Boost the Potential of EA: Essential Practices

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Abstract: Enterprise Architecture (EA) has been applied widely in industry as it brings important benefits to ease communication and improve business-IT alignment. However, various challenges were also reported due to the difficulty and complexity of applying it. Some empirical studies showed that EA stilled played a limited role in many organizations. In this research, we showed other findings where the potential of EA could be better used. They are derived from our analysis of advanced EA tool recommendations. Based on these findings, we proposed four essential EA practices and the rationales behind them in order to improve the understanding of current practices and bring insights for future studies to boost the potential of EA.

1 INTRODUCTION

Enterprise Architecture (EA), defined as "fundamental concepts or properties of an enterprise in its environment and governing principles for the realization and evolution of this entity and its related life cycle processes" (ISO/IEC/IEEE, 2019), has been applied widely in industry to address communication issues and align business and IT. Despite the high expectations and some reported benefits (Korhonen, Lapalme, McDavid, & Gill, 2016; Winter, Buckl, Matthes, & Schweda, 2010), challenges often arise that block the efficient application of EA (Engelsman & Wieringa, 2012; Isomäki & Liimatainen, 2008; Olsen & Trelsgård, 2016). As a result, in many organizations, EA still plays a limited role (Guo, Li, & Gao, 2019; Kotusev, 2019). But what is the reason for that? To the best of our knowledge, the root causes are still unclear, and there is no general agreement about the best practices to improve the EA application yet.

The objective of this study is to enhance the understanding of how to boost the potential of EA in practice. In this paper, we present our reflections on how EA could be used (and might be already used) in organizations in a more efficient manner. We analysed the differences between the tool vendor guidelines and the state of the practice of applying EA based on a comprehensive study of 27 organizations as reported by (Kotusev, 2019). Based on the data analysis results, we proposed four essential practices to raise the potential of EA accordingly. These practices are: "use EA in a business outcome-driven way," "develop EA gradually when using it," "maintain a complete digital EA repository," and "base EA on an integrated meta-model."

The rest of this article is structured as follows. Section 2 introduces relevant background information. Section 3 briefly introduces the method and sources where we collected evidence. In Section 4, we present our data analysis and results. We then discuss how to boost the potential of EA in Section 5. And in Section 6, we put forward and motivate the essential practices identified. Lastly, Section 7 discusses the limitations of this research, points out future directions, and concludes this paper.

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2 BACKGROUND

2.1 EA Basics

EA is often referred to as a blueprint for enterprise composition and enterprise operating systems. Despite many kinds of benefits EA might bring (Winter et al., 2010), one main **role of EA** is to provide the service of understanding and communicating enterprise interaction patterns through abstract and graphical expressions, and to facilitate the alignment of business and information systems (Korhonen et al., 2016).

EA usually exists in the form of a set of abstract graphics which cover the high-level content of the enterprise across areas such as strategy, business, information, and technology. We call these abstractions **EA artefacts, EA documents** (usually in more textual form), or **EA models** (usually in graphical form).

EA is traditionally and usually developed based on one or more **EA Frameworks** (**EAFs**). These EAFs provide a common foundation for EA practitioners. For example, TOGAF (The Open Group, 2020) is maintained by a standardization organization (The Open Group) and is one of the most widely used EAFs. An EAF usually consists of two parts. One part is a content framework, which mainly describes what concepts should be included and what are the relationships among them. The other part is a development method, which provides guidelines for developing related EA documents.

For a content framework, a **meta-model** is often used to accurately define (about both syntax and semantics) the concepts as well as the relationships between them. Since the basic form of EA is usually a set of graphical models, content frameworks are also often associated with a set of graphical notations. For example, the ArchiMate standard that is hosted by the Open Group includes a set of symbols that are fully compatible with the TOGAF meta-model. The meta-model is usually one of the most important components of an EAF.

EA tools are defined as "software applications designed to support enterprise architects and other business and IT stakeholders with strategically driven planning, analysis, design, and execution (Gartner, 2021)." EA tools should be selected to keep compatible with enterprises' approaches to transformation, modernization, and innovation to avoid failure of such efforts. EA tools store, structure, analyse, and present EA information to aid in the investment, development, and delivery of IT solutions that enable business success. EA captures and connects context information across business, information, solution, and technology domains to support strategic and tactical decision making. EA tools also help with planning and executing a business strategy and focus on diagnostic, actionable, operational, and enabling deliverables (Gartner, 2021).

2.2 EA Benefits and Challenges

EA is often mentioned as a means to provide a holistic view of an enterprise. Such a holistic view is elaborated as "*a coherent whole of principles, methods, and models that are used in the design and realization of an enterprise's organizational structure, business processes, information systems, and infrastructure*" (Lankhorst, 2009). The main idea here is that EA captures the essentials of an enterprise. While essentials are thought to be more stable than specific solutions for currently at-hand problems, EA is therefore regarded as helpful to guarding the essentials of the business while keeping maximal flexibility and adaptivity. Furthermore, it was thought that "*without good architecture, it is difficult to achieve business success*" (Lankhorst, 2009).

Despite the high expectation for EA becoming "*the determining factor that separates the winners from the losers*" (Zachman, 1997), over the last twenty years and through many successful examples (Zachman, 1997), EA application has also met with numerous challenges (Engelsman & Wieringa, 2012; Isomäki & Liimatainen, 2008; Olsen & Trelsgård, 2016). In one of the latest empirical research studies (Kotusev, 2019), representatives from 27 diverse (in size, industry, and EA experience) organizations were interviewed about how they have been using EA (artefacts). Results from (Kotusev, 2019) indicated that EA in general still played a limited role in many organizations. The findings suggested that some important EA documents such as roadmaps were empirically invalid, and that overall EA was discrete instead of coherent.

To the best of our knowledge, there is no clear answer as to why there is such a difference in the perceived usefulness of EA for organizations and the limited usage of EA in industry. This inspired the present research. Our goal is to investigate what caused insufficient exploration and usage of EA as reported by (Kotusev, 2019). We also want to identify essential practices in order to boost more potentials of EA.

3 DATA COLLECTION AND ANALYSIS METHOD

With the aim to shed some light on ways of better adopting EA, we studied how methods and tools are used to explore EA potentials for organizational performance from the tool vendor perspective.

To do so, we have collected evidence from publicly available content on official EA tool vendor websites and websites providing third-party reviews of the EA tools. We primarily used the **grey literature review** approach (Garousi, Felderer, & Mäntylä, 2016) to collect and analyse the data. Grey literature reviews have been acknowledged as a valid alternative to academic literature reviews when the state of the practice is concerned, as they can give substantial benefits (Garousi et al., 2016).

The evidence mainly comes from the website contents of 16 leading EA **tools**. There are three reasons for us to review such website contents. First, tools are both instrumental and very important in EA discipline (Korhonen et al., 2016). Second, tools in general make it easier for users to accept one technology. For EA, user acceptance was perceived as one of the critical challenges. Thus, we assume that tool support could facilitate EA application. Third, according to our preliminary observation, the content offered in the tool vendor websites is rich and informative. Many white papers, use cases, and feature descriptions were provided on the vendors' websites to provide knowledge to their potential customers and show vendors' expertise.

We **collected data** primarily from 16 websites of EA tool vendors. The vendors were selected from the **list of vendors** administered in Gartner's (Forbes Media LLC., 2021) annual report named "*Gartner Magic Quadrant for Enterprise Architecture Tools*" (Gartner, 2020), which includes long-established manufacturers as well as insightful new challengers. We believe that how these leading vendors apply EA represents the current trend of first-line EA applications. To complement the opinion and information declaimed by the vendors themselves, we have also referred to **user reviews** available in (Gartner, 2021). The user reviews were verified as explained by (I. Gartner, 2020) to ensure their quality and reliability according to some criteria, such as not containing plagiarized content and highlighting experiences related to vendors/products. Some reflections were also triangulated with the analysis of user reviews in IT Central Station (IT Central Station, 2020), which unfortunately have not been explicitly presented in this paper due to the space limitations.

Our **data analysis** aimed to compare the state of the art as reported in a recent comprehensive study of organizations applying EA (Kotusev, 2019) (further referred to as "**results-of-survey-study**"), with the recommendations suggested by the tool vendors (further referred to as "**vendor recommendations**"). We used (Kotusev, 2019) as a representative of the state of the practice because it proposed clear statements about the comprehensive EA application which makes it easier for us to make the comparison.

Notably, it was not easy to compare evidence extracted from the empirical study and the tool vendor websites, as the concepts and structures often differed. In fact, terminology misalignment in scientific papers is a known issue (Korhonen et al., 2016). In order to compare and map different aspects of EA implementation that differ, we focused on **four essential aspects of EA application**: how to use, how to create, how to organize, and how to regulate EA artefacts. Our analysis started by reading through the contents of the websites and gaining an initial understanding of the overall breadth and depth of the information and supporting evidence. Next, we extracted evidence relevant to the four chosen aspects of EA application. As similar evidence was presented on multiple websites and for multiple products, we chose the most representative formulations (clear and complete statements). As a result, evidence presented in this paper mainly came from the websites of six vendors: Avolution (Avolution, 2021a), Sparx (Sparx Systems Pty Ltd., 2021), Ardoq (Ardoq AS., 2021), ValueBlue (ValueBlue B.V., 2021), Mega (MEGA International, 2021), LeanIX (LeanIX, 2021).

4 DATA ANALYSIS RESULTS

In this section, we present **four aspects** of how to use, create, organize, and regulate EA as critically evaluated in a recent empirical study (Kotusev, 2019) presented as "**results-of-survey-study**" versus as suggested by the tool vendors accomplished with some user reviews as "**vendor recommendations**." "**Reflections**" are derived based on the analysis of the differences between the extracted evidences.

The four reflections related to EA are summarized as:

- Roadmap (EA usage): empirically invalid versus feasible and useful.
- EA (organizations): not a single description for all stakeholders versus a single, comprehensive, and valuable repository.
- EAFs/meta-models (EA regulations): purely declarative versus fundamental.

- EA creation/development: for specific purposes versus for specific business output with limited extra costs.

4.1 Roadmap: Empirically Invalid vs. Feasible and Useful

Results-of-survey-study: According to (Kotusev, 2019), "*the conceptualization of EA as the current state, future state and transition roadmap is empirically invalid*." The author presented two main reasons for this. First, many useful EA artefacts do not distinguish current and future states. Second, none of the organizations had comprehensive descriptions of their current and future states.

Vendor Recommendations: Leading vendors such as Avolution (Avolution, 2021a) promote a roadmap as one of the key features of their EA tool products. The roadmap can be based on state gaps and is recognized by some verified users according to (Gartner, 2021). The summary of the evidence is shown in Table 1.

Reflection 1 (R1): Roadmap based on gap analysis might be feasible and useful.

Table 1: Evidence to R1.

Reflections	Evidence
Vendors provide roadmap.	*Avolution* promotes roadmap as one key feature.
Might be based on gap analysis.	*Avolution*: "The architectures under consideration will include a current state plus at least one 'target' or 'future state' architecture."
Users recognize the value of roadmap.	*User reviews to Abakus* (Avolution's EA tool product): Among two out of eleven verified reviews, "product roadmap and future vision" was enumerated as one of "the key factors that drove your decision." In another verified review, it was commented that "(Abakus) helps to create the entire roadmap" in overall comment.

4.2 EA: Not a Single Description for All Stakeholders vs. a Single, Comprehensive, and Valuable Repository

Results-of-survey-study: "EA is a complex set of very diverse descriptions intended for different decision makers and purposes rather than a single comprehensive description that is developed and then used by all stakeholders" (Kotusev, 2019).

Vendor Recommendations: Several vendors such as Sparx, Avolution, and Ardoq advocate that their products provide a complete repository and name it as a key feature of "a single source of truth." The vendors also highlight the value of this feature and think it is essential for data integration, providing a holistic view and solving complex decision-making problems. This evidence is presented in Table 2.

Reflection 2 (R2): EA as a single comprehensive repository is very valuable.

Table 2: Evidence to R2.

Reflections	Evidence
Vendors advocate having a single repository.	*Sparx*: "A single source of truth." *Avolution*: "A single source of truth." *Ardoq*: "A complete repository for all integrations."
Vendors highlight the value of having a single comprehensive repository.	*Sparx*: (A single source of truth/ repository) solves the problem of managing networks of decisions. *Avolution*: "The value is in being able to wire our data together using integrations" and "create a single source of truth, pulling in your chosen master data." *Ardoq*: "Understand your integration architecture from a holistic point of view to better manage life cycles, outages, and the impact of change."

4.3 EAFs/Meta-Models: Purely Declarative Vs. Fundamental

Results-of-survey-study: "*The use of EA frameworks is purely declarative and does not define resulting EA practices in any real sense*" (Kotusev, 2019). Notably, the term "meta-model" is not mentioned in the study (Kotusev, 2019), so we assume that meta-models are either overlooked or used interchangeably with EAFs.

Vendor Recommendations: Eight out of 16 vendors claim their support for more than one standard EAF such as TOGAF and ArchiMate in prominent positions on their websites. The top three vendors even support a big number of EAFs. One vendor reveals how EAFs relate to their own meta-models and notations. The evidence is presented in Table 3.

- Half of the leading EA tool vendors (eight out of 16) clearly advocate that their tools are

compatible with at least one notable EAF such as TOGAF and ArchiMate in prominent positions on their official websites. These tool vendors are Avolution, BiZZdesign, MEGA International, QualiWare, UNICOM Systems, Sparx Systems Pty Ltd., BOC Products & Services AG., and ValueBlue.

- The top three vendors (Avolution, BiZZdesign, and MEGA) are keen to widely support industry EAFs. For instance, Avolution supports over 100 frameworks. Such EAFs include high-level and low-level ones. High-level ones are referred to typical EAFs such as TOGAF which covers full domains for organizations. Lower-level ones are referred to more local frameworks such as BPMN, which covers more specific domains for organizations (Avolution, 2021b).
- Avolution also explains the mechanism about how they use EAFs/meta-models. The central idea is to use one single meta model to decouple underlying frameworks/meta-models and upper-level notations. Therefore, they can benefit from both standard EAF/notation compliance and one single inventory (structured by the meta-model). This principle seems to also explain why ValueBlue, which supports one EAF only, namely ArchiMate, provides multiple formats to visualize the data, while Erwin, which is a leading meta-data management vendor, does not advocate their support to any standard EAFs.

Table 3: Evidence to R3.

Reflections	Evidence
Vendors advocate their support to standard EAFs.	*Overall:* 8/16 leading vendors support at least one standard EAF. *Avolution*: "Ships with over 100 industry leading frameworks, metamodels and notations."
Vendors recognize the value of EAFs.	*Avolution*: "Selecting a framework is often one of the first steps to delivering enterprise architecture success," "provide a set of assets and templates which allow architects to get started quickly," "set best-practice and standards for governance," "helpful for collaboration and communication between architects."
Vendors explain the relations among EAFs, meta-models, and notations.	*Avolution*: "Practitioners can configure, adapt or combine frameworks and metamodels." *ValueBlue*: "Models can be presented in a variety of ways, but under the hood it is a consistent model within ArchiMate® 3.1." *Ardoq*: "20+ out of box visualizations."

It turns out that the majority of the reviewed EA tools is employing such an integrated meta-model for integrating EA data. On one hand, such meta-models can be created in-house based on one standard EAF or by integrating meta-models from multiple standard EAFs. On the other hand, one or multiple notations/formats/visualizations can be supported to visualize the data. Such notations may or may not come from one or multiple standard EAFs also. Therefore, we think the use of EAFs/meta-models provides a fundamental function (a rigorous definition for EA data structure).

Reflection 3 (R3): The use of EAFs including meta-models, is fundamental to EA application.

4.4 EA Creation: For Specific Purposes vs. for Specific Business Output with Limited Extra Cost

Results-of-survey-study: "*No EA artefacts are created merely for the sake of having some descriptions*" (Kotusev, 2019). "All EA artefacts are created for specific purposes, rather than simply to describe some aspects of organizations" (Kotusev, 2019).

Vendor Recommendations: Many vendors such as Avolution and Mega (MEGA International, 2021) advocate for their solutions to support "outcome-driven EA" and be "out-of-the-box." This indicates that EA is developed/used when a specific purpose arises. It also means limited cost is incurred ahead of actual EA usage. The evidence is summarized in Table 4.

EA can be used/developed for a specific outcome with limited additional costs. This reveals organizations' eternal expectations of Return on Investment (ROI) for various tasks including EA development/usage. Traditional framework-based usage of EA usually involves a big amount of development work ahead, and it is difficult to evaluate the benefits and costs of using EA.

This might explain why organizations reviewed in (Kotusev, 2019) discarded/simplified complex cases such as roadmaps (many EA artefacts needed are not available and huge and/or unpredictable workloads are required). In the picture described by vendors, it is claimed that users are only suggested to use EA for specific purposes, and they do not have to spend much extra effort ahead of that. Considering how EAF/meta-models and EA inventories are generally used as previously presented, we assume that EA

inventory is gradually accumulated while being used on purpose.

Reflection 4 (R4): Creating EA for specific business outputs and accumulatively might present appealing ROI.

Table 4: Evidence to R4.

Reflections	Evidence
Vendors advocate the purposeful use of EA.	*Avolution*: "Business-Outcome Driven Enterprise Architecture" *Mega*: "Business-outcome-driven Enterprise Architecture," "outcome-driven approach," "based on value-added use cases" *LeanIX*: "Outcome-driven approach"
Vendors advocate the "out-of-the-box" feature.	*Ardoq*: "Out-of-the-box integrations with leading tools," "20+ out of box visualizations" *LeanIX*: "30 Minutes to Lift Off"
Vendors explain the expectation of ROI behind.	*Mega*: "Achieve faster time-to-value and generate demonstrable ROI through an outcome-driven approach."

5 DISCUSSIONS

We intended to collect and compare four pairs of facts described in (Kotusev, 2019) and "vendor recommendations" above. Subjects in the four aspects, namely the EA use case (R1), EA repository (R2), EA frameworks (R3), and expectations on EA costs (R4), are related. First, the premise of maintaining a complete EA repository is to use a common meta-model. Second, the roadmap is not a simple document describing a certain aspect of an enterprise, but a complex use case based on the understanding of multiple aspects of the enterprise. Effective support for such complex cases therefore requires multiple related EA documents. Third, the purposeful use of EA represents a rigid requirement or restriction in practical environments, which means that the development of EA must demonstrate acceptable ROI, although this ROI may be perceptual and qualitative rather than rational and quantitative.

We further analyse where EA is applied in (Kotusev, 2019) and "vendor recommendations." According to the original claims in (Kotusev, 2019), in these involved organizations, there is no complete and unified EA repository. EA is simply a collection of discrete artefacts. These artefacts are not well structured and digitized. Therefore, it is impossible to accumulate and reuse artefacts that were developed by different people at different times. The benefits of EA using a certain framework are limited to the conceptual unification of these artefacts. Some simple use cases can be satisfied by constructing specified artefacts, while complicated cases are difficult to be satisfied due to the consideration of cost performance.

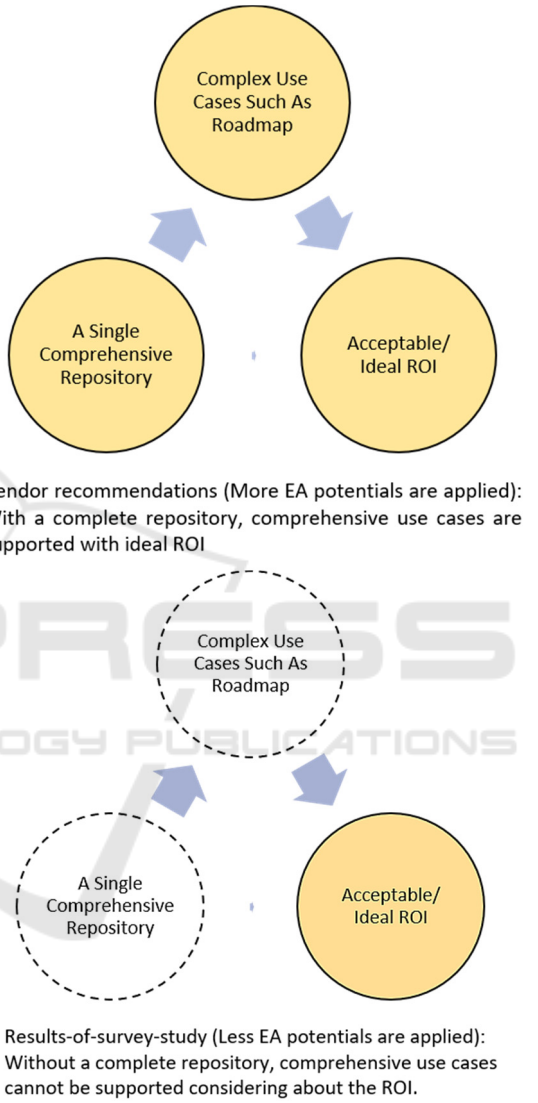

Figure 1: Two situations where EA potentials are applied differently.

While based on our analysis of the vision described by leading tool vendors, EA is constructed and maintained as a complete digital repository, this repository is well structured based on a common meta-model. Therefore, benefiting from reusing the data accumulated in the previous simple case application, even if it is necessary to provide ideal cost performance, complex cases may still be supported.

As shown in Figure 1, appropriate ROIs are required/expected in both situations. From the vendor perspectives, with the support of a digital and comprehensive inventory (structured with a common meta-model), complex use cases are still possible to be satisfied. But in (Kotusev, 2019), instead of one comprehensive inventory, there is only a complex sets of EA artefacts. Only simple use cases can be satisfied under significant pressure of expected ROI, therefore. Thus, (Kotusev, 2019) and vendors show different exploitation of EA potentials. Here, EA potential has at least two meanings. One is the satisfaction of complex use cases. The other is to extract more value from data in digital EA inventory such as automated data capturing, data integration, data analysis, and data visualisation.

6 ESSENTIAL PRACTICES TO BOOST THE POTENTIAL OF EA

Based on the above discussion, we can see that in order to boost the potential of EA, the key is to maintain a unified digital EA inventory. Such an inventory needs to be based on a common meta-model (i.e., by integrating multiple existing EAFs). If EA is always used for a specific purpose, and at the same time is gradually accumulated in the inventory, it is promising to demonstrate a satisfactory or at least acceptable cost performance. These essential practices were summarized in Table 5.

In Table 5, we also listed the main rationale. While "**essential EA practices**" mainly address the technical part of how to develop and use EA, the "**rationale behind**" mainly addresses the motivations from EA users' perspectives. It should be noted that these practices are not simply juxtaposed, but there are dependency relationships among levels from top (P1) to bottom (P4).

Table 5: Essential practices and possible rationale behind boosting the potential of EA.

Essential EA Practice	Rationale Behind
P1: Use EA in a business outcome-driven way.	To generate demonstrable ROI.
P2: Develop EA gradually when using it.	To minimize unnecessary costs.
P3: Maintain a single digital EA repository.	To benefit from the single source of truth.
P4: Base EA on an integrated meta-model.	To normalize a common vocabulary.

These practices seem to be in line with spirits advocated by modern tool vendors. For instance, LeanIX (LeanIX, 2021), the vendor which tops the rank according to (Gartner, 2021), proposes five guidelines to satisfy all stakeholders and therefore continuously explore the most EA value. First, the language should be easy to understand. Technical jargon should be avoided, and important information should be conveyed. Second, the data should be available to everyone at any time. Third, the quality of the data should be maintained actively so that reliable information can be used for decision making. Fourth, useless models should be avoided, and practical benefits should be pursued when solving real problems. Fifth, it is recommended to focus on a few areas and use cases so that repeatable success can be proven. Then, such processes could be incorporated gradually, and more opportunities and disruptions can be addressed. Among these five guidelines, we can distinguish that the first is about meta models. The second and third is about EA data. The fourth and fifth are about how to use EA data and gradually develop/accumulate it.

7 CONCLUSIONS

In this research, we present our reflections on the comparison of EA applications reported in a recent comprehensive empirical study (Kotusev, 2019) and advanced EA vendors' recommendations and their users' reviews. As is evident in our results, several aspects of EA application differed in the evidence obtained from the two sources. Based on our results, we put forward suggestions on how to boost EA potential the most. One thing to notice is that although we derived essential EA practices by extracting behaviour traits from leading EA tools, the resulting recommendation is not to promote the simple use of such tools, but to learn from their practices.

One limitation of the present research is that most evidence comes from the description of vendors. We compensate for this by reviewing some verified user comments. We plan to use the tools in real scenarios ourselves and follow other tool users through interviews or surveys to further validate and enhance our proposal.

With proposed practices and the rationale, we expect that more techniques and methods can be aligned in this strategically important area effectively. By doing so, more potential of EA could be employed in order to address critical issues such as lack of communication and misalignment between business and IT in a more reliable way.

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