EA Management in the German Public Sector: An Initial Perspective on Priorities

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Abstract. Worldwide, Enterprise Architectures (EAs) have been gaining popularity due to benefits, like, e.g., increased transparency of dependencies between business and technology, reduction of efforts for system customization or optimizing integrated and enterprise-wide processes and matching actions. Private businesses and the public sector show significant differences in the use of EA. Thus, the application of reference architectures originating from the private sector for purposes in the public sector creates substantial challenges. For a better understanding of the challenges, it is necessary to identify the most affected EA layers and the insufficiently defined, modeled or described elements of EA models in general. Based on an investigation in the Germany, this paper identifies weaknesses of EA in the public sector, like an incompletely modeled technology layer, and also strengths, such as existing definitions, descriptions and models of enterprise objectives. These findings are the foundation for deriving actions and recommendations to strengthening the existing structure and turning it into a coherent overall architecture for federal and state agencies in Germany.

Keywords: Enterprise Architecture, Enterprise Architecture Management, Reference Models and Architecture, Public Sector.

1   Introduction

Fundamentally, IT is gaining in importance, making the development of IT strategies necessary. A holistic and guiding strategy development cannot be reduced to solely the IT perspective or solely the business perspective. Both must be adapted and tuned to achieve long term goals such as transparency, cost reduction and short term process adjustment [3, 4, 9, 18, 23, 24]. Past research has been mainly focused on the private and not the public sector (cf. section 2). In contrast to private enterprises, public authorities have some characteristic features, which are mainly due to their enormous scope of tasks, the hierarchical and externally induced organizational structure, as well as their (legal) principles, obligations and horizontal decision-making processes.

In Germany the constitutional law defines both the principle of federalism (GG Art. 20(1)) and responsibilities of the departments (GG Art. 65). This characterizes the organization and task fulfillment of state agencies. Thereby processes like making

decisions and carrying information about the right places are complex and not as direct as in private enterprises [18].

Private (i.e. for-profit) companies aim to grow and maximize their profit, whereas public enterprises are only permitted to fulfill the assigned tasks by not taking risks and keeping fiscal limits [18]. All of the characteristics of the public sector result in difficult management, confusion due to heterogeneity, complexity and slow reaction times for adjustments and change. To compensate, IT and its strategies become more important and have to align with the organizational structure.

There is a need of firstly knowing and secondly modeling the structure of the agency while introducing and mapping EA´s in order to achieve flexibility to adapt to changing frameworks - material, institutional, organizational, or IT. This requires the definition and description of elements, their modeling among each other and procedural relationships. Attention: Political programs determine the organizational strategy. This is subject to strong fluctuations, for example due to election cycles. There is no continuity due to the constant influence of laws and authorities, the principle of the department and federalism [3, 4, 5, 9, 18, 23, 24].

Therefore this research tries to answer the following Research Questions (RQ):

1. *Which common elements of selected EA frameworks are already implemented in the public sector in practice? To what extent?*
2. *Which architecture layers are difficult and why?*

The common vocabulary to understand this work and background from EA are defined in Section 2. After that, the methodology for answering the questions is described in Section 3. Subsequently, in Section 5, the lessons learned from the requested documents in 3.2 are mapped to various established reference architectures (section 4) and their perfection and definition are classified. The gaps and strengths of the current mapping of EA in the healthcare sector are discussed. The work concludes with a summary and an outlook of further research in section 6.

2 Background

In order to reach a basic understanding of the terms in the field of EA and its management (EAM), important terms like enterprises and their strategies are explained as used for this work (section 2.1). Due to its holistic, continuous importance for introducing, modeling and using EA, the term of EAM is specified in section 2.2.

2.1 Terminology

„*Enterprises* name complex and highly-integrated systems, containing various entities working together to reach a common goal or to produce a common product" [23]. Consequently it can be an entire company, a collaboration of several ones, a specific number of departments of a company, as well as all other forms of separations and networking units [21, 23]. Obviously, they are characterized by relationships and inter-dependencies across their boundaries, resulting in being influenced by both external and internal factors [23]. *EA* "is a complete expression of the enterprise; a

master plan […] between aspects of business planning such as goals, visions, strategies, and governance principles; aspects of business operations such as business terms, organization structures, processes, and data; aspects of automation such as information systems (IS) and databases; and the enabling technological infrastructure of the business such as computers, operating systems, and networks" [21]. EA in the field of public authorities is an iterative improvement process to achieve models of the current and future state, transitions between them, the entire business improvement and strategic outcomes. [5, 7, 10]

Enterprise strategies name the abilities for identification and evaluation of opportunities in the organizational business corresponding specific aims. In practice, strategies are understood as impulses for actions to reach certain goals. These should be not redundant advantages, which are not replaceable by others [23]. For this work, especially the strategies of public agencies must be focused to depict their core target. There is, naturally, no competition within the public sector, just legal requirements of the business tasks. Therefore, holistic and overarching strategies must be explicitly defined from above (by law) for federal systems. [5, 18, 24]

2.2   Enterprise Architecture Management

In general, an EA captures and structures all relevant components for describing an enterprise, including the processes used for development of the EA as such [1]. Research activities in EAM are manifold. The literature analysis included in [28] shows that elements of EAM [8], process and principles [11], and implementation drivers and strategies [24] are among the frequently researched subjects. Furthermore there is work on architecture analysis [16], decision making based on architectures [15] and IT governance [22]. However, there is no specific focus on EAM use in the German public sector.

The existing research on EAM and IT governance for the public sector to a large extent is specific to certain countries. This is obviously caused by the strong influence on national regulations and laws on governing structures, decision and implementation procedures, and policies. Much work for the public sector has been done in the USA (see, for example, [19]) which is due to the fact that the Clinger-Cohen act already in 1996 made it mandatory for public agencies to show how planned investments in information technology would improve efficiency and effectiveness. Similar regulations and related research can be observed in Australia (see [2]). Examples for EA in public administration in Europe can be found in Denmark, the Netherlands [14] and Finland [26]. However, due to the specifics of the German governmental system with its federal structure and a combination of state-level and federation-level regulations, the work from other European countries is not easily applicable in Germany.

3   Methodology

As a fundamental basis for the identification of layers, their elements and dependencies of EA´s in public administration a literature search was carried out. Literature,

which is primarily related to the use of EA in other countries, was identified and examined with regard to the above mentioned emphases on the implementation of EA and identified difficulties and adaptations.

Afterwards one German state agency for health and social affairs was examined. It aims to picture a holistic and general pre-version of the actual state of EA(M) in Germany´s public administration.

3.1   Literature Analysis

As part of a literature review conducted in the department of the University of Rostock (see [24]), the current state of using EA and EAM in public administration in Germany was examined. Primary literature (19 documents) was searched by accessing various databases (AISeL, SpringerLink and Google Scholar) and defining a comprehensive search query[1] of German and English keywords to make the identification traceable. Only documents published between 2007 and 2017 have been considered. Secondary literature (6 documents) was obtained from the references of the primary literature. The selection of the total amount of 25 selected papers by abstract and full-text analysis yielded 13 relevant documents over all. Due to the small amount of existing literature on the subject, a free Internet search of company pages and literature was carried out.

The sources provide information related to the requirements for EAM, possible procedures for introducing it, or up-to-date status information. Most of the literature is based on common EA frameworks, and extends or provides guidance on its introduction and principles. The work of Birkmeier et al. [5] should be highlighted as they developed their own way of aligning business and IT architecture. According to the authors, it is to be integrated into existing EAM frameworks. The majority of sources emphasize the differences between private and public characteristics of companies, the need for EAM for public administration, and attempt to provide guidance, less in the form of reports from experience in the field (e.g. [7]), but rather in context of scientific papers and case studies (e.g. [18]).

Another focus of the analysis – the comparison of Germany to the countries Finland and USA - offered the following legislation: There are no laws for the usage of EA(M) in Germany. The Federal Ministry of the Interior just provides guidelines for the EA usage in public administration. These primarily include objectives and management aspects like increasing the cooperation of institutions and IT effectiveness as well as its cost reduction. In contrast, the USA is pioneering the use of EA(M) due to the Clinger Cohen Act as a legal obligation to reduce maintenance costs and avoid unnecessary expenditures. Finland also passed a similar law in 2011.

In conclusion, the digitization in the area of EA(M) has hardly been discussed in public administration so far. However, the authors of the reviewed literature empha-

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[1] („Enterprise Architecture Management" OR „Enterprise Architecture" OR „EAM" OR „Unternehmensarchitektur") AND („Public Sector" OR „öffentlicher Bereich" OR „Public Administration" OR „öffentliche Verwaltung") AND („Germany" OR „Deutschland")

size the need for EAM implementation also in public administration due to the digital age and the increasing demands on it. Keywords are efficiency and effectiveness. These efforts are slowed down by the limited budget, the legal fluctuations and the requirements of the public administration. The overall picture sets little or no previous implementation in the German administration.

3.2   Initial Analysis of the Examination Object

The aim is to gain an overview of the formal structuring of the object under investigation. The initial research object is one German state agency in the field of health and social affairs. For this purpose, various question catalogs were sent to the contact person in the agency, which should cover the main elements of EA (e.g. organization, processes / processes, roles, instruments).

In short, it can be stated that the organizational objectives are well formalized and defined. The legal regulations and guidelines make this necessary. The interplay of roles is also formalized, but has gaps for specific cases due to the lack of mapping processes in form of scenarios. The complete technology level of the agency is outsourced to a data center. This and the limited time of this initial investigation step are hampering the information acquisition and their mapping (using models). In-depth analyzes must follow here in order to map interfaces between organizational and technical levels.

Permitted types to answer the requested issues were formal definitions (e.g. organizational charts and balanced scorecards), descriptions and explanations (e.g. monitoring instruments as part of strategic controlling) as well as experience reports (of agency experts) referring to processes, roles and rights.

4   Reference Enterprise Architecture

EA Frameworks offer a set of documents, data, roles, models and their relations to provide a common approach with a defined vocabulary to depict the entire enterprise [3, 4, 9, 13, 17, 18, 21, 23].

4.1   TOGAF – The Open Group Architecture Framework

TOGAF [25] is a holistic EA reference modeling that is currently available in version 9.2. It was developed by members of The Open Group Architecture Forum and is constantly being revised. The approach is aimed primarily at the controlling and executing bodies of the architectures, regardless of the view to be processed (data, business or IT).

TOGAF defines components (Building Blocks) and an architecture development method (ADM) for the creation of EA. A distinction is made between four levels of the organization that requires an EA: 1. Business architecture, 2. Data architecture, 3. Application architecture, 4. Technology architecture.

Based on the definition, description and modeling of the individual building blocks, ADM must be carried out cyclically in order to always be up-to-date and optimized for the company conditions. [8, 17, 25]

4.2 FEAF – Federal Enterprise Architecture Framework

Based on the Clinger-Cohen Act, the USA are pioneers in the definition of architectural frameworks in order to optimize the development of public authorities. FEAF is developed by the USA Chief Information Officers Council since 1999. [17, 21]

Due to provide a common approach of aligning strategic, business and technology aspects, it differentiates several models, which mainly aim to improve the interoperability within the government. Furthermore it aims to make IT acquisition as well as the general share of information and resources easier, to reduce costs and to improve customer services. [21]

The reference model of FEAF differentiates between four layers: 1. Business architecture, 2. Data architecture, 3. Application architecture, 4. Technology architecture.

Based on these layers, six reference models are derived:

- *Performance Reference Model* (PRM) to support the analysis of integrated EA by comparing both material and monetary incomes and outcomes of strategic actions,
- *Business Reference Model* (BRM) as the combination of business and service components to depict the entire organization and its elements,
- *Data Reference Model* (DRM) to store data and their meaning in specific storages of interest,
- *Application Reference Model* (ARM) to categorize standards and technologies of single applications or whole systems,
- *Infrastructure Reference Model* (IRM) to categorize the standards and technologies of the network to support and enable data delivery and capabilities,
- *Security Reference Model* (SRM) to provide a common terminology and methodology in the field of federal agencies security to achieve business goals.

The first und last mentioned models are superior to the other layers.

4.3 ISO 19439

ISO 19439:2006 defines the International Standard of an enterprise modeling framework, including modeling principles and dimensions. It aims to provide a "unified conceptual basis for model-based enterprise engineering that enables consistency, convergence and interoperability of the various modeling methodologies and supporting tools. The framework does not encompass methodological processes; it is neutral in this regard" [13].

 "There are three dimensions for defining the scope and content of an enterprise model" [12, p.1321]: 1. *Phase* dimension in relation to the life cycle of an enterprise model, 2. *View* dimension, which differs between four specific objectives to enterprise entities, 3. *Genericity* dimension describing the enterprise elements in an ab-

stract way. The designated model views can be expanded for specific conditions, e.g. user concerns.

Furthermore, seven modeling phases are mentioned to run cyclically and iteratively. The most important ones are layer three to five due to defining the business function within its domain (overall collection of processes, inputs, outputs, resources and capabilities), resulting in specifying the concrete field of domain operations and additionally describing needed information for the tasks of operational systems. [12, 13]

5 Adaption of Reference EA into the Public Sector

To outline the weaknesses and strengths of defining the EA of a public office, the named elements of the three chosen approaches (see section 4) are summarized and broken down to their common layers and related core elements. The illustrated priorities are based on the empiric data (cf. Section 3.2).

Domains are considered as layers, containing specific components (e.g. processes and roles) and offering services for layers above. Due to the massive influence, determination and support of public agencies by both internal and external entities, the environment layer is set on top. Depending on the view, specific scenarios can be derived and analyzed on a focus.

As a conclusion of the comparison (see table 1), common EA elements were mentioned and summarized in one view (cf. table 2). It is common to differentiate the Business Architecture in objectives/scopes and its modeling. The other layers were taken over. The columns are based on Zachman´s Framework due to depicting the main questions of modeling EA. Views can be summarized and mapped to some of the mentioned elements.

Table 1. Comparison of selected EA frameworks.

	TOGAF	**FEAF**	**ISO 19439**
Architecture Domains	Business Architecture Data Architecture Application Architecture Technology Architecture (Security Architecture)	Business Architecture Data Architecture Application Architecture Technology Architecture (Security Architecture) (Performance Architecture)	
Process of EA Modeling	Cyclical Up-to-date Optimized		Cyclical Iterative
Views		*What*, *How*, *Where* according to Zachman´s Framework[2]	Function View Information View Resource View Organization View

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[2] Zachman´s Framework, developed in 1987 by John Zachman, is one of the earliest and well-known EA frameworks. It is focused on roles, perspectives and their related elements. Nowadays, the framework is considered as basis and aid for other frameworks such as TOGAF. [17]

Table 2 shows the well-definedness of the actual implementation of the EO. It is used to outline the findings regarding RQ1. A grading scale of three is used. Red is the weakest grade, illustrating that no effort has been made to reproduce or even aspire it yet. Dark green represents the most strongly modeled units. Bright green defines items with potential for expansion. Black elements could not be included in the previous research process due to the complexity of elements and/or their assignment to different departments (e.g. Data Architecture) on the one hand, but also to the lack of knowledge about structures (Network Architecture) on the other hand.

Table 2. Illustration of EA core elements and their degree of implementation. (cp. [6], [27])

	Data (What)	Function (How)	Network (Where)	People (Who)	Motivation (Why)
Environment	Data value storage	Operational Instructions	Messaging (sending and receiving)	Personal (external and internal)	Operations (due to laws and standards)
Business Architecture Objectives	Important things, concepts	Processes, Mission	Operating locations	Organizational Units	Business goals/ strategies/ policies/ vision
Business Architecture Model	ERM, business language	BPM	Networks	Organization charts, roles, skills	Business plan
Data/ IS Architecture	Data Model	Flow Diagrams, Application Architecture	Distribution systems	Models of roles, data and access	Business rules in detail
Technology Architecture	Data architecture	Pseudo-code, structure chart	System architecture	User Interface Design	Business rule design
Technology Architecture	Data design	Detailed program design	Network architecture	Screens, security architecture	Rule specification in program logic

Obviously, in terms of RQ 2, the first levels of EA are highly structured and defined in practice of this public agency. The Environment is well defined due to mainly use lists and other forms of written formulations, not specific models. This decreases downwards from level to level. This is justified by the determination of organizational elements by the federal government, the states or the leadership of the individual agency. Information systems, data as well as technological aspects are largely the responsibility of the manufacturers of software solutions, the supervisors of specific specialized procedures or data centers. Effort and time are needed to analyze the affected structures.

6   Conclusion and Future Work

This analysis is based on the research results of just one public agency in Germany. The study could be extended to additional authorities in order to strengthen the pic-

ture. Beyond that, further research expects to analyze and model example processes of the EO. Thereby a comparison of both, the described and defined facts towards the reality, as well as the prior detected weaknesses and strengths of the literature towards the current reality are needed.

For writing a study in the field of EA it is important to define the terms relating to. The chosen Reference EA´s are mentioned because of depicting an international standard (ISO 19439), a highly referenced model (TOGAF) and an architecture example, which is already used in public practice of a different country. Further architectures (e.g. military frameworks) might offer different elements and layers.

The research results demonstrate that the purely formal and descriptive layers of a corporate architecture are well-defined in the public sector. In contrast, there are strong deficits, the more you go down the hierarchy. Based on the findings, recommendations for the implementation of EA can be developed in future work..

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