A Viable System Perspective on Enterprise Architecture Management

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***Abstract*—A number of approaches towards Enterprise Architecture (EA) management is proposed in literature, differing in the underlying understanding of the EA as well as in the description of the function for performing EA management. These plurality of methods and models should be interpreted as an indicator of the low maturity of the research area. In contrast, some researchers see it as inevitable consequence of the diversity of the enterprises under consideration. Staying to this interpretation, we approach the topic of EA management from a cybernetic point of view. Thereby, we elicit constituents, which should be considered in every EA management function based on a viable system perspective on the topic. From this perspective, we further revisit selected EA management approaches and show to which extent they allude to the viable system nature of the EA.**

***Index Terms*—Enterprise Architecture, Cybernetic, Viable System Model, EA management Process, EA management governance**

I. Motivation

Enterprise Architecture (EA) management forms a research subject, which has been approached from various directions over more than two decades. These approaches have lead to a multitude of definitions, what an EA is or is not, although no commonly accepted definition has yet emerged. Schönherr [24] gives an overview on the approaches towards EA management and shows, that not all of them are complemented with a definition of *Enterprise Architecture*. The situation becomes even more complicated, when the topic EA management is regarded. Some research papers target towards a clear distinction between the artifact *Enterprise Architecture* and the management function planning its evolution (*Enterprise Architecture Management*). Other papers regard the EA to be more *normative* and hence consider the planning process as an integral part of the EA itself [24]. Nevertheless, many of the latter approaches stay on a rather abstract level with their description of the planning function – for details on selected approaches see Section IV. This absence of step-by-step guidelines might be caused by the fact, that no EA management process model detailing the management function has yet gained provenience. Some researchers even doubt the existence of an *one-size-fits-them-all* EA management process, but expect these processes to be company-specific [7], [15], [27]. This situation is similar to the one in software development, where albeit a general agreement on important activities as e.g. *requirements elicitation* or *testing*, various process models exist, which strongly differ concerning the level of realization of the single activities.

In the main contribution of the paper in Section III, we approach the topic of EA management from a cybernetic point of view and discuss, how the EA forms and is embedded into a *viable system*. From this, we elaborate on the different constituents of this viable system and introduce a helpful distinction of different aspects of EA management, which are reflected by higher level systems in the viable system model (VSM). Having discussed, how the EA as a viable system is operated, managed, and planned, we discuss on the importance of a *governance* function for EA management representing the topmost (*identity*) level in the respective model. Having discussed this VSM perspective on EA management, we revisit selected approaches to EA management from literature in Section IV and emphasize on their coverage of the different systems. Final Section V summarizes the key findings of the paper and gives an outlook on the next research steps leading to a method for creating governed enterprise-specific EA management approaches based on best-practices from industry.

II. Overview about EA Management

Essential to our subsequent contribution is an understanding of the term *EA management*, for which various definitions exist in literature. These definitions are based on an even broader variety of notions of the term EA, which originate from academia (see e.g. [4], [7], [17]), practitioners (see e.g. [23], [24]), and standardization bodies (see e.g. [12], [13], [26]). These definitions differ concerning their level of abstraction and their coverage of enterprise-level concepts and management activities. A good overview about the definitions can be found in [24], we abstain from discussing them here and from adding one or two defining sentences. Instead, we advocate that the EA is the application of the rather generic understanding of architecture as presented in [16] to the entire enterprise on an abstract level, i.e. *the fundamental conception of the enterprise in its environment embodied in its elements, their relationships to each other and to its environment, and the principles guiding its design and evolution* [16]. In consequence, a large number of constituing concepts contribute to the EA such as *business processes*, *business applications*, and *infrastructure components* as well as *hardware devices*.

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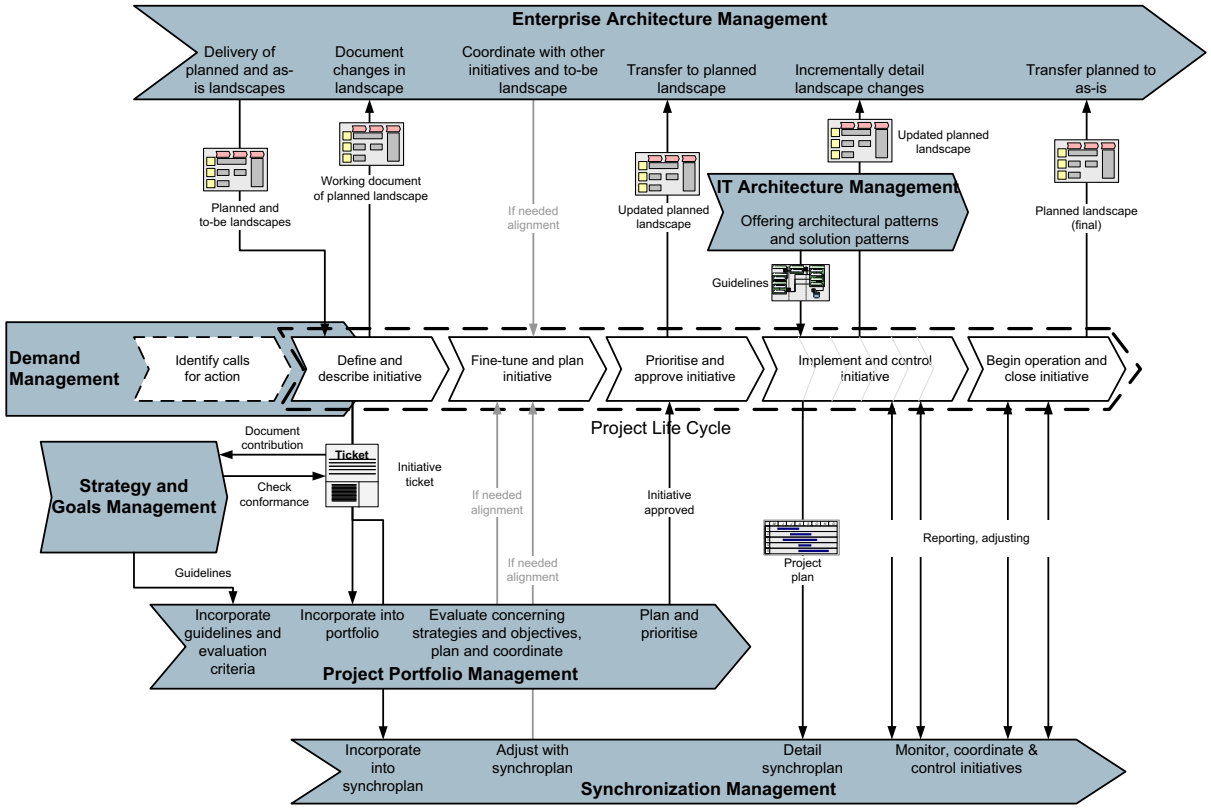

Fig. 1. The EA management function as ”glue”

The guiding principles of design and evolution form additional constituents of the EA, such as *strategies and goals*, *demands and projects*, as well as *standards and patterns*.

The holistic and integrated management of the above concepts is the challenge, EA management seeks to address. To do so, no all-embracing management function is set up, superseeding already existing management activities in this field. In contrast, EA management is designed to **integrate** with the existing *enterprise-level management functions* and to act as ”glue” between the processes to conjointly manage and develop the EA towards aligned business and IT [33]. Figure 1 illustrates this central principle of EA management, by showing how the EA management function integrates with selected other enterprise-level management function via the exchange and provision of information. Beyond the communication level of EA management, the funciton also provides additional guidance to the management functions on lower level by resolving conflicts. which cannot be addressed on a peer-level. Further, EA management is expected to take into account environmental influences, e.g. changing markets, regulations, or industry standards. In the subsequent section, we discuss these aspects of EA management more in detail and take a viable system perspective on the management subject.

III. EA Management and the VSM

Enterprises form, as discussed above, complex systems consisting of various elements with a large number of interdependencies. In order to survive, an enterprise has to adapt to changes in the environment, e.g. changing markets, competitors, or legal regulations. The VSM, developed by Beer [1], [2], [3] provides a framework to describe such systems, which consist of five interacting subsystems – *operation*, *coordination*, *control*, *planning*, and *identity*. The VSM has been applied in various contexts, e.g. project management [5] or organizational modeling [6], [14].

Similar to EA management, the VSM can be used according to [6] as a tool to support an enterprise during the implementation of large scale organizational change. Whereas, a definition and description for each of the systems of the VSM is given in e.g. [1] no such common understanding about the constituents of the function of EA management exists. Therefore, the five subsystems of the VSM are subsequently detailed and used to derive implications on the main constituents of an EA management function.

System one – operation – contains the primary activities of the system under consideration, which directly interact with the environment. In the context of EA management these primary activities should be identified with the enterprise-level management functions introduced in Section I. The enterprise-level management functions form the systems that change the EA via projects, which have been initiated in the demand management, aligned in the strategies and goals management, selected in the project portfolio management, scheduled in the

synchronization management, and realized with standards from the IT architecture management. A description of the function of EA management therefore must consider the role of related enterprise-level management functions.

System two – coordination – includes the information channels and bodies, which ensure that the primary activities of **System one** work harmoniously in coordination. EA management, as introduced above, provides a common basis and the means for communication between the various stakeholders with business and IT background involved in the enterprise-level management functions. Therein, especially visualizations to support *communication* are used and exchanged between the different enterprise-level management functions to coordinate their activities. All project proposals originating from the demand management for example, are used as input to create possible planned landscapes to prepare the project portfolio management [10], [22], [33]. Accordingly, a description for the EA management function should emphasize on the communication task.

System three – control – represents the structures and controls, which establish the responsibilities and rights to maintain the resource allocation of the operating system **System one**. Thereby, **System three** monitors the primary activities as well as the communication and coordination tasks of **System two** and adapts them according to the holistic view on the primary activities. If, for example, newly agreed standards from IT architecture management are not available for the project portfolio management, the projects considered therein cannot be checked for standard compliance. **System three** should therefore set up a structure e.g. an intranet, where the standards can be viewed and communicated to the respective stakeholders. **System three** can be referred to as *reactive* EA management and should be considered in the description of the respective process.

System four – planning – contains the EA intelligence function. Thereby, the system is concerned with a holistic and future-oriented perspective to support strategic decision making. Whereas **System three** is capable of dealing with immediate concerns, **System four** focuses on future aspects, which emerge from the system's environment and also considers strategic opportunities, threats, and possible future directions. Typical processes in **System four** in the context of EA management include the analysis of the status quo of the architecture, the development of a target architecture representing the envisioned state in the future, and planning the transformation of the enterprise to pursue the target. Alongside the reactive aspect, an EA management approach must cover the aforementioned *proactive* aspect, containing a vision how a possible target enterprise should look like.

System five – identity – is responsible for managing the overall policy decisions. It should provide clarity about the overall direction, values, and purpose of the system under consideration. The main goal of **System five** is to balance present and future efforts, and to steer the system as a whole. In the context of EA management, **System five** addresses concerns like the scope and reach of EA management. Typically, a piloting project is performed in the initial phase of an EA management endeavor, e.g. starting with a limited number of concerns, e.g. compliance issues, availability aspects, or with restricted reach e.g. within one business department. Nevertheless, after the initial phase, when the EA management has matured and become more adopted, an *EA management governance* is established to redefine EA management scope and reach. According to the typical quality control cycle [11], [25] the EA management governance aspect should be part of a description of the EA management function.

Summarizingly, the **Systems one** to **three** can be regarded as managing the *inside and now* of the EA whereas **System four** and **five** manage the *outside and the future* of the EA. In the context of EA management, the former systems relate to the operative EA management tasks – *running the enterprise* – while the latter ones consider the strategic EA management tasks – *changing the enterprise*. The application of the VSM to the EA management process as described above is illustrated in Figure 2.

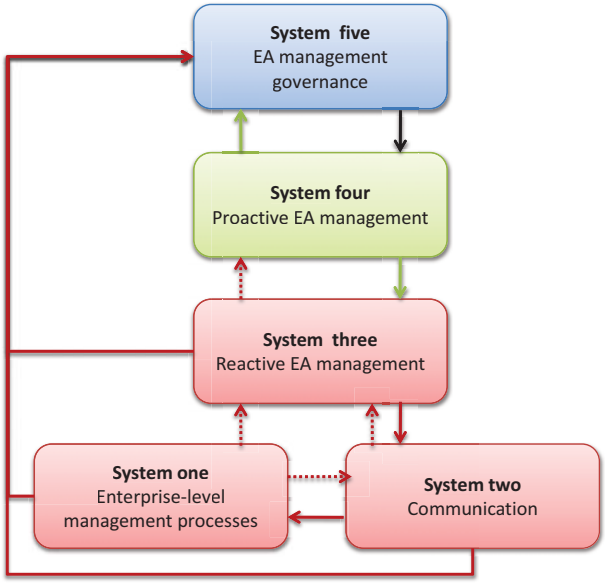

Fig. 2. Applying a viable system perspective to EA management

This systemic view on EA management is further complemented with the concept of the *algedonic signals* from the VSM. These signals, originating from **Systems one** to **three**, provide an alerting mechanism, which is employed, if one of these systems is not able to perform as intended in the current situation. Such a signal is escalated to **System five**, which then can adapt the overall management function and can provide guidance to maintain the identity, i.e. the purpose of the EA management system. To exemplify these considerations, one may think of an EA getting increasingly heterogeneous albeit a standardization board has been established. At the point, this board notices that it has no means to counteract the tendency, an alert is escalated to the EA management governance. The governance function then has to e.g. either

empower the board to stop non standard conform projects, in order to enact the envisioned homogenization, or to rise the question, if a standardized EA is necessary in the future.

IV. A Viable System Perspective on Selected Approaches from Literature

Based on the definition of the core systemic functions and the derived implications for the EA management function given in the preceding section, selected EA management approaches are revisited in the following from a viable system perspective.

According to [9] The Open Group Architecture Framework (TOGAF) [26] is one of the most prominent frameworks for EA management. A central contribution of TOGAF 9 is the *architecture development method (ADM)*, which provides a generic process description for EA management, that can be adapted to the demands of a specific enterprise. The ADM process can be split into different "iteration cycles" – *architecture context iteration, architecture definition iteration, transition planning iteration,* and *architecture governance iteration* [15]. A core aspect of the architecture context iteration is the *stakeholder management*, which emphasizes on the importance of identifying stakeholders from related enterprise-level management functions and wining their support. Based on the output of the stakeholder management, a *communication plan* is developed, which represents the master plan for communicating EA related topics. Thereby, different viewpoints defining, which information should be visualized in order to satisfy the information demands of certain stakeholders, are used. Although the architecture definition iteration partially addresses the aspect of reactive EA management via the documentation of the current architecture, an operational analysis is not directly referred to within the ADM. The transition planning iteration focuses on the strategic architectural planning process, which includes the development of a target architecture and the derivation of a roadmap for EA evolution. Whereas, the architectural governance iteration cycle refers to the establishment of responsibilities and boards to govern the implementation of changes to the EA, the EA management governance function is performed within the architecture context iteration, where the scope and reach of the used EA management approach is defined. In order to deal with (unforeseen) changes in the requirements TOGAF introduces the process of *requirements management*, which drives the ADM process via feeding new, updated, and deleted requirements in and out the different ADM phases.

Another prominent approach in the field of EA management is the *systemic enterprise architecture methodology* (SEAM) [32]. The methodology emphasizes on the role of the EA (management), which is *to federate the efforts of the specialists [from the enterprise-level functions] to ensure successful projects* [32]. SEAM's point-of-view hence corresponds to the interpretation of EA management as the "glue" between the different functions, i.e. to bring together information in this multi-disciplinary environment. The federation of efforts is achieved via *enterprise models*, which form means of analysis and communication of EA relevant information. These models account for the multi-disciplinarity of the environment, but go beyond specific models for each discipline, e.g. process-chains or network topology models, by providing an integrated view on the enterprise. In [21], two important aspects of EA management according to SEAM are highlighted: firstly, the *reactive* aspect, which deals with necessary business and technology changes ex post; secondly, the *proactive* aspect, which anticipates future changes of that kind and prepares the enterprise to these potential changes by increasing agility and flexibility. SEAM especially centers around these two aspects and emphasizes on EA management being a multi-disciplinary endeavor, but abstains from discussing questions of how to establish and govern an EA management process.

In [20] different perspectives on the EA function[1] are taken. One of these perspectives is explicitly called *communication perspective of EA*, highlighting that in the EA management function communication between the different architecture stakeholders is indispensable. Another perspective emphasizes on the iterative character of the management function; initially high level business visions and strategies can be used to derive the purpose of the management function and hence the connected process of creating a model of the EA. But as the EA management function evolves, feedback from the stakeholders and a changing environment may influence the specific purpose (concern) of EA management and may make it necessary to adapt the function. This discussion gives an implicit notion of how to establish and govern an EA management function, although no dedicated considerations on this topic are formulated.

The work presented in [19] presents a rich theory for analyzing EAs as part of an EA management function. Such analyses can be helpful for determining for selecting the future architecture to pursue, i.e. by providing means to compare different architecture scenarios for supporting EA decision making. The analyses are exemplified along EA attributes from the security domain; a brief indication of further attributes is given. In contrast, a discussion on the selection of the attributes to consider is only sketched (cf. [18]). The same is true for indications on how to realize the selected architectural scenario, where the considerations stay fairly abstract. Also aspects of establishing and governing an EA management function are not in the focus of the article.

A reference model of the EA management function (called *EA function* there – Footnote 1 here also applies) is presented in [28]. In this model, the EA management function is said to be concerned with creating, maintaining, ratifying, enforcing, and observing EA decision-making. Thereby, the function utilizes means of interaction ranging from *formal* (governing) to *informal* (collaboration) techniques, and acts on different levels in the enterprise hierarchy in a this similar manner. Complementing the propagation of EA deliverables, such as architecture documentation and plans, to enterprise-wide decision-making in a *feed-forward* information flow, the

[1]The work understands the term *architecture* in a normative way (cf. Section I). We subsequently stay to the distinction between artifact and management function as pursued in the remainder of the article.

reference model advocates for the existence of a *feedback* flow. This should be used to feed the successes and constraints of implementing the decisions at lower levels back to higher levels. The feedback mechanism as discussed in [28] is focused on a hierarchic escalation of information, aiming at an improvement of the EA deliverables created on higher levels in the hierarchy. Using the feedback to adapt the roles and process of the overall EA management is not explicitly stated in the paper, although concluding remarks in the paper point towards this direction of thought, but abstain from providing additional details.

An EA management function that employs an iterative approach, which can be enhanced when the EA of an enterprise matures, is presented in [27] and [31]. The *Dynamic Enterprise Architecture (DYA)* model consists of four processes. The *strategic dialog* establishes the business goals, the *architectural services* form support processes for developing possible architectures, which is performed in the *development without* or *with architecture*. A critical success factor of the DYA process according to the authors is the integration of the architectural process with related enterprise-level management functions of the organization [27]. The focus of the approach presented in [30] and in [31] is to provide a tool for EA management improvement via a SWOT analysis and an architecture maturity matrix. This matrix contains eighteen key areas of architectural maturity: development of architecture, use of architecture, roles and responsibilities, maintenance of the architectural process, etc. The architectural maturity matrix can be used to set priorities for the enterprise-specific EA management function as well as to assess the stage of the reached maturity.

V. Conclusion and Outlook

The approaches from literature as discussed in Section IV can to a certain extent be mapped to the viable system perspective on EA management, as discussed in Section III.

System one, formed by the EA-related enterprise-level management functions, is mostly sketched to be important. Nevertheless, more in-depth considerations on how the higher level systems interact with these functions are not undertaken. Also, yet no comprehensive enumeration of these functions exists, although the functions as shown in Figure 1 are alluded to in most approaches.

System two, focusing on the communication and coordination aspect of EA management, is also emphasized by all approaches. This is especially true for communicating the EA, for which various techniques and visualizations have been proposed (see e.g. [8], [29]). These visualizations are said to provide benefit for coordinating the EA-related activities, although the discussions, how coordination is actually achieved, stay on a rather abstract level.

Systems three and **four** representing the *reactive* and *anticipating* aspects of EA management, respectively, are often not clearly distinguished (with the exception of [21], which originates from a system theoretic background). This amalgamation of systems might have different causes. Most simple, the novelty of the field and the ambiguity of terms, like *EA planning*, might have prevented a clear distinction between these aspects of EA management. We nevertheless regard a separation of the systems to be beneficial for understanding EA management, especially in the context of EA analyses (cf. [19]). Such analyses are most likely to differ concerning the instruments and techniques, which they can rely on; if reactive management is considered, the assumption of a stable architecture state might be sensible. In contrast, proactive management is most likely to be concerned with destabilizing and potentially disruptive influences on the EA-related concepts, which should be considered adequately.

System five that represents the identity function complementing the lower level EA management systems is also only partially alluded to. As system five is needed to ensure that EA management keeps performing the function, which it is intended for, it can be considered important to prevent EA management from degenerating to a worthless exercise in data collection and analysis. Thereby, especially the reaction to alerts from systems one to three is of importance, which can give indications of failing management instruments. Changing these instruments, e.g. setting up new policies and roles that influence the related enterprise-level management functions, forms one of the most the important tasks of system five. Additionally, it is this system, which has to be considered during the setup of an EA management function, whose central enterprise-specific purpose and understanding is encoded into system five.

We do not expect that applying a viable system viewpoint to the topic of EA management will provide groundbreaking insights in this area. Nevertheless, understanding and distinguishing **Systems one** to **five** may be helpful for structuring the research subject more clearly. Additionally, the experienced lack of in-depth considerations on initializing, maintaining, and governing an EA management process (**System five**) provides an interesting direction for future research. The discussion on the necessity of such system is undeniably far from comprehensive, but should have risen indications, which are worth more in-depth considerations in the future, especially, when the viable system viewpoint is also used to establish a stricter distinction between reactive and a proactive EA management (**Systems three** and **four**).

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