities with strategic planning and investment analysis (Carlock and Fenton 2001). Interestingly, only one paper considered all of the three former identified evaluation focuses: business, technical and financial (Figure 3).

6 Conclusion

While this study shows that there is a body of extant literature that either directly or indirectly touches upon how an EA can be evaluated, evaluation of EA can also be approached in many different ways. By dissecting EA evaluation, the current study shows that EA evaluation is a complex research area that can be viewed from many angles. While 45 contributions were identified in total, very few articles were contributing to the same area of EA evaluation by e.g. evaluating the same element, employing the same evaluation focus etc. Instead, the different papers had many different takes on EA evaluation. Taking the many different perspectives and ways to evaluate into consideration, one must say that surprisingly little literature exist on the topic. Additionally, while, disparate and heterogeneous attempts have been made, less than a handful of papers were concerned with a holistic understanding of how EA can be evaluated. Similarly, knowledge is lacking concerning how EA evaluation unfolds in practice.

Hopefully, these insights on EA evaluation can serve as stimulation for further research into the area in general, but also guide future papers towards the more unexplored areas within EA evaluation – including inductive studies of practice, holistic approaches to evaluation, and more focus on the business elements in the evaluation of EA. For example, it is argued that EA evaluation within most organizations is not performed systematically (Klein and Gagliardi 2010). Arguably, some organizations are more mature in the way they conduct EA and EA evaluation. Hence, much insight could be gained from for example studying both low and high EA maturity-level organizations in order to determine the barriers in low maturity organizations and best practice at organizations of higher maturity regarding their EA evaluation practices. Another option could be to empirically test some of the different deductively derived measurements and methods using action research (Baskerville 1999). Yet another avenue of research could be to explore methods that can help facilitate EA evaluation done by practitioners rather than developing normative methods and measurements that might not apply to every organization.

One limitation to this study is related to the ambiguous, ill-defined and changing nature of terms within social sciences (Papaioannou et al. 2010). Due to this, the used search string was iterated upon several times; searching not only for enterprise architecture, but also related terms. Since evaluation was also understood broadly in this study, the search string encompasses e.g. searches for evaluation, measurements, assessment etc. As already stated, this broad search resulted in a large quantity of papers (2192 papers) which were afterwards analyzed. Even though much time and effort was put into developing a suitable search string, and much literature was analyzed, it is possible that important contributions were undetected by the search. Further iteration on the search string, and the use of more forward and backward searches might reveal more relevant literature.

By giving an overview of the current knowledge and research on EA evaluation, and additionally identifying the relevant research gaps, this study will hopefully motivate further studies into this rather unexplored research area.

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