

The Contribution of Enterprise Architecture to the Achievement of Organizational Goals: A Review of the Evidence

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Summary. This paper reports the findings of a systematic review on the literature concerning the potential contribution of Enterprise Architecture (EA) to the achievement of various business goals. The review revealed the current state of the scientific and practitioner's literature concerning the potential benefits of EA as describing 29 unique contexts within which EA has been found to deliver 100 unique benefits through 3 value-generative mechanisms. This review enhances the understanding of EA of both researchers and practitioners by providing valuable information on the potential benefits of EA and their relationships, their applicability (context), and the mechanisms that generate them. Additionally, this review is expected to enable practitioners to establish the business case for EA by means of scientifically grounded reasoning about how EA might contribute to the achievement of certain business goals.

Key words: enterprise architecture, organizational goals, systematic review

1 Introduction

Although considered to be relatively young [1, 2, 3], Enterprise Architecture (EA) has generally evolved into a well-accepted discipline [3] and its importance is considered to be growing [1]. Curiously enough, to date, there exists no single comprehensive view of the ways EA might add value to an organization. This carries several implications:

Firstly, it inhibits establishing a common understanding, among practitioners and researchers alike, of the potential of EA as a discipline and how it may lead to desirable organizational outcomes [4]. As a consequence, comparisons to other, already established business governance instruments become difficult and ambiguity is introduced over the specific value proposition of EA.

Secondly, it inhibits the establishment of the business case for EA due to the difficulty of demonstrating the business value of the project at hand. Slot,

Dedene, and Maes find it surprising that to a large extent, the business case for the current EA activities that take place in the business and IT world is non-existent [5]. Increasingly, traditional cost-justification methods are found to be inappropriate for measuring the contribution of IS/IT investments in general [6]. More specifically, quantifying the value of EA is considered to be a challenge [2, 7] and research strictly focusing on financial benefits is considered to represent a very limited view [3]. The alternative is to make use of contribution-justification. In this respect though, the absence of a comprehensive, scientifically grounded framework of potential EA benefits inhibits establishing the business case for EA. Finally, it inhibits the establishment of standardized and reusable technical EA effectiveness metrics since the entire breadth of the indirect effects of EA is not known.

Although on the whole the (mostly practitioner-oriented) literature displays an abundance of potential EA benefits, these are mostly inconsistently scientifically grounded [4]. Even in those cases that the EA benefits are consistently and scientifically grounded, they are usually presented as being under the direct influence of the architectural practice, lacking any justification as far as the cause and effect relationships between them, the EA practice, and the ultimate business goals are concerned. However, Steenbergen and Brinkkemper [3] conducted several relevant exploratory case studies and found that in reality, the nature and complexity of the cause and effect relationships occurring between multiple differencing benefits is far more indirect and complicated.

In this first in a series of upcoming research papers reporting on the establishment of a comprehensive, scientifically grounded framework of potential EA benefits, we present a systematic review of the evidence regarding the effectiveness of EA. With the goal of researching not only the benefits of EA, but equally important, the cause and effect relationship chains between them, and in order to maximize the richness and depth of the analysis of the evidence, we apply the design-oriented research synthesis method proposed by Denyer et al. [8], an extension of Pawson’s *realist synthesis* method [9]. Using this method we extract *design propositions* (or technological rules [10]) in the lines of the Context Intervention Mechanism Outcome (CIMO) logic [8]. For Aken, a technological rule is a fragment of general knowledge (or general solution) that in a specific field of application links an intervention or an artifact with some expected outcome or performance [11]. Denyer et al. similarly see a design proposition as offering a general template for creating solutions for a specific class of problems [8].

A design proposition made up of CIMO-logic components is formed in principle as follows: for some problematic Context(s), use some specific Intervention(s) that will invoke some generative Mechanism(s) that in turn will deliver the desired Outcome(s). Design propositions thus not only inform on what to do in a specific situation in order to create a specific effect but more importantly, they offer some insight on why it happens [8].

In Section 2 we describe the literature review methodology. In Section 3 we present the findings of the review in terms of Context, Mechanism and Outcome elements as well as by applying a model, the Enterprise Architecture Benefits

Map (EABM), for documenting, structuring and making sense of the Outcomes (or EA Benefits) and their relationships. In Section 4 we discuss the findings, their implications, and we propose future research. We conclude in Section 5.

2 Research Method

For the literature review we followed the Systematic Literature Review (SLR) methodology of Tranfield et al. [12]. The authors propose a methodology for conducting SLRs pertinent to the management research domain by transposing relevant, established and highly influential methodologies from the medical research domain (i.e. [13, 14]). The rationale for adopting such a highly structured and systematic methodology lies in maximizing rigor, minimizing bias, and enhancing the traceability and reproducibility of the results. In this line, certain enhancements were applied to certain process steps of the SLR methodology by extending them with methodological adaptations from the *Cochrane Handbook for Systematic Reviews of Interventions* [13].

The review begun with identifying the need for a review and a small scoping study for acquiring a broad idea of the available literature, relevant search engines, appropriate keywords, etc. A review proposal was produced and a review panel of experienced researchers and practitioners in the field of EA was assembled with the aim of resolving disputes. Departing from Tranfield et al., and along the guidelines for review protocol construction presented in the Cochrane Handbook, a protocol was developed for laying down the methods/guidelines for conducting the review.

The following seven search engines were searched: Science Citation Index, The ACM Guide, IEEE CSDL, CiteSeerX, Emerald, Elsevier/Science Direct, and EBSCO. We retrieved 613 results from all search engines. Judging by the title and abstract, 543 contributions were found to be duplicates or obviously irrelevant. To compensate for the mechanistic approach of the systematic review, 19 contributions were added from the researchers' personal collection of studies and another 18 contributions from examining the references of other contributions. In total, 107 contributions remained for full-text review.

Studies Quality Assessment Two types of criteria for considering studies for this review were developed. The first relates to an evaluation of the eligibility of the study type and the second to an evaluation of a study's inner quality aspects. Eligible study types were considered to be quantitative, qualitative, and mixed-method scholarly research and *gray literature* (i.e. literature that has not been formally published) in an effort to capture the broadest possible definitions of EA benefits. Inclusion of gray literature to systematic reviews is considered to be advantageous in order to help minimize publication bias effects [15, 16].

For qualitatively evaluating the studies, we adopted a *post-positivism*¹ standpoint. More specifically, we constructively embraced the *subtle-realism* philoso-

¹ Post-positivism is associated with those researchers that advocate the use of the same broad criteria for evaluating all research types [17].

phy [18] which advocates that quantitative and qualitative research can be qualitatively assessed using the same broad concepts of validity and relevance, but operationalized differently [19]. Both relevance and validity reflect common, recurring research evaluation criteria in the scientific literature (e.g. [17, 18] and [17, 20] respectively). In operationalizing the validity and relevance concepts we developed a set of common screening questions as well as separate criteria lists for quantitative (adapting the list appearing in [21]) and qualitative (adapting lists appearing in [22, 23, 19]) studies.

In line with other researchers' views, and as a *realist synthesis* approach for the data synthesis was adopted, every contribution was additionally judged based on its "fit for purpose" [24], whether it added anything important to our understanding of the phenomenon under review [25], and on its quality as it was established in relation to the rest of the contributions of the synthesis [26]. Thus, highly relevant and original contributions were included in the review even if they displayed certain quality issues.

During the full-text review 6 contributions were found to have invalid study types and 68 were found to be irrelevant to the synthesis; these were subsequently removed. During the synthesis of the remaining 33 studies, 19 were removed based on qualitative issues. In total, 14 studies were included in the synthesis: [1, 4, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38].

Synthesis Methodology For the data extraction and synthesis, we conformed to the CIMO-logic categories proposed by Denyer et al. [8], described above. Adjusting the CIMO-logic to this research's goals, we extracted and synthesized data into the following categories:

- (C) contexts for which EA has been found to be of value,
- (I) EA as the sole intervention of interest,
- (M) mechanisms that answer how or why EA produces or contributes, directly or indirectly, to certain organizational outcomes, and
- (O) organizational outcomes-results of the application of EA (alternatively referred upon as *EA Benefits*).

The 14 eligible contributions that were processed with CIMO-logic had their data extracted into appropriate electronic extraction forms created in a commercial RDBMS. Data was extracted by the principal researcher only. No ambiguities occurred, so the Review Panel was not called for resolving any disputes at this stage. In total, 163 CIMO Elements and 181 CIMO Elements Relationships were extracted. Next, those CIMO Elements that were deemed to be semantically equivalent were merged in order to create a list of unique CIMO Elements. After the merge, remained in total 133 Unique CIMO Elements and 168 Unique CIMO Elements Relationships.

It is important to note that not all CIMO Relationships reflect cause and effect relationships. A relationship between a Context and EA (the Intervention) suggests that EA has been found to be of value in the specific Context; between EA and a Mechanism, suggests that EA has been found to invoke/realize the specific Mechanism; between EA or a Mechanism, and an Outcome, suggests

indeed a cause and effect relationship between them: the Outcome being the result of the application/introduction of the EA or the Mechanism.

3 Results

We begin by presenting an overview of the most important (for brevity reasons) Context themes identified in the included studies. Where they exist, the Relationships of the Contexts with other elements (i.e. the EA, EA Mechanisms, and Outcomes) are described in-text. We then present the EA Mechanisms identified in the included studies, which are given in their entirety since we were only able to locate scarce evidence along three studies. We also textually describe existing Relationships between EA Mechanisms and other elements (i.e. Contexts, EA, and Outcomes). Finally, with the aid of the EABM, we graphically present an overview of the Outcomes and some Relationships, as identified in the included studies.

A complete account of the CIMO Elements and their Relationships, along with a description when necessary, is provided in [39]. For a better understanding of the nature of the individual elements the reader is strongly advised to refer to the original studies.

Contexts for which EA has been found to be of value (C)

Organizational Design EA has been found to provide the necessary support in the context of organizational design problems. These problems might relate to the design of new organizational structures [37] or the re-design of existing ones, during mergers and acquisitions [36, 1], and during general organizational change and restructuring [31, 34]. In designing new organizational structures specifically, and in the context of an action research study by Arnold, Op't Land, and Dietz [37], EA was reported to enable the communication of project investment decisions, to enable the conceptual consolidation of a project's to-be situation between stakeholders, and to support project scoping.

Project Portfolio Management EA has been found to provide support in the context of Project Portfolio Management, in cases like project portfolio planning [1], IT portfolio management [36], and in addition in related investment decisions [36].

Decision Making EA has been found to aid in the context of general decision-making [36] activities, as well as in making decisions relating to Sourcing [1] and the adoption of COTS Software [1].

Regulatory Compliance EA has been found to provide support in the context of regulatory compliance, be it general compliance management [1] or quality management [1].

Systems Development EA has been found to be of help in the context of Systems Development, from the first phases during Project Initialization (e.g. project scoping) [1] to general Systems Development support [36].

Risk Management EA has been proposed to aid in the context of Risk Management. Although there were cases identified where EA has been found to assist in Business Continuity Planning [1] most of the risk management scenarios identified were IT-related; ranging from Security Management [1], Technology Risk Management [1], and IT Service Management [1], to more specific cases of integrated Security Management solutions in business networks with heterogeneous ICT [29]. In the latter, and in the context of a single case study, Pulkkinen, Naumenko, and Luostarinen [29] report that EA contributes to a number of Outcomes, like increasing the inter-organizational transparency and security of exchanges of information and services, and ensuring the comprehensive and coordinated IT and Security Management and Planning.

IT Costs Reduction EA has also been found to be supportive in the context of reducing IT-related costs, either through IT Consolidation (e.g. by eliminating costly, redundant technological platforms) [1] or by better Management of IT operations costs [1].

Organization Type There has been some evidence concerning the applicability of EA in both public and private organizations. Gregor, Hart, and Martin [33] reported in the context of a study of an Australian government organization that the application of EA was found to contribute to a number of Outcomes and ultimately to that of Business and IT alignment, partially as a result of introducing the EA Mechanism *IS/IT Governance Framework*. Similarly, Martin, Gregor, and Hart [38] reported in the context of a study of two Australian government organizations that the application of EA was also found to contribute to a number of Outcomes and ultimately to that of Business and IT alignment (or business processes and IS alignment). Finally, Kamogawa and Okada [30] deal with the business value of EA for private organizations in the context of a survey of 300 stock-exchange-listed Japanese companies. Notably, their study addresses, among others, the unearthing of a positive correlation between various financial measurements (e.g. ROA, ROS) which reflect an improvement in business performance and the application of EA.

EA Mechanisms that generate Outcomes (M)

EA Standards In the context of a firm-level survey of 90 respondents that represent large and geographically dispersed organizations with subunits with considerable autonomy in IT resources management, Boh and Yellin [32] reported on the significant effect of EA Standards on reducing the IT infrastructure's components heterogeneity and services replication, and on achieving better integration of enterprise applications and data.

EA Models In the context of a relatively small survey of 51 respondents, Bucher et al. [1] reported on a multitude of Contexts (or application scenarios, e.g. Security Management, IT Service Management) along four industry sectors (manufacturing, telecom, finance/insurance, and software/IT) that EA Models are said to support or constitute the foundation of.

IS/IT Governance Framework In a context previously explicated, Gregor et al. [33] reported, among others, on the important contribution of an IS/IT Governance Framework to the achievement of Business and IT alignment. Beyond the scope of this research's theme, but very important nevertheless to note, is that Gregor et al. reinforce with their study the notion of the EA *contribution* towards specific goals (in this case, alignment), in combination with—and not in isolation from—other organizational alignment mechanisms.

The Enterprise Architecture Benefits Map

In this section we briefly present the Enterprise Architecture Benefits Map (EABM), a full account of which is provided in [39]. The EABM serves as a visual-oriented model to provide and enforce an appropriate structure on the EA Benefits and their Relationships, so that they can be effectively and efficiently understood and utilized. It could be argued that the sheer number and complexity of the EA Benefits and their Relationships alone could provide the *raison d'être* for devising such an artifact. Furthermore, we argue that, although a “traditional” synthesis can be effective in presenting the originating studies in relation to their researched outcomes, maintaining a narrative account of the relationships between the outcomes can be cumbersome and counter-intuitive. The EABM does not represent a novel artifact but rather builds on Kaplan and Norton's Strategy Maps (SM) [40]. As such, the EABM structurally echoes, but semantically differs in certain aspects from the SM.

The EABM is comprised of four main Perspectives, each of which consists of a number of Categories, which can be thought of as the second-level logical grouping of EA Benefits. In antithesis to the SM, and for reasons of semantic consistency, no Perspective directly groups EA Benefits; instead all EA Benefits are grouped in Categories.

The Financial Perspective Consists of the Financial Outcome Benefit Category, which is used to describe how various financial-related organizational EA Benefits contribute to the achievement of possibly *multiple* financial-related strategies. Financial Outcome Benefits relate to financial-related organizational outcomes including, but not limited to, financial gains occurring in relation to or as a result of the i) more effective use and re-use of artifacts, processes or other resources, ii) increase in profit or similar financial indicators, iii) reduction in costs and wasted resources.

The Customer Perspective Consists of the Customer Outcome Benefit Category, which is used to describe how various customer-value-related organizational

EA Benefits contribute to the achievement of possibly *multiple* customer-value-related strategies. Customer Outcome Benefits relate to customer-value-related organizational outcomes referring either to a customer-value objective achieved or to the contributing effect on such an objective. Additionally, they can relate to the i) achievement of or the contributing effect on a customer-value-related strategy, ii) realization/attainment of or contributing effect on a strategically important customer characteristic (e.g. customer group).

The Internal Perspective Used to describe the various business process benefits—results of implementing an EA program on internal business processes. It consists of four Categories that group benefits stemming from the implementation of an EA program to processes relating to: i) *Operations Management Processes Category*—the production and delivery of an organization’s products and services; ii) the *Customer Management Processes Category*—customer acquisition and customer relationship sustainment and growth; iii) the *Innovation Processes Category*—product/service/process innovation through R&D programs; and iv) the *Regulatory & Social Processes Category*—the management and reporting of organizational performance on national and/or local regulations, and other aspects of social interest.

The Learning & Growth Perspective Used to describe those various intangible asset benefits—results of implementing an EA program on the intangible assets of an organization, and how these benefits contribute to the achievement of possibly *multiple* organizational strategies. It consists of three Categories which group benefits stemming from the implementation of an EA program to intangible assets relating to: i) the *Human Capital Category*—an organization’s stock of workforce competencies; ii) the *Information Capital Category*—IT infrastructure and information capital applications; and iii) the *Organization Capital Category*—culture, leadership, teamwork and knowledge sharing, and alignment (in the EABM, *alignment* applies to individual employees towards BU and/or strategic objectives and incentives, between individual employees, and between inter/intra-organizational structures).

Organizational outcomes-results of the application of EA (O)

After assigning the EA Benefits to the EABM categorization scheme, we drew the actual EABM (Figure 1). We observe that the majority of the EA Benefits belong to the Learning & Growth (52%) and the Internal (30%) Perspectives. The Financial Perspective ranks third (16%), and the Customer Perspective appears extremely underrepresented (2%). From the 52 EA Benefits of the Learning & Growth Perspective, almost two thirds belong to the Information Capital Category (60%), exactly one third to the Organizational Capital Category (33%), and just 8% to the Human Capital Category. From the 30 Internal Perspective EA Benefits, half belong to the Innovation Processes Category, almost all of the other half (47%) to the Operations Management Processes Category, only one belongs to the Customer Management Processes Category (3%), and none to

the Regulatory & Social Processes Category. All of the 15 Innovation Processes Category’s EA Benefits belong to its Design & Development Subcategory. Similarly, most of the Operations Management Processes’ EA Benefits belong to its Produce Products & Services Subcategory.

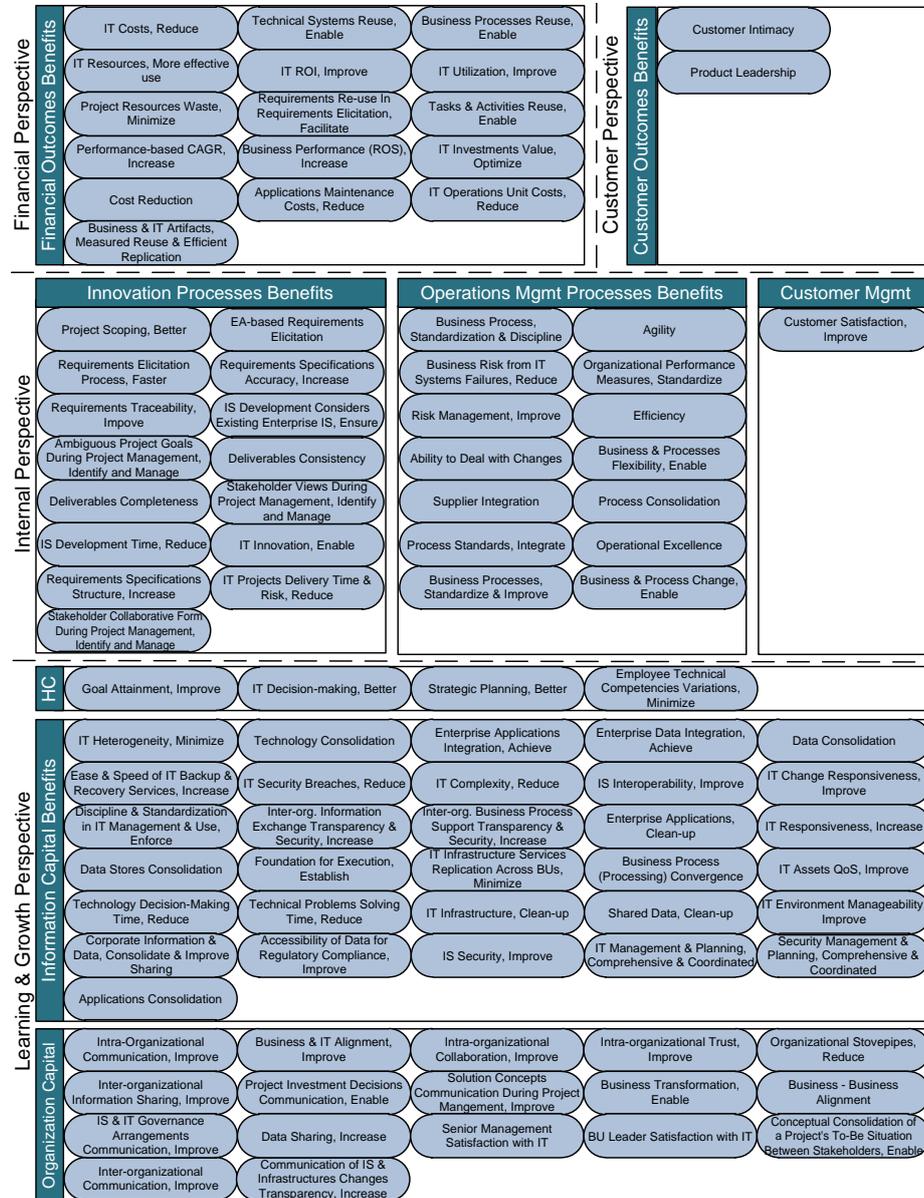


Fig. 1. EABM displaying all EA Benefits

In total, we identified 65 Relationships between EA Benefits. As an example, and for brevity and readability reasons, we limit ourselves in providing a second EABM (Figure 2) that displays only a subset of them: those EA Benefits that directly contribute to the Improvement of Business-IT Alignment ².

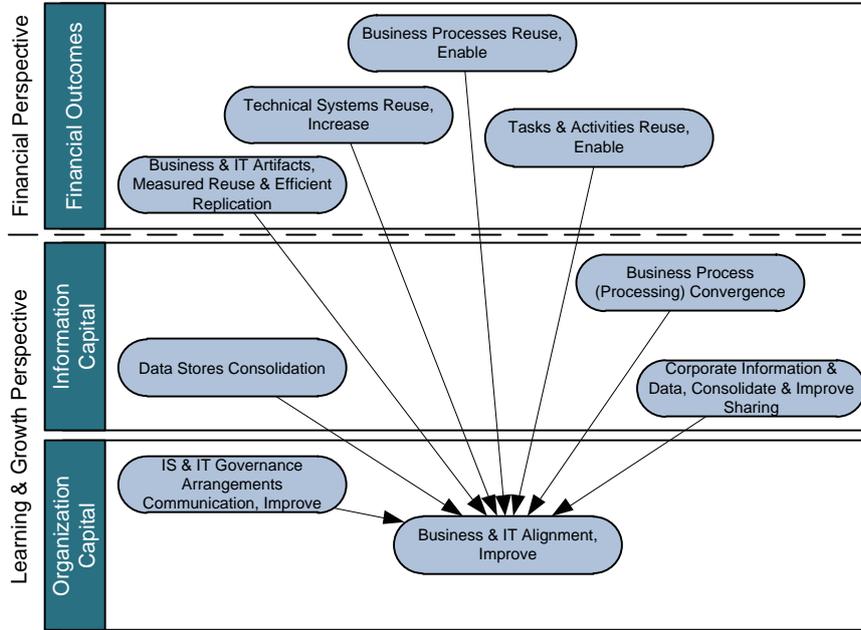


Fig. 2. EABM displaying those EA Benefits that directly contribute to the *Improvement of Business-IT Alignment*.

4 Discussion

Major Findings & Quality of the Evidence Our research results provide a rich, consolidated and scientifically established picture of the potential organizational benefits of EA. By *rich*, we mean a full account of the available research findings: unlike similar research on EA benefits (e.g. [4, 41]) that reported on EA benefits without taking into account any relevant context, this research sought to understand and report not only the context within which certain benefits appear as results of the application of an EA program on an organizational structure, but also the generative mechanisms of EA that cause them.

The analysis of the 14 eligible studies revealed the current state of the scientific and practitioner's literature concerning the potential benefits of EA, as

² A complete account of the Relationships is available at [39].

describing 29 unique contexts within which EA has been found to deliver value, 100 unique benefits of EA, and 3 mechanisms that generate the value of EA. The analysis of the results in relevant themes pinpointed, among other issues, the evident emphasis of those studies towards IT and IT-related issues, both in terms of Contexts and Outcomes—benefits of EA.

Certain contexts and several benefits have been found to semantically overlap or to group more than one notion. Some benefits could arguably pose as application scenarios (contexts) and vice versa. Others might appear vague or of high-level abstraction. These facts are characteristic of the different intentions of the original studies' authors. The “affected” elements were incorporated with the rest of the results without any alterations since that could potentially introduce a range of issues from semantic discrepancies to non-existent cause and effect relationships.

The vast majority of the potentially relevant studies we located was finally excluded from the synthesis, primarily because approximately two out of three were found to be irrelevant, and secondarily because the remaining relevant studies displayed various methodological or other qualitative “deficiencies” against the assessment questions. We hold these results as indicative of the absence of a sufficient number of research programs being conducted on the effectiveness of EA, and additionally, of the relatively poor quality standards of either the contributing research or its reporting; at least as these score against the SLR's assessment questions.

Additionally, our results suggest an almost equal number of qualitative and quantitative research designs among the eligible studies. We believe though that the quantitative research design is not the most appropriate for researching and reporting rich, highly contextual evidence. For that, we hold these results as supportive to the notion of a deficit on the relative amount of rich evidence available from the eligible studies. Supportive evidence to the last claim comes from the large number of IO-logic design propositions found (in addition to CIO-, CIM-, and CI-logic), as compared to the small number of CIMO-logic design propositions found, which is a clear indication of the relatively shallow depth of analysis undertaken in several studies. This last effect was nevertheless expected; it has been acknowledged by other researchers as it appears to be a common characteristic of the research conducted in the management domain [8].

Meaning & Importance of the Major Findings The results of this research project respond to recent calls for research, not only on the potential benefits of EA [4] but—equally important—on the relationships among them [41]. This study however delivers additional value in that it takes into consideration the context in which EA benefits occur and the mechanisms through which the benefits are generated.

For the problem of defining the applicability of EA as an organizational problem-solving tool, relating EA benefits with a specific context functions as a heuristic for minimizing the problem space. Additionally, relating EA benefits with specific mechanisms of EA that generate them, provides an answer on how

the benefits were actually brought about and offers an additional, critical layer of understanding of the applicability of EA.

Overall Completeness & Applicability of the Evidence We hold our results as providing a competent amount of evidence regarding the identification of the benefits of EA, as these are perceived or established by researchers and practitioners of the field. The evidence put forth by the review, however, is only transferable to the extent that the individual, eligible studies' results are. The results of the literature review should be seen as *potential* benefits of EA and their realization in real-world scenarios might depend on many other contextual factors that require careful examination. Additionally, we acknowledge that there might exist other EA benefits, not yet explored in research.

The results of the SLR carry several implications for both researchers and practitioners: i) enhancing the understanding on EA by providing valuable information on potential EA benefits and their relationships, their applicability (context), and their generative mechanisms, ii) enabling the scientifically grounded reasoning on how EA might contribute to the achievement of certain business goals, establishing thus the business case for EA and EA projects, and iii) providing an extensive list of EA benefits that can function as a source for defining relevant objectives for EA programs, as well as for defining EA effectiveness metrics.

Potential Biases & Limitations in the Review Process The SLR method utilized enabled a highly structured process with transparent and traceable results: all aspects of the evidence produced and the relevant rationale that produced them, are readily available and reported in [39]. However, the studies' eligibility compliance was undertaken solely by the main researcher. To counter possible bias, ambiguities were resolved after consulting with members of the review panel.

In addition, although the study contends to be highly inclusive regarding the total number of available studies on the subject of EA effectiveness, we understand that it is highly improbable to have located all of them with the reported search process, for a number of good reasons. First, we expect additional studies to be available in other languages than the one our search focused on (English). Second, we expect more gray literature to exist in sources that the researchers do not currently have access to or are unaware of (e.g. organizational statistics, internal reports). Third, we excluded search keywords relating to and studies specifically reporting on the effects of Service Oriented Architecture (SOA), as we have found the relationship between EA and SOA to be currently vaguely—and sometimes even contradictory—defined in the relevant literature. Since SOA has been defined (among others) as a competitor or an alternative to EA [42], it follows that any reported benefits of SOA cannot be readily claimed by EA.

Suggestions for Further Research We propose that additional systematic reviews are conducted in the future with the aim of locating multilingual contributions and additional gray literature. Judging by the results of this SLR, it is only

natural to call for more original, rigorously designed, executed, and reported research on the ways EA contributes to the achievement of specific organizational goals. Additionally, we invite researchers to make use of the EABM as a tool for charting the existing academic research, in order to identify prominent or currently uninvestigated organizational domains.

Furthermore, we propose that future research targeting the benefits of EA, might utilize the CIMO-logic prism in an effort to create useful, rich evidence that successfully relates outcomes to specific contexts and generative mechanisms; breaking thus away from the sterile IO-logic usually purported in the management domain.

5 Conclusion

In the context of this research we conducted a systematic review of the literature relating to the effectiveness of EA, with the explicit goal to discover those ways that the EA has been found to contribute to organizational goals. With the aid of the CIMO-logic prism for extracting design propositions from the eligible studies, and the EABM for making sense of EA Benefits and their Relationships, the review produced rich evidence on the effectiveness of EA and at the same time revealed the current state of the relevant literature. Insights gained include an evident emphasis of the existing research targeting IT and IT-related effects of EA, an evident shortage of research programs being generally conducted on the issue, an apparent poor research design and/or reporting quality of several literature contributions, and an apparent “shallow” research evidence depth—to an extent the result of the quantitative research design focus of several studies. However, we acknowledge that the study might not have covered the entire span of available literature for a number of reasons (e.g. the language of the retrieved publications).

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