A Framework for Managing Enterprise Architecture Debts - Outline and Research Directions

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Abstract: Even though enterprise architecture management (EAM) offers a wide range of methods and tools for aligning business with IT, an architect's work is challenged by reality. The evolution of enterprise architecture (EA) and given constraints (e.g. legacy systems and processes) lead to debts which may complicate and hinder opportunities; however, the management of such debts has not been considered in EAM research. This paper presents a framework for strategically managing EA-debt-related issues and propose open questions as well as future research directions in this field.

Keywords: Enterprise Architecture; Enterprise Architecture Debts

1 Introduction

The EA discipline provides methods and tools for aligning business with corporate IT and even fostering (digital) innovation in an organisation [La12]. Despite the plethora of research and practice, business-IT alignment is still a challenging task as it requires changes throughout an enterprise's technology, processes, and organisation [Ju19]. The complexity of those changes does not only lie in their nature but is also influenced by the corporate environment. Established IT systems, technical debt (TD), out-dated processes or even an extensive EAM framework might hamper the introduction or renovation of required business systems and processes. Furthermore, those debts slow down innovation and impose a tremendous risk on continuously optimising business and IT.

To overcome those risks and facilitate innovation, a guided management approach is needed. This paper presents our vision of a framework for managing EA debts which can help decision makers to mitigate/avoid EA debts issues. To motivate future research on this topic,

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we highlight research directions towards realising the envisioned framework. In this manner, we aim at bringing organisational aspects of EAM into sharp focus as current research in EAM tends to rather emphasize technical aspects [Ko17].

2   Background

The metaphor of TD was coined by Ward Cunningham in 1992 to describe past technical shortcuts that hamper IT developments. [Cu92, LAL15]. Afterwards, this concept gained widespread interest in the software engineering community, especially after 2010 [Am15, LAL15]. Over the past decade, the original idea of TD has been further refined [Av16] and extended to software architecture, documentation, requirements, and testing [Br10, YHL19].

However, such a concept has not yet been proposed in the EA domain which would address a significant issue within the EAM practice [Ha19b]. This is due to the increasing use of agile methods in organisations, which leads to reduced EAM conception phases to define proper target architectures [Ul17]. In addition, product owners tend to prefer short-term business value over solid architectural solutions. At the same time, enterprise architects lack effective means to prevent the neglect of long-term architectural solutions [URM19].

To overcome these shortcomings in EA, [Ha19b] has adapted this concept to the EA domain by extending the scope of the metaphor not only to technological but also to business aspects. Thereby, [Ha19b] defines EA debt as *"a metric that depicts the deviation of the currently present state of an enterprise from a hypothetical ideal state."* Such deviation is the result of architectural decisions that are expedient in the short term but set up a context for the enterprise that can make a future change more costly or even impossible. If not mitigated in time, EA debts may exert negative impact on the enterprise's business.

3   Outline of an EA Debt Management Framework

To seamlessly integrate EA debt management (EADM) into business development, we designed a framework, as represented in Figure 1, to provide the core for a comprehensive EADM methodology. The framework defines the following nine key activities, most of which are adopted from TD management (TDM) [LAL15].

The **identification** activity focuses on recognising signs of possible EA debts, like slowing or even stagnating EA evolution, across the analysed EA. This then enables the **collection** of evidence (e.g. by observing the development of EA artifacts) based on which suspicions of EA debts can be raised, confirmed/dispelled, and organised for further management activities. However, identifying EA debts can be intricate if no systematic approach and supporting analysis tools are in place. Therefore, future research must focus on characterising EA debts and their respective indicators (e.g. [Ha19b]), assisting EA observation, and
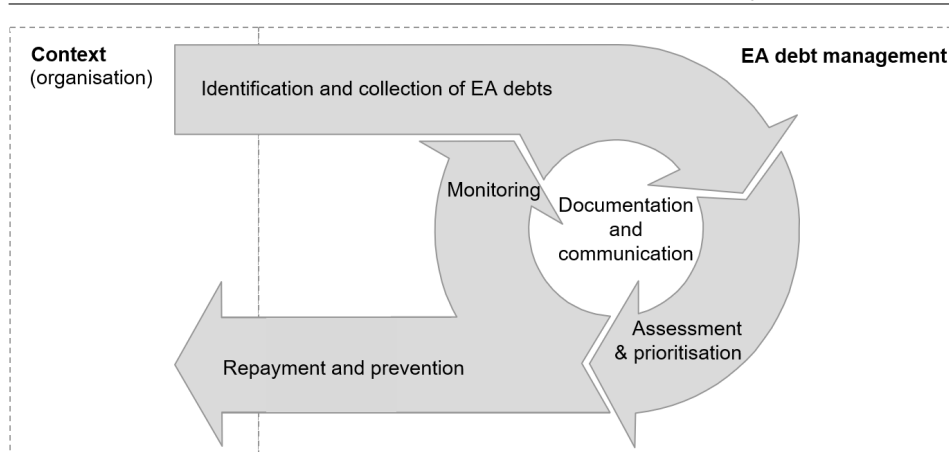
Fig. 1: EADM framework overview

providing valuation criteria for judging the suspected EA debts in the next phases of the framework.

Next, business consequences of the identified EA debts are quantified through the **assessment** activity. The cost and benefit of mitigating each EA debt is measured and presented from perspectives relevant to the enterprise, like business-IT alignment, financial growth, or socio-technical performance. The assessment results are then used as a basis for reasoning in the **prioritisation** activity. With respect to business goals and circumstances, EA debts are ranked based on a set of criteria such as the overall impact (both positive and negative) and mitigation intricacy, thereby helping to come up with a feasible and effective mitigation strategy. However, prioritising EA debts while taking all relevant assessment perspectives into account can be challenging. Therefore, future research must focus on defining relevant perspectives and measures in assessing EA debts, performing a full-scale EA debts assessment, and developing techniques in EA debts prioritisation (e.g. [YHL19]).

The **monitoring** activity addresses the continuous changes in EA due to changing business requirements, technical innovation, or reorganisation. If not continuously updated, views of EA debts may become obsolete and, in consequence, further mitigation decisions may be taken based on the wrong assumptions. To avoid this, relevant changes in EA must be continuously anticipated and incorporated into the existing views of EA debts. Not only does this put stakeholders' decisions on a firm footing, but it also enables timely decisions as soon as a monitored EA debt becomes intolerable. However, monitoring complex EA development can be intricate because of the high number, complexity, and diversity of artifacts and entities in EA environments. Although, some approaches to EA monitoring have been conceived [BGP11, KUM17], they have not yet come into practice. Therefore,

future research must focus on developing methods and tools for monitoring various EA artifacts, managing the captured information, and keeping views of EA debts up-to-date.

Ultimately, mitigating EA debts can be realised in two ways: the **repayment** of existing EA debts or the **prevention** of a worsening EA debts situation (e.g. accumulating EA debts interest or incurring additional EA debts). Through these activities, alternative scenarios in repaying/preventing high-priority EA debts are devised, and the best activity is selected based on a specific principle. In the field of TDM, a number of such principles have been proposed, such as *higher benefit first*, *high interest first*, or *high remediation cost first* [LAL15]. Finally, after implementing the chosen activities, the improved EA must be re-evaluated to verify whether the expected cost and benefit have been realised. To achieve such mitigation mechanisms, future research must focus on describing and comparing mitigation scenarios; identifying and solving sources of uncertainty in mitigation scenarios through simulation; and detecting potential EA debts through continuous EA debt evaluation.

Cutting across the aforementioned activities, the **documentation** and **communication** activities sustain the flow of EA debt knowledge among the involved stakeholders. The main challenge in realising these activities is to integrate the employed documentation and communication approaches with the viewpoints and information interests of different stakeholders (cf. [BS17]). To address this issue, future research must focus on identifying different viewpoints of EA debt, presenting EA debt in various views, and structuring the complex EA debt information in an intuitive and user-friendly manner.

4   Conclusion and Future Research Directions

The novel concept of EA debt poses new research questions about the adoption thereof in the context of EAM. To motivate and guide future research in this topic, we present our vision of an EADM framework with nine key activities: the identification, collection, assessment, prioritisation, monitoring, repayment, prevention, documentation, and communication of EA debts. Some challenges and important questions towards enabling these activities are foreseen and discussed in this paper.

Furthermore, the new field of EADM research opens a broad range of future research directions which is twofold. Firstly, research that focuses on the technical aspects of EA debt (primary aspects). Secondly, research that covers EA debt environments like socio-technical aspects (secondary aspects).

The primary aspects can be further divided into three categories: EA smells, methods, and tools. Research on EA smells [SH20] can, first, be directed towards the identification and categorisation of smells by transforming known smells to the EA domain or identifying new ones through exploratory research (e.g. detection of symptoms [Or17] and monitoring of key performance indicators [Ma12]). Second, EA debt research incorporates a holistic view on the entire organisation, thus, interplay of different smells should be studied. Third,

the discovered EA smells need to be evaluated. Research regarding method support for EADM covers different facets from smell detection, over debt repayment, to debt prevention. Supporting tools for EADM can be interrelated to the discovery of EA smells and debt visualisation as well as management, possibly integrated with known EA tools [Da15]. Additionally, we recommend future research to explore research in TDM (e.g. [LAL15]) to find insights or methodologies that can be adapted and adopted in the domain of EADM.

The secondary aspects do not focus on EA debts themselves but rather on their interrelation with their environment. To seamlessly put the new EADM framework into practice, synergy between the EADM framework and already established practices is required; therefore, any overlaps and gaps between them must be identified and solved. To create the synergy, future research must develop mechanisms for bridging the EADM framework with adjoining business-IT management instruments, tailoring the EADM framework according to company-specific needs and circumstances, and gaining acceptance among the employees to apply EADM practices. Therefore, we recommend future research to investigate the applicability of relevant methods, such as for evaluating and adapting EA frameworks (e.g. [Gr14]), benchmarking EAs of different organisations (e.g. [GLA15]), interchange of EA issues across different domains (e.g. [ŐS20]), application or project portfolio management (e.g. [ha19a]).

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