

# A Situated Approach to Enterprise Architecture Management

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**Abstract**—Today’s enterprises are confronted with a challenging environment that demands continuous transformations. Globalized markets, disruptive technological innovations, and new legal regulations call for enterprises, which flexibly adapt to these requirements. A commonly accepted means to guide such enterprise transformations is enterprise architecture (EA) management. Enterprises seeking to introduce and establish such a management function see themselves confronted via a plethora of tools, approaches, and frameworks that claim to provide “the definitive design prescriptions” for an EA management function. The applicability of the different prescriptions nevertheless heavily depends on the organizational context and the EA-related goals that the enterprise wants to pursue.

This paper presents an extensible set of selection guidelines, that helps enterprises to choose the EA management approach best suited for their goals and context. These selection guidelines are linked to different EA management approaches and frameworks, which are related to organizational contexts, in which they can operate, and EA management goals, that the approaches can help to pursue. Utilizing the selection guidelines, an enterprise can specify the applicable context as well as its EA management goals, and is provided with a selection of suitable approaches. Finally an outlook critically reflects the findings of the paper and provides an outlook on future areas of research.

**Index Terms**—Enterprise architecture management function, systemic approach, theory nexus, viable system

## I. MOTIVATION

Modern organizations find themselves confronted with ever changing economic, regulatory, and technical environments that they are forced to continuously adapt to (cf. [30], [37]). Performing the changes that are necessary or could help to leverage opportunities is a complex task, aggravated by the intricate and highly interwoven architecture of the overall organization. Local adaptations of one organizational artifact, e.g. a business process or a business application, might have unforeseen global consequences at and potentially detrimental impacts on related artifacts. Enterprise adaptations can be differentiated into optimization (incremental change) and transformation (fundamental change) [2]. Whereas support for the former type of change is typically provided by functional methods of business administration, e.g. human resources, distribution, or marketing, while the latter requires a holistic approach to systematically support organizational transformation [38]. A commonly accepted instrument to support and guide such transformations is enterprise architecture (EA) management, whose main goal is to enhance and maintain

the mutual alignment of business and IT (cf. [24], [20]). Effectively executed EA management leads to a) reduction of local maintenance costs due to increased standardization (cf. [36]), b) increased responsiveness via reduced project duration (cf. [34], [36]), c) facilitates risk management through reduced complexity and a organization-wide view on organizational changes (cf. [34], [30]), and d) enhances strategic business outcomes by increasing effectiveness of business processes, applications, etc. through standardization (cf. [9]).

Although the topic of EA management has been approached from various directions and according to Langenberg and Wegmann in [23] forms a topic of increasing interest, no commonly accepted understanding or definition of EA management has yet emerged. Schönherr [32] gives an overview on the approaches towards EA management and shows, that not all of them are complemented with a definition of the term *enterprise architecture*. The situation becomes even more complicated, when the topic EA management is regarded. Some authors aim towards a clear distinction between the artifact *enterprise architecture* and the management function concerned with the evolution of the EA (*enterprise architecture management*). Others regard the term EA to be more *normative* and hence consider the planning process as an integral part of the EA itself [32]. Nevertheless, many of the latter approaches stay on a rather abstract level with in respect to the description of the planning function. This absence of step-by-step guidelines for managing the EA might be caused by the fact, that no EA management process model detailing the management function has yet gained prominence. Some researchers even doubt the existence of an *one-size-fits-them-all* EA management approach, but expect the management function to be organization-specific [12], [35], [34].

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. The situation of EA management is even more complicated than the one in software development. The goals of a software development process are typically agreed upon as “developing a software system in time, with the required functionality and quality, as well as within the planned budget” [21]. The objectives of an EA management initiative in contrast vary widely. While typical goals of EA

management can perhaps be summarized on a very abstract level, as mentioned at the beginning of this section, they have to be substantiated in order to identify the relevant elements of the EA. Reducing maintenance costs via standardization can e.g. be performed on business processes, application systems, or a technical infrastructure level.

Besides the variety of different goals, which need to be appropriately addressed by the EA management function, the organizational context, in which the function has to be embedded and operated, influences the suitability of an EA management approach. While in a smaller company with a kindly atmosphere, the communication of architectural principles might be sufficient to ensure compliance. A more hierarchical corporate culture might demand for the establishment of quality gates, e.g. architecture reviews, to ensure adherence to architectural principles and standards. Existing approaches to EA management originate from practical backgrounds, as e.g. the one proposed by Niemann in [26], Hanschke in [19], and Schekkermann in [32], are developed with an academic perspective, e.g. Aier et al. in [3], Ross in [29], and Frank in [18], or are devised in standardization bodies, as e.g. The Open Group Architecture Framework (TOGAF) in [34]. Although none of these approaches explicitly states the organizational context for which it provides a suitable solution, they are often implicitly mentioned, e.g. in an expository example. A better situation can be identified regarding the goals pursued by applying the different approaches.

This paper addresses the organization-specificity of EA management by proposing a *nexus*, which facilitates the selection of a suitable EA management approach based on the constraining organizational context and the pursued goals of the initiative. Section II introduces a systemic perspective on the topic of EA management, which fosters the comprehension of EA management as a viable management function, which has to be adapted to a changing environment. Based on the understanding elicited in Section II, Section III presents the concept of a *nexus* for competing solutions and details on its applicability by discussing the work of Pris-Heje and Baskerville [27], who initially introduced the term *nexus* in the context of decision support systems. Based on this prefabric, Section IV proposes a *nexus* for EA management and details its constituents as well as its application in the context of EA management. Final Section V gives a critical reflection of the approach and an outlook on future topics of research.

## II. A SYSTEMIC PERSPECTIVE ON EA MANAGEMENT

Enterprises form 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 or legal regulations. The viable system model (VSM), developed by Beer [6], [7], [8], provides a framework to describe such systems. According to the model, five interacting subsystems – *operation*, *coordination*, *control*, *planning*, and *identity* – can be identified. The VSM has been applied in various contexts, e.g. project management [10] or organizational modeling [11], [17].

Similar to EA management, the VSM aims according to [11] to support an enterprise during the implementation of large scale organizational transformations. Whereas a definition and description for each of the systems of the VSM is given in e.g. [6] 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 mapped to typical activities performed as part 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 are identified with enterprise-level management functions, e.g. project lifecycle management, project portfolio management, synchronization management (cf. [39]). The enterprise-level management functions align with the projects that actually change the EA. These projects are 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 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 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 [25], [39]. Accordingly, the EA management function must encompass a communication dimension.

**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. a wiki, where the standards can be viewed and communicated to the respective stakeholders. **System three** can be referred to as *reactive* EA management.

**System four** – planning – contains the EA intelligence function. 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. Following typical quality control cycles [15], [33] the EA management governance aspect is concerned with measuring the achievement of the pursued goals.

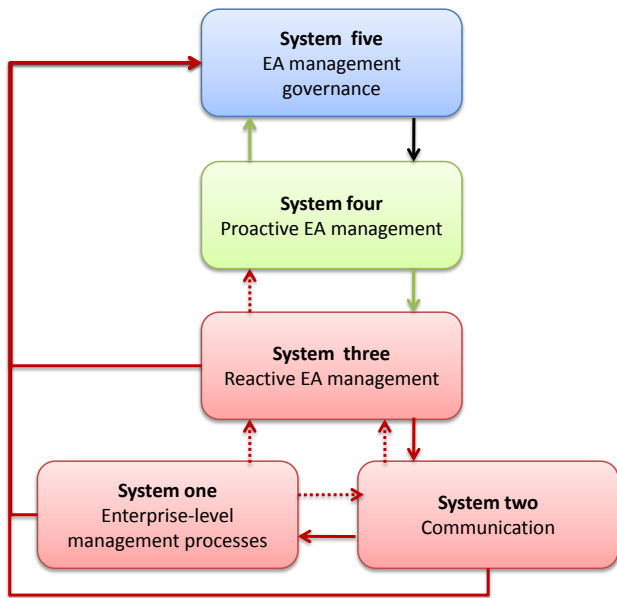


Fig. 1. Applying a viable system perspective to EA management

Summarizingly, the **Systems one to three** can be regarded as managing the *inside and now* of the EA whereas **Systems 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

ones – *changing the enterprise*. The application of the VSM to EA management as described above is illustrated in Figure 1.

This systemic view on EA management is further complemented with the concept of the *algedonic signals* from the VSM. These signals, triggered by **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. 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.

### III. A THEORY NEXUS FOR COMPETING SOLUTIONS

In [27] Pries-Heje and Baskerville present the idea of a *theory nexus* as means to connect competing approaches, so-called theories, which provide competing solutions for a problem domain. A theory nexus not only connects competing solutions, but further helps “decision makers in choosing which of the theories are most suitable for their particular goals and their particular setting” [27], i.e. the organizational environment. Pries-Heje and Baskerville discuss that the presented approach is especially useful in cases of solving so-called *wicked problems*. Wicked problems, according to Rittel and Weber in [28] share the following characteristics: i) they can only be formulated in terms of a solution, ii) solutions are value laden and can only be denoted “good” or “bad” instead of “true” or “false”, iii) their solution space is unbound, iv) solutions are irreversible, and v) wicked problems neither can be approached nor can alternatives be evaluated without engaging considerable uncertainty.

Based on the above understanding of wicked problems, developing and establishing an organization-specific EA management function can be understood as wicked problem. As already mentioned in the motivating Section I EA management approaches in literature are mostly derived from successful case studies in practice. This characteristic regarding EA management solutions can be found in academic approaches as well as in practitioners’ approaches (i). Applying such a best practice solution in another setting can only be shown up as good or bad, more precisely as “working good” or “working bad” (ii). Although a common agreement on the main activities of the EA management function in the meantime exists (cf. Aier et al. in [1]), the realization of these activities is unbound, e.g. analysis of different states of the EA can be performed in various ways ranging from expert-based analysis via pattern-based ones to quantitative assessments via metrics. Similarly, the main objective of EA management – fostering mutual alignment of business

and IT by providing decision-support regarding the enterprise transformation – on the one hand is commonly agreed upon, while on the other hand the more detailed objectives of an particular EA management endeavor in an organization change over time (iii). Finally, the establishment of an EA management function cannot be simulated or tested due to the complex management subject (iv) or at least require a simplification of the examined interrelations, which makes predictions on the appropriateness of a management approach only possible with considerable uncertainty (v). Following this understanding of establishing an EA management function as a wicked problem, for which a plethora of competing solutions exist, we propose in accordance with Pries-Heje and Baskerville in [27], to develop a theory nexus for EA management.

Such theory nexus consists of the following five constructs:

- **Goals** describe what the system is intended for.
- **Environment** refer to contingencies, which are outside of the people involved.
- **Theory nexus** defines the connection point at which the competing theories are bound with realities into a design solution.
- **Design solution** represents the result constructed from highly dissimilar decision alternatives.

Figure 2 provides an overview about the single components of a theory nexus and illustrates their relationships.

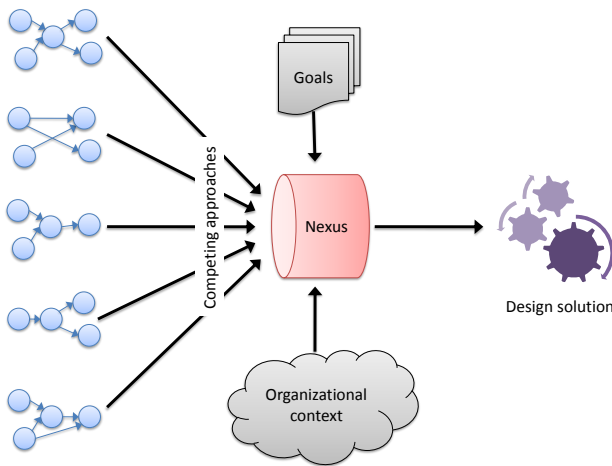


Fig. 2. Components of a theory nexus according to Pries-Heje and Baskerville in [27]

The construction of a theory nexus according to Pries-Heje and Baskerville (cf. [27]) follows a five step approach. In the first step, the available approaches in the area under consideration are examined, e.g. via a literature analysis. In a second step the identified competing theories are investigated for explicit or implicit conditions, which must hold for the approach to achieve the highest utility. Here, it has to be noted that these conditions might be unequal for any pairing of the theories. The third step assesses the identified conditions for practical relevance and formulates them to assertions. In the fourth step, a decision-making process for evaluating the developed assertions is undertaken. Final step five combines

the approaches, conditions, assertions, and the process into a tool, which supports the evaluation regarding the fit for each approach in a given situation.

#### IV. A NEXUS FOR EA MANAGEMENT

Following the systemic perspective on EA management as developed in Section II and the understanding of establishing an organization-specific EA management function as wicked problem, we detail on the single components of a theory nexus for EA management in this section. The theory nexus for EA management is thereby developed utilizing the five-step method as introduced before.

While the framework developed by Zachmann in 1978 (cf. [40]) is commonly regarded to be the hour of birth of the topic EA management, the number of researchers and practitioners targeting this area of interest since that time has increased. An overview on the current state-of-the-art in EA management is given by Aier et al. in [4] and the most active research groups in the area are determined by Schelp and Winter in [31] and Aier and Schelp in [5]. We utilize the thereby identified "major players" and their approaches to designing an EA management function in step one of the construction of the theory nexus as input for the competing theories. Accordingly, the approaches of the following groups form the basis for our subsequent elaborations<sup>1</sup>:

- **EPFL Lausanne, Switzerland**
- **Telematica Institute, The Netherlands**
- **University of St. Gallen, Switzerland**
- **TU Berlin, Germany**
- **KTH Stockholm, Sweden**
- **TU Munich, Germany**
- **TU of Lisbon, Portugal**

Step two involves analyzing the competing approaches identified in the first step in order to determine their distinguishing characteristics. Thereby, we in particular focus on the essential goals of each approach and the respective means, i.e. processes, to achieve these goals. In this way, we identified the following goals: 1) reduce operating cost, 2) increase disaster tolerance, 3) reduce security breaches, 4) ensure compliance, 5) increase homogeneity, 6) improve project execution, 7) enhance strategic agility, 8) improve capability provision, 9) foster innovation, and 10) increase management satisfaction. Complementing, we identified different means to establishment of an organization-specific EA management function, e.g. an engineering based approach as presented by Aier et al. in [2], a pattern-based approach presented by Buckl et al. in [13], [14], or an analysis-focused approach introduced by Johnson and Eksted in [22]. These different approaches represent the input for our theory nexus for EA management. Based on the systemic perspective on EA management discussed in Section II, the approaches can be analyzed and evaluated for their coverage of all systems from the operation level to the governance system.

<sup>1</sup>For a more detailed discussion of the contributions of these groups as well as for literature references see Schelp and Winter in [31].

In the third step, we derived a number of assertions that are based on prominent characteristics of each approach as expressed in literature. For the approach presented by Ernst in [16], for example, we formulated inter alia the following assumptions:

- Detailed information on applications and standardized technology needs to be available.
- A centralized IT organization is required to enable an architecture review process.
- Upper management support needs to be available to ensure architecture conformance of projects.

The assumptions formulated for the competing approaches were gathered and reformulated to use a common terminology. The following non-exhaustive list provides an overview on the thereby identified assumptions, which represent the organizational context descriptions of our theory nexus for EA management:

- Centralized vs. decentralized IT organization.
- Upper Management support for the EA management team.
- Budget for architectural relevant project is available for the EA management team.

The above identified goals of EA management and the organizational contexts are formulated in forms of conditions and mapped to the assumptions of the above identified approaches. The suitability of the competing approaches for any combination of the conditions can then be defined utilizing a *fitting matrix* with the competing approaches on the y-axis, the identified conditions on the x-axis, and a scoring of the fitting function in the cell. The fitting function can thereby take a value from the set *required, excludes, helpful*. The patterns for enhancing standard conformity as proposed by Ernst in [16], for instance, would require a centralized IT organization, while the upper management support would only be helpful but is not necessarily required.

Based on this fitting matrix, a decision-making process for selecting one or more appropriate approaches for designing an EA management function is developed in step four. The appropriateness of the EA management function is heavily influenced by the goals pursued by the organization as well as by whatever pertinent issues are presented in the organizational context. Therefore, these constraints, i.e. goals and organizational context, determine whether a competing EA management approach succeeds or fails.

Finally, a tool supporting the utilization of the nexus for EA management is developed in final step five. Thereby, the competing approaches, goals, organizational contexts, as well as the process, which applies the fitting matrix, are reflected in the design of the tool. Possible realizations of the tool may range from simple excel based approaches in line with the scoring matrix of Pries-Heje and Baskerville (cf. [27]) to more sophisticated tools, which cannot only be used for selecting an appropriate EA management approach, but provide further assistance for performing single activities of the EA management function, like e.g. documenting a current state of the EA.

The above developed theory nexus can further be used to deal with the *algedonic signals*, which might arise during EA management, due to non-intended results. If, for instance, an organizational context changes, e.g. the budget available for the EA management team is canceled due to economic savings, the theory nexus for EA management can be used to re-select appropriate EA management approaches.

## V. CONCLUSION AND OUTLOOK

This paper addresses a common but intractable problem faced by managers of organizations willing to introduce an EA management approach. While the importance of EA management as competitive advantage in times of ever changing environments for enterprises is unquestioned, a plethora of different EA management approaches has been developed in academia and practice. These approaches reflect the various goals and organizational contexts available, but propose highly dissimilar, competing solutions with different focus. This reflects the diversity of EA management as enacted in different enterprises, which can further be illustrated from a viable system perspective. In particular system five (identity) stresses the importance of defining the scope and reach of the EA management endeavor.

The theory nexus proposed in this paper addresses the challenge of selecting "the right" EA management approach by providing a decision support system. With this system the approach(es) optimally suited under the constraints of the EA management goals pursued and the environmental context of the organization can be selected. The development of such a nexus for EA management has been sketched in the paper alongside the competing approaches of the most active research groups in the area of EA management. Although the approach promises to provide better guidance for managers faced with the challenge to design and develop an organization-specific EA management function, an evaluation of the utility of the proposed nexus has not yet been undertaken.

We regard such an evaluation as greatly benefiting from a tool-based realization of the nexus. Therefore, we are currently developing a tool, which enables managers in selecting and, if necessary, combining different EA management approaches. Nevertheless, as no standardized modeling language for method or model descriptions in the context of EA management has yet been developed, such a tool needs to be capable to integrate constituents from different approaches, which are described in different languages – a challenge not yet addressed.

Furthermore, the literature survey, which forms the basis for the development of the theory nexus for EA management, needs to be critically reviewed. The selection of approaches is based on the activity of academic research groups in the field. Besides the question, if all relevant academic groups were included in the survey, also active communities of practitioners exist in the area of EA management. These communities promote and evolve widely-known approaches in the area (e.g. The Open Group Architecture Framework in [34] or Niemann in [26]). In order to ensure usability and generality

of the approach, the theory nexus should be enhanced with an extension mechanism to include further approaches to EA management, based on changing EA management goals or newly identified organizational constraints.

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