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Identification and Documentation of the State-of-the-Art Enterprise Architecture Management Foundations Using a Semantic Wiki

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Abstract

Over the last years, Information Technology (IT) turned into a critical success factor for businesses in many branches. In the course of this development, the amount of applications supporting the daily business of enterprises grew rapidly, resulting in complex application landscapes. A high complexity of IT landscapes reduces the flexibility of enterprises to adapt to the fast changing environments they are operating in. A means to cope with this complexity and therefore to enable the easy transformation of organizations is Enterprise Architecture Management (EAM).

Even though there is a generic understanding of what the field of EAM comprises, there is also a lack of consensus with regards to theoretical foundations and stringent definitions of foundational terms. This vagueness makes it difficult for prospects to find access to the topic and for experts to communicate its value. To solve this issue, the online community *eam-initiative.org* is created, which aims at fostering consensus within the EAM community and thereby to advance the topic of EAM. The distinctive feature of this online community is the use of a wiki-approach, which guides the structure of the website. Wikis have proven to be a successful tool for collaboratively collecting and consolidating knowledge. However, in the beginning a wiki has to generate sufficient utility in order to find value for users in their participation.

The goal of this thesis is to provide the initial utility for the eam-initiative.org by developing and implementing the structure of the website as well as enriching it with an initial set of foundational wiki articles on EAM. Additionally, a concept map is introduced as a tool for navigating through the wiki content. The resulting website including the wiki articles and the concept map is evaluated using an online survey. Finally, after the initial utility is provided, an action plan for future community building is presented.

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Chapter 1

Introduction

1.1 Motivation

Over the last years, Information Technology (IT) turned into a critical success factor for businesses in many branches [Han12a]. This development goes as far as IT not only being an enabler but also a driver for innovation [Han12a]. Moreover, IT is the starting point of many new business models like Uber or Airbnb [Des14]. Due to these advancements, the amount of applications supporting the daily business of enterprises grew rapidly, leading to complex IT landscapes [SM14]. A high complexity of IT landscapes makes it difficult for organizations to quickly adapt to new business needs. This inflexibility conflicts with the continuous need for organizational transformation caused by influence factors like globalized markets, specialized customer demands and emerging legal requirements [Myk+11]. A prominent means to cope with IT landscape complexity and therefore to enable the easy transformation of an organization is Enterprise Architecture Management (EAM) [Myk+11].

Even though there is a generic understanding of what EAM comprises, there is also a lack of consensus with regards to theoretical foundations and stringent definitions of foundational terms [Sch09]. This leads to a general vagueness regarding the subject matter, which is aptly pointed out in [BBL12]:

> *"[...] there seems to be a mystical mist surrounding the field of EA. This mist obscures the meaning and purpose of this field - not only for the naive observer but also for the mature architect."*

The reasons for this vagueness are manifold. First of all, there is no uniform definition of EAM [ARW08; Sch09; BBL12; BMS10b; BMS09b]. This starts with the distinction between the terms Enterprise Architecture (EA) and EAM. While some authors treat the terms as synonyms [Sch09;

ARW08; Ste09], others strictly differentiate between the EA, being the structure of architectural elements of an organization and EAM, representing the management function guiding the EA's evolution [SSM13; BBL12; BMS09b; BMS10b]. A work highlighting the missing consensus with regards to the definition of EA is provided in [Sch09]. The results of the literature review show that 39% of the examined publications use a proprietary definition of the term EA, while at the same time 34% of the publication don't provide any definition at all [Sch09]. Further literature reviews show that there are also inconsistencies in the understanding of subareas of EAM, e.g. with regards to the approach to EAM [ARW08], EA principles [Ste09], EAM goals [SSM13] and EAM frameworks [BS11]. These outcomes do not only show the ambiguity in the subject area, but also the dissent within the EAM community.

Additionally, there is no EAM core literature and research results as well as practitioner experiences are typically published in books or presented at workshops, not in journals [Myk+11]. Also, different EAM language communities exist in academia as shown in [SW09]. A language community in this context is defined as being a group using a common terminology in the field of EAM [SW09]. This leads to key terms being used interchangeably with slightly different meaning [Buc+10d]. Similarly, in [Lap12] three schools of thought are defined based on the scope and the purpose of EAM and authors with mainly practical background are assigned to these categories. Again, the lack of a commonly accepted understanding or definition of EAM is emphasized. Finally, frameworks which are meant to make EAM accessible for non-experts are hard to understand, overloaded, lagging behind and connected with a high effort to adapt to specific enterprise needs [Han12a; Kel11]. An example for such a standard is the *The Open Group Architecture Framework (TOGAF)* developed by The Open Group[1]. The latest version of the framework is TOGAF 9.1, which was published in late 2011 and comprises 690 pages [11b] that are difficult to understand, especially for non-experts [Kel11].

Summarizing, there is no definition of state-of-the-art EAM foundations relevant to practitioners and scholars. This makes it difficult for prospects to find access to the topic [Myk+11; Han12a] and for experts to communicate its value.

A new approach to foster the creation of consensus and therefore to advance the field of EAM is the community-based website *eam-initiative.org*. Community-based approaches for knowledge management are considered to be amongst the most effective tools for knowledge creation and transfer [WS00]. The distinctive feature of this community is the use of a wiki-approach, which guides the structure of the website. However, in order for users to find value in their participation in a wiki-based online community, the wiki has to provide sufficient initial utility [Kit+07].

[1] See `http://www.opengroup.org/`.

1.2 Objective

Given the motivation and the context of the eam-initiative.org, the overall objective of this thesis is defined as being the creation of the initial utility for the eam-initiative.org to enable the success of the knowledge community. As depicted in Figure 1.1, this overall objective will be reached by satisfying the following objectives:

- *Objective 1: Identification and implementation of a website structure enabling the wiki approach.*
- *Objective 2: Creation of wiki articles summarizing foundational EAM topics.*
- *Objective 3: Creation of a concept map to enable easy navigation through the EAM topics.*

1.3 Research Question & Approach

Four research questions (RQ) are determined in this thesis, which will be addressed by a combination of literature research, an expert survey, a user survey and the analysis of community activity metrics. The four research questions (RQ) and the applied research design are defined as follows:

RQ 1: Is the general idea of the eam-initiative.org accepted by the EAM community?

RQ 1 is addressed by the user survey as well as by the analysis of community activity metrics.

RQ 2: What is a suitable structure for the website eam-initiative.org?

To answer RQ 2, first a structure of the website is designed given the requirements for wikis extracted from literature as well as the requirements identified based on the concept of the eam-initiative.org. After implementing the structure, it is evaluated in the user survey.

RQ 3: What are foundational EAM topics?

The process of answering RQ 3 comprises literature research as well as an expert survey.

RQ 4: Does a concept map provide a useful tool for easy navigating through the topics?

To answer RQ 4 first a the concept map is generated based on literature research and the foundational wiki articles resulting from RQ 3. The resulting concept map is is evaluated in the user survey.

As indicated in Figure 1.1, RQ 2 - RQ 4 can be derived from the thesis' objectives. Even though not directly linked to a goal of this thesis, RQ 1 will also be evaluated, since without the general acceptance of the idea of the eam-initiative.org by the EAM community, the whole endeavor of setting up a website for the eam-initiative.org would be useless.

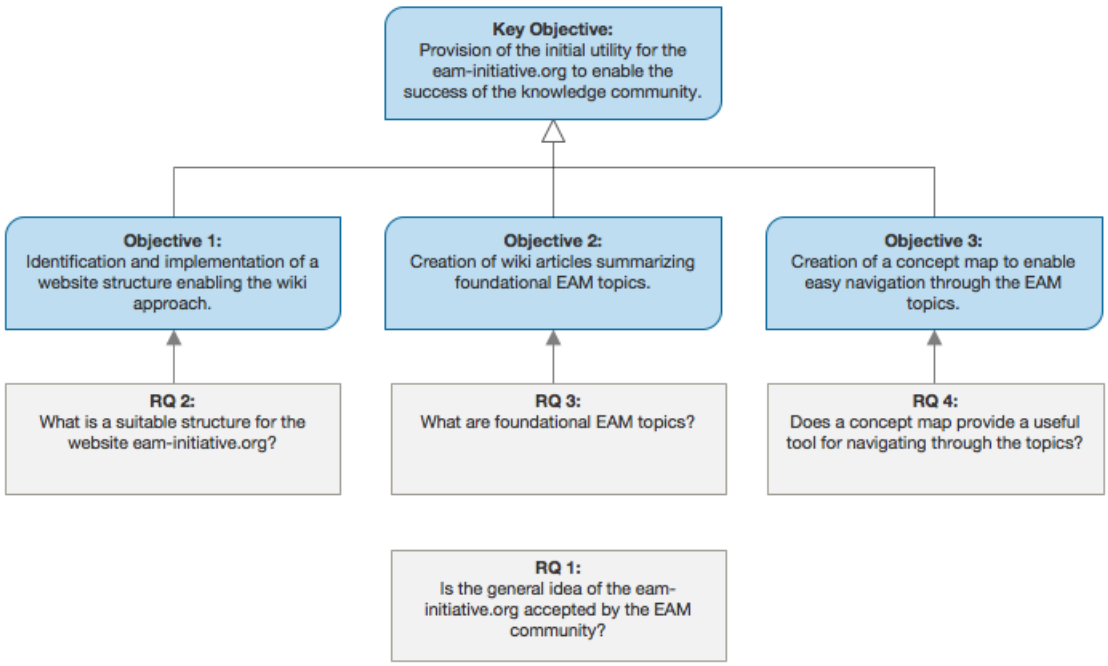

Figure 1.1: Conceptualization of the objectives and research questions.

1.4 Outline of the Thesis

The remainder of this thesis is structured as follows. First, in chapter 2, foundations regarding the topics EAM, wikis and concept maps are provided. Afterwards, in chapter 3, two already existing online communities concerned with EAM are examined. In chapter 4, the concept of the new EAM online community eam-initiative.org is presented. Given this context, chapter 5 outlines the process of creating the the initial utility for the eam-initiative.org. These resulting EAM platform is evaluated in chapter 6 using a user survey and community activity measures. Finally, in chapter 7 the thesis findings are discussed and an action plan for further advancing the success of the eam-initiative.org by fostering community building is identified.

Chapter 2

Foundations

This chapter provides a fundamental terminology for the remainder of this thesis. Since the eam-initiative.org aims at advancing the field of EAM, first the terms EA and EAM are introduced in section 2.1. Afterwards, the concept and the advantages of using wikis are outlined in section 2.2. Finally, because a concept map is used as navigation tool for the eam-initiative.org, relevant basics are presented in section 2.3.

2.1 Enterprise Architecture (EA) & Enterprise Architecture Management (EAM)

A frequently cited[2] definition of EA is provided in [11a]. According to the standard, a system architecture constitutes the *"fundamental concepts or properties of a system in its environment embodied in its elements, relationships, and in the principles of its design and evolution"* [11a]. In the context of EA, this system comprises the whole enterprise [BBL12]. To give some examples, the elements of an EA are e.g. *organizational units*, *stakeholders*, *locations* or *business processes* while the relationships between them can be e.g. *supports*, *hosts* or *is responsible for* [Buc+09c]. Principles which guide the evolution of an EA could be e.g. *profit*, *continuity* or *innovation* [Buc+09c].

Even though some authors use the terms EA and EAM interchangeably [BBL12; BMS09b; BMS10b], in the context of this thesis they will be strictly differentiated. This means, EAM is defined as the structured approach of creating, managing and utilizing the models provided by the EA [BBL12; Nie08]. Therefore, EAM is a management function that captures and transforms an EA [Nie08].

A high quality EA enables a lot of benefits to IT leaders [Han12a]. Some of the most prominent goals of EAM are IT cost reduction [BBL12; Fuh11b; Fuh11d], alignment of business and IT

[2] Inter alia cited in [Buc+10d; BMS10b; WS08; 11b; Buc+09c; BBL12].

[BBL12; Nie08; Man12; Fuh11c; Fuh11b], and reduction of IT landscape complexity [BBL12; Man12; Han12a].

2.2 Wikis

Wikis are a type of Web 2.0 platforms, just like web blogs and social media platforms [ST09]. Web 2.0 platforms form participative environments, allowing users to easily create, disseminate and modify content with limited technical expertise [ST09]. If these Web 2.0 platforms are adopted to an enterprise context, the buzz-word changes from Web 2.0 to Enterprise 2.0 [McA06]. Generally, wikis are used in enterprises as lightweight web based authoring tool supporting knowledge workers and their practices by enabling collaborative content creation [ST09].

When talking about wikis, it needs to be differentiate between the wiki engine and the wiki itself [Gei+07]. The wiki engine is software which enables the creation of websites [Gei+07]. On each of these websites, information regarding one narrowly defined topic or knowledge domain is collected [Mat11]. Similar to the World Wide Web (WWW), these websites are linked with each other creating a network of topics and their descriptions [Gei+07]. The resulting interlinked collection of websites is the wiki itself, also called the wiki installation [Gei+07]. Introducing Wikipedia as an example, Wikipedia[3] constitutes the wiki itself while being based on the wiki engine MediaWiki [4] [Gei+07].

A distinctive feature of wikis is the easy creation of wiki pages [AL07]. In comparison to setting up a website on the WWW, the creator of a wiki page does not need any prior knowledge of, for example, programming languages like HTML, CSS or JavaScript [Gei+07]. Instead, the software provides an user interface, which enables the prospect to quickly (wikiwiki = »schnell« (Hawaiian)) write down his knowledge, without prior training [Cun11]. Thus, wikis lower the barrier to share knowledge [ST09] and transform the user into a *Prosumer*, meaning that he can be a consumer as well as a producer of information [Cha06].

The advantage of using a wiki-approach as basis of the eam-initiative.org is that a wiki page always represents the current status of collaboration [Mos08]. Compared to blogs or forums, where entries usually cannot be changed by anyone but the writer of the contribution, in wikis every user can manipulate the contents [Mos08]. Therefore, the emphasis is on the product being the wiki article, while meta data like authors are of subordinate importance [Mos08].

[3] See `https://www.wikipedia.org/`.

[4] See `https://www.mediawiki.org/wiki/MediaWiki/de`.

2.3 Concept Map

The basic idea of concept maps is that elements of knowledge constitute concepts which are related to each other [Can+05]. Concepts in this context are defined as being *"perceived regularities in events or objects, or records of events or objects, designated by a label"* [Nov10]. Two concepts linked via a relation form a proposition, which corresponds with a unit of meaning [NC06]. This type of propositional structure provides semantics to the relations between concepts, that cannot be captured using other approaches to knowledge visualization, e.g. Mind Mapping [Can+05].

The concept map constitutes a graphical two-dimensional display of knowledge using concepts and propositions as building blocks [NC06]. Concepts are represented within circles, and their relationships with other concepts are indicated by lines connecting these concepts [NC06]. Linking phrases are words placed close to these lines, that specify the relationship between the concepts [NC06]. These linking phrases can depict any type of relationship, instead of being restricted to a limited set of propositions [Can+05]. Further, concept maps have a hierarchical structure, since more general concepts are presented by nodes close to the top and more specific concepts closer to the bottom [Can+04]. Thus, the relations run top-down by convention, with exceptions being annotated by an arrowhead [Can+05].

Due to the freedom in creating a concept map, there is not one correct concept map for a particular knowledge domain, but several slightly differing ones [Can+05]. Nevertheless, a well constructed concept map should fulfill the following requirements:

- Each proposition forms an individual statement or proposition that makes sense [Can+05].
- The linking phrases are as short as possible [Can+05].
- The root node represents the overall knowledge domain covered by the concept map [Can+05].
- The concepts are organized hierarchically with the highest being most inclusive and the lower ones getting progressively more specific [Can+05].

Wikis don't have a hierarchical navigation structure, since single pages are connected via multiple links [Mos08]. Therefore, to visualize the content and enable easy navigation of the eam-initiative.org website, a sequential table of contents is not applicable. Instead, a concept map is used for visualizing the contents of the website. By integration the concept map with an image map, the concept map is further exploited as a website navigation tool.

Chapter 3

Related Work

This chapter examines existing online communities with the goal of advancing EAM. The selection of online communities is limited to initiatives that are independent of profit-oriented sponsors like EAM tool vendors, EAM consultancies or EAM training suppliers. This is due to the communities provided and moderated by commercial actors aiming at the promotion of their respective product instead of trying to foster a general, unbiased advancement of the EAM field. The Enterprise Architecture Body of Knowledge (EABOK®), examined in section 3.1 and the Association of Enterprise Architects (AEA), discussed in section 3.2, are the only two initiatives that meet this requirement.

3.1 Enterprise Architecture Body of Knowledge (EABOK®)

The Enterprise Architecture Body of Knowledge[5] or EABOK® is an initiative with the explicit goal *"to enable the advancement and visibility of the EA practice"* [Cora]. The initiative is hosted by the MITRE Corporation [Cora], a non-profit research and development organization sponsored by the U.S. federal government [Corb]. Further, individuals with EAM expertise support and promote the initiative in their roles as Advisory Board members, Editorial Review Board (ERB) members or EABOK® Consortium members [Cora]. These experts are currently exclusively U.S. based [Cora].

The core idea of the EABOK® is to provide a platform for collecting EAM knowledge made available by experts. Hence, specialists are asked to submit articles or whitepapers concerning EAM topics to the EABOK® ERB, that will review the content before it is published on the website. In order to allow for a structured collection of the documents provided, the EABOK® splits the field of EAM into the knowledge areas illustrated in Figure 3.1. These knowledge areas are organized in accordance with an EAM life-cycle and each area is divided into further

[5] See `http://www.eabok.org`.

subsections. Additionally, the knowledge topic *Perspectives on EA* enables the collection of documents concerning meta topics in the EAM field. For each of the knowledge areas as well as for each subsection, a short summary is provided. The accepted documents assigned to the respective topics are freely available [Cora].

Figure 3.1: EAM knowledge areas as defined in the EABOK® [Cora].

Even though the basic idea of the EABOK® is to provide a platform for collecting EAM documentation similarly to the eam-initiative.org, there are some shortcoming to its implementation. First of all, the provision of new content to the website is very laborious and time-consuming. This does not only mean, that the submission has to satisfy quite strict requirements with regards to the format, but also that the author has to submit a *Submission Table* and a *Author Certification Form* [Cora]. Additionally, even after the successful review of a contribution, it can still take up to one month until the document is actually available on the website [Cora]. A further limitation of the EABOK® concept is that if a user wants to propose a new knowledge area or subsection, he needs to send an official request including a rational for the need of the new topic [Cora]. Also, there is no comments function for users to comment on the knowledge areas, subsections or documents [Cora], which prevents the emergence of an open discussion between experts.

Summarizing, the EABOK® applies a community-based approach just like the eam-initiative.org, but the high effort of contributing together with the restrictive functionalities of the website could discourage users from providing their knowledge. Based on this observation, the indications for the eam-initiative.org are that the autonomy of users and quick availability of contents should be fostered by allowing contributors to upload their files themselves regardless of the format.

Additionally, the eam-initiative.org should provide some functionality to enable discussions between users.

3.2 Association of Enterprise Architects (AEA)

The Association of Enterprise Architects (AEA)[6] calls itself *"the definitive professional organization for Enterprise Architects"*. Again, the AEA uses a community-based approach to advance the field of EAM, but this time with a clear focus on increasing job opportunities for its members [Ent].

The AEA enables its users to get in touch with other EAM experts [Ent]. In order to do so, the AEA offers the participation in virtual *Work Groups*, which are formed to achieve a certain outcome, as well as in virtual *Chapters*, that aim at advancing the EA profession in a certain geographical area [Ent]. The Chapters are further encouraged to organize Chapter meetings and other events for their members to create additional networking opportunities [Ent].

Besides the provision of the different forum groups, the AEA additionally publishes the *The Journal of Enterprise Architecture (JEA)*, a peer-reviewed international journal, which is issued on a quarterly basis. The journal is concerned with the promotion of the EAM profession, and covers EAM practices and methods, case studies, and standards [Ent].

While the benefits of being a member of the AEA are major, there is also a downside, namely the cost of 75USD per year [Ent]. Thus, while being a good platform for EA experts to network, it will always be a closed community. In consequence, the eam-initiative.org should offer free membership to attract more users with more diverse backgrounds and not exclusively inveterate Enterprise Architects.

Recapitulating, neither the EABOK® nor the AEA offer the possibility of free knowledge sharing in the same way as the eam-initiative.org. While the EABOK® provides free access to EAM documentation to advance the field of EAM, it makes the collection of such documents cumbersome, possibly limiting the amount of submitted contents. The AEA on the other hand, fosters the advancement of EAM by hosting closed forum groups. This leads to an exclusion of a lot of prospects and experts not willing to pay a fee for their participation.

[6] See `https://www.globalaea.org/`.

Chapter 4

The eam-initiative.org - a wiki-based knowledge community for EAM

The eam-initiative.org is a wiki-based knowledge community and forms the context in which this thesis is embedded. Hence, first the basic idea is introduced in section 4.1, followed by the timeline of the initiative outlined in section 4.2. Afterwards the EAM experts standing behind the eam-initiative.org as well as the concept are presented in section 4.3 and section 4.4. Finally, the technical solution and special features of the website are outlined in section 4.5 and section 4.6.

4.1 Basic Idea

Within an organization, the community-based approach for knowledge management is considered to be one of the most effective tools for knowledge creation and transfer [WS00]. In this context, a *community of practice (CoP)* is defined as a group of employees of an enterprise, that are informally bound together by shared problems or areas of interest [WS00]. When talking about their experiences and exchanging their knowledge with regards to specific problems, people distribute and internalize tacit knowledge [APW03]. If the communication between members of a CoP is mainly computer-mediated, it is also called a virtual community [KK04].

Several positive outcomes can be observed when virtual communities are supported [APW03]. Those outcomes comprise the exchange of information and knowledge with each other [HA97], the creation of new knowledge [WS00] as well as the emergence of group cohesion and unity [Org88]. The basic idea of the eam-initiative.org is to transfer the approach of a CoP into an enterprise independent setting and to build such a virtual community around the knowledge domain of EAM. The expected benefits of this endeavor are the advancement of the field of EAM and the convergence of EAM terminology in the EAM community.

4.2 Timeline

The initial decision of creating a collaborative knowledge platform for EAM was made in a meeting between Prof. Bente[7] and Prof. Matthes[8] on the 17th July 2015. After this initial decision, the development of the eam-initiative.org can be split into the seven phases illustrated in Figure 4.1.

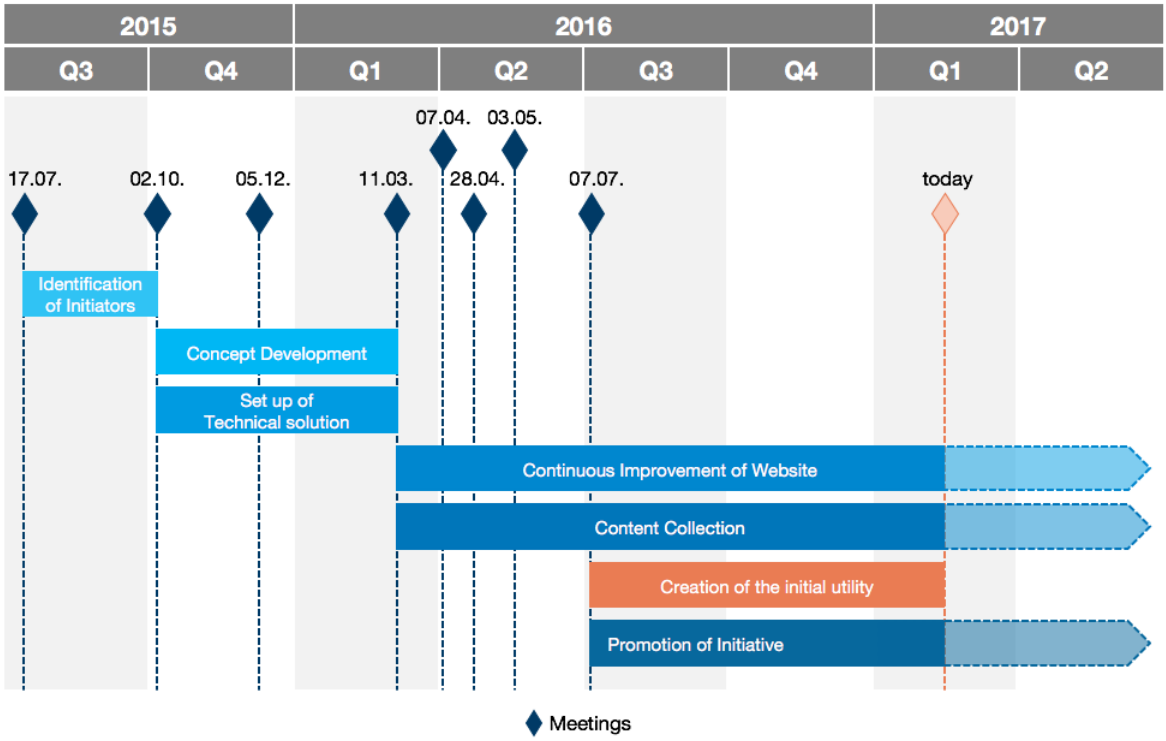

Figure 4.1: Timeline of the eam-initiative.org implementation.

The first phase comprises the identification of sponsors, with the group of initiators being presented in section 4.3. In the second phase, the initiators develop the concept of the eam-initiative.org. The results of this phase are summarized in section 4.4. Afterwards, a technical solution is set up as discussed in section 4.5. Like with every technical solution, after the initial implementation bugs and new change requests emerged, which are solved in the fourth phase. Special features of the eam-initiative.org which are implemented during this phase are presented in section 4.6. The fifth phase comprises the collection of contents for the eam-initiative.org. An initial content base comprising 66 files is provided by the initiators. Further content is supposed to be uploaded by new members of the eam-initiative.org. The creation of the initial utility of the website is the major contribution of this thesis. The exact approach to the identification of EAM topics and the authoring of wiki articles will be discussed in chapter 5. Finally, the last phase

[7]Chair for Software Engineering, Technische Hochschule Köln.
[8]Chair for Software Engineering of Business Information Systems, Technische Universität München.

captures the promotional efforts of the initiators to raise awareness of the eam-initiative.org in the EAM community. These promotional efforts comprise the presentation of the concept of the eam-initiative.org at EAM related conference as well as email campaigns.

4.3 Initiators

Research suggests that people feel more comfortable working in virtual communities, which include people already known to them [APW03]. Also, it is required that people have trust in the integrity of an organization and the competence of its members for a community to be successful [APW03]. Thus, a group of eight EAM experts from industry and academia has been identified as sponsors for the eam-initiative.org. The initiators are depicted in Figure 4.2.

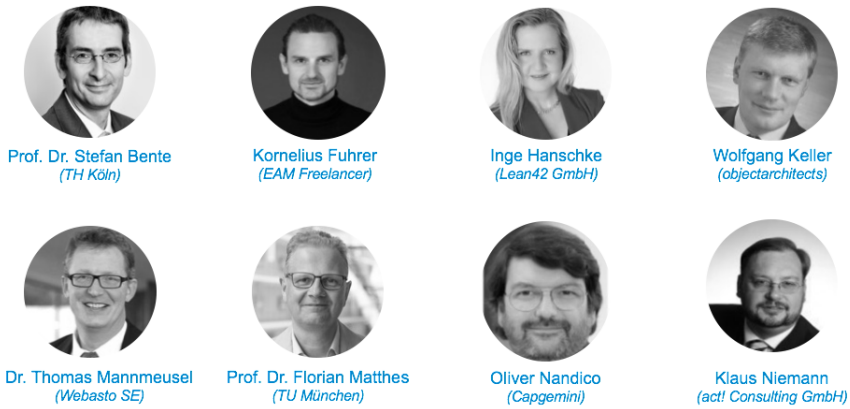

Figure 4.2: The eight initiators of the eam-initiative.org.

The initiators each have many years of experience in the field of EAM and will be shortly introduced. Mr. Bente is professor for software engineering[9] at the Technische Hochschule Köln (THK) with one of his research areas being EAM, especially lean EAM. Mr. Fuhrer is EAM freelancer with several years of experience in EAM consulting. Mrs. Hanschke is the CEO of her own IT consulting company Lean42 GmbH[10], that inter alia offers consulting services in the field of EAM. Mr. Keller is an IT interims manager, who himself states that Enterprise IT Architecture is his professional hobby [Kel11]. Mr. Mannmeusel is the CIO of the Webasto SE[11] and is mostly concerned with EAM in small and medium-sized enterprises (SMEs). Prof. Matthes holds the chair Software Engineering for Business Information Systems (sebis)[12] at Technische Universität

[9] See `http://blogs.gm.fh-koeln.de/bente/`.
[10] See `http://lean42.com/de/`.
[11] See `https://www.webasto.com/de/`.
[12] See `https://wwwmatthes.in.tum.de/pages/t5ma0jrv6q7k/sebis-Public-Website-Home`.

München (TUM) with one of his major research areas being EAM. Mr. Nandico occupies the role of the Principal Enterprise Architect at Capgemini[13] and Mr. Niemann is the Managing Director at act! consulting GmbH[14], an IT consulting company with a focus on EAM.

In addition to the group of initiators, a website team is set up to support the initiators with the implementation of the eam-initiative.org.

4.4 Concept

The concept of the eam-initiative.org is split into the subsections mission, organizational structure, format, target group, type of content, and naming & branding.

Mission

The mission statement[15] of the website eam-initiative.org describes the guiding principles of the initiative:

> *"We are an open Enterprise Architecture Management (EAM) platform and provide guidance based on an organized topic map. This map guides you to examples from practice and to reusable study material based on a consolidated conceptual foundation. We want to make EAM accessible to a wider audience and to advance the effectiveness of EA initiatives based on contributions from the EA community."*

Given the mission statement, important characteristics of the initiative can be extracted. First and foremost, the goal of the eam-initiative.org is defined as being the advancement of the EAM domain. Further, reusable documentation on practical experiences as well as study material are uploaded and freely available to everyone. Moreover, consolidated conceptual foundations are made available to the audience in the form of wiki articles. These foundational topics can be explored using an organized topic map, which is implemented using a concept map as introduced in section 2.3. Finally, a very important feature of the eam-initiative.org is that the community is based on participation. This means, registered users can easily upload new material to the website and adapt or change wiki articles. Also, they can comment on existing documents and wiki articles. Summarizing, the eam-initiative.org aims at enabling an open, participation-based EAM community.

[13] See `https://www.de.capgemini.com/`.
[14] See `http://www.act-consulting.de/`.
[15] As off 01/16/2017.

Organizational Structure

The eam-initiative.org is based on a non-profit business model, with the goal of enabling the easy access to EAM knowledge for everyone and thereby foster consolidation of terminology in the field. Currently, the legal responsibility lies with the sebis chair [16] at TUM.

Format

The structure of the website is based on a wiki-approach instead of e.g. a blog analogy. The wiki articles comprise text and, if appropriate, pictures. Moreover, the wiki articles can be linked with other wiki articles as well as with uploaded documents. For further foundational information on wikis, see section 2.2.

Target Group

The target group of the eam-initiative.org comprises all players within the EAM field. These are consultants, training providers, academic organizations, as well as professional enterprise architects themselves. Additionally, people working together with enterprise architects, and therefore wanting to gain quick and easy insights into the topic of EAM are targeted.

Generally, the website enables less experienced stakeholders to quickly and easily get access to EAM using the wiki pages. Besides that, more experienced stakeholders can deepen their knowledge with regards to specific topics by diving into the documents linked to each topic.

Type of Content

The focus of the uploaded content is practice driven, meaning that particular emphasis is put on real-world examples and best practices. Nevertheless, especially in the beginning, content uploaded to the platform can cover any material related to EAM. This decision is motivated by the fact, that first a critical amount of content needs to be collected to attract a stable amount of users. Accepted files are journal articles, white paper, study material, conference paper, case studies, tool studies, Bachelor and Master Theses, to name just a few. The uploaded contents can be written in English or in German language.

The basic directive of the eam-initiative.org is “start small, think big”, meaning that in the beginning, the initiators will upload their content as a starting point. This is supposed to encourage other experts of the German EAM community to contribute their files too. In the long run, the goal is to create an international EAM community with contributions from all around the world.

[16] See `https://wwwmatthes.in.tum.de/pages/t5ma0jrv6q7k/sebis-Public-Website-Home`.

Compliance with regards to copyright of the uploaded content is addressed using the free, easy-to-use *creative commons licensing standard*[17]. The users are requested to ensure that they have the necessary rights with regards to the content prior to uploading the file. As soon as the file is uploaded, the user can assign a creative commons license indicating the conditions they want users to adhere to when utilizing the content of their files. The default setting is set to the *CC BY attribution*, allowing other users to distribute and build on the content for private or commercial purposes as long as the owner is credited [Com]. The content providing user has the option to change this attribution to one out of five more restrictive licenses defined by creative commons. The most restrictive license constitutes the *CC BY-NC-ND attribution*, restricting other users to exclusively utilize the uploaded content without changes and for private purposes while still being obliged to credit the author [Com].

Naming & Branding

The name of the initiative is eam-initiative.org. The eam-initiative.org has an own logo as depicted in Figure 4.3.

Figure 4.3: Winning logo design for eam-initiative.org.

4.5 Technical Solution

To enable the success of a virtual community, community developers need to provide a basic technology with good usability. This enables easy knowledge generation and dissemination [KK04]. The software underlying the eam-initiative.org is *SocioCortex*[18], a collaborative information system which is developed at the sebis chair at TUM. SocioCortex enables the implementation of a *hybrid wiki concept*, meaning that wiki pages can easily be created and enriched with unstructured content like text as well as with structured content, comprising attribute-value pairs [MNS11].

[17] See `https://creativecommons.org/`.

[18] Formerly called Tricia. See `https://wwwmatthes.in.tum.de/pages/13uzffgwlh8z4/SocioCortex-A-Social-Information-Hub-SC`.

Further features of SocioCortex relevant in the context of the eam-initiative.org are the extended search options [Res+16]. First of all, the software provides a full-text search for the wiki contents [Res+16]. Additionally, tables including all entities of a certain type can be created and embedded into a new wiki page [Res+16]. The resulting table updates itself in case of changes to the underlying entities [Res+16]. In a subsequent step, this table can be sorted or filtered according to certain attribute values [Res+16]. An example would be a user filtering for all wiki pages that represent foundational EAM topics.

SocioCortex also provides a comments function, which can be activated for each page [Neu12]. This allows users to comment on wiki articles as well as on uploaded content and collected links. The availability of such a function fosters the creation of consensus with regards to certain topics as well as the general development of a knowledge community.

Another feature, which increases the usability of the website for the users are change-logs and RSS-feeds [Neu12]. The change-log documents which user created a new version of a certain object at what time [Neu12]. Users can further subscribe to RSS-feeds of single pages, which automatically inform them of such changes [Neu12]. These functionalities are interesting in the context of collaboratively writing wiki articles but also for users that want to be automatically informed about changes or new comments on their uploaded contents.

The availability of inverse links prevents redundancies when linking two pages with each other. This means, if e.g. a document is linked to a topic, this link is automatically shown on both pages. As a result, it is not necessary to declare the link on both pages, reducing effort for users and preventing inconsistencies between pages [Res+16].

A feature relevant from the perspective of the community developers are the easy allocation of access rights, allowing single users or whole user groups to receive certain read and/or write rights [Neu12]. This functionality could be relevant in case of abuse or if a certain content needs to be protected. Also the easy connection of SocioCortex with other applications via REST APIs provides the possibility to expand the functionality of the website in the future.

Finally, functionalities provided by SocioCortex which are not relevant in the context of this initiative but nevertheless mentioned for the sake of completeness are the possibility to model knowledge intensive processes [Hau+14b], the definition of key performance indicators (KPIs) based on the existing content of the collaborative information system [Res+16] and the flexible integration of existing data from different data sources [Res+16].

4.6 Special Features

During the beta phase and also in later phases of the project, bugs and new change requests emerged. These incidents were collected in a log file together with the name of a responsible person and a due date, which was determined based on criticality of the incident and on the availability of fitting resources. Major implemented changes and their purpose are listed below:

Smart Upload Button

- **Description:** Implementation of an upload functionality on the website eam-initiative.org which suggests topics that should be linked to the uploaded file. The suggestions are based on scanning the uploaded file for predefined keywords. These keywords are defined as structured data for each available topic. The function is available for all files that can be uploaded, independent of the format.
- **Purpose:** The purpose of the smart upload button is to facilitate the topic allocation for users. Additionally, consistent use of topics is fostered, meaning that the creation of new topics which already exist with slightly different naming, e.g singular vs. plural of the same term, is prevented.

Topic Cloud

- **Description:** Implementation of a tag cloud, which visually depicts the topics defined on the website eam.initiative.org. The more files are linked to a topic, the bigger the font size of the topic. By clicking on a writing in the topic cloud, the user is automatically forwarded to the website of the respective topic.
- **Purpose:** The purpose of the topic cloud is to give users an overview of the available topics and the relevance of single topics.

Foundational Topic

- **Description:** Addition of structured data to each topic on the website eam-initiative.org, which indicates if a topic is categorized as being foundational or not. The structured data consists of a boolean attribute-value pair. The attribute is called *Foundational Topic* and possible values are *Yes* and *No*. Exactly one value needs to be assigned to this attribute when creating a new topic.

- **Purpose:** The purpose of this attribute-value pair is to indicate to the user if a topic is categorized as being foundational or not.

Newsletter

- **Description:** Implementation of a functionality that enables the users to subscribe to a newsletter. To subscribe to the newsletter, the user must be registered.
- **Purpose:** The purpose of the newsletter function is to enable users to subscribe for newsletters and thereby to stay up-to-date with regards to news concerning the website eam-initiative.org.

Chapter 5

Creation of Initial Utility of the eam-initiative.org

The goal of this thesis is to provide the initial structure and content of the eam-initiative.org website in a way that creates enough value for new users to utilize it for EAM knowledge acquisition and distribution. In order to achieve this goal, the three areas of action *website structure*, *EAM wiki articles* and *concept map* have been identified. First, the timeline of the approach will be outlined in section 5.1. Afterwards, the approach to each of the areas of action is discussed in detail and their results are presented in section 5.2 to section 5.4.

5.1 Timeline

The overall timeline for the approach is depicted in Figure 5.1. The first major task is the definition of the approach to the thesis itself. In parallel, the structure of the website is set up as detailed in section 5.2. The most time intensive task is the identification of foundational EAM topics and the authoring of related wiki articles. This exercise is split into three iterations, with the first iteration aiming at providing a first feeling for the topic of EAM and a first set of EAM wiki articles. The second iteration categorizes the EAM topics into foundational and non-foundational groups using literature research. Additionally, the wiki articles are refined. The last iteration aims at capturing emerging topics foundational to the field of EAM based on an expert survey. This measure is necessary, since available literature is always retrospective and therefore emerging trends could be overlooked if the identification of EAM topics is limited to literature research. Just like the creation of wiki articles, the development of a concept map is split into three iterations. This is due to the concept map organizing the foundational EAM topics, which change in every iteration. Finally, the current status of the eam-initiative.org is evaluated using a survey and community

activity metrics. While some of the results are used as input to the third iteration of the wiki articles, most of the results are discussed in chapter 6.

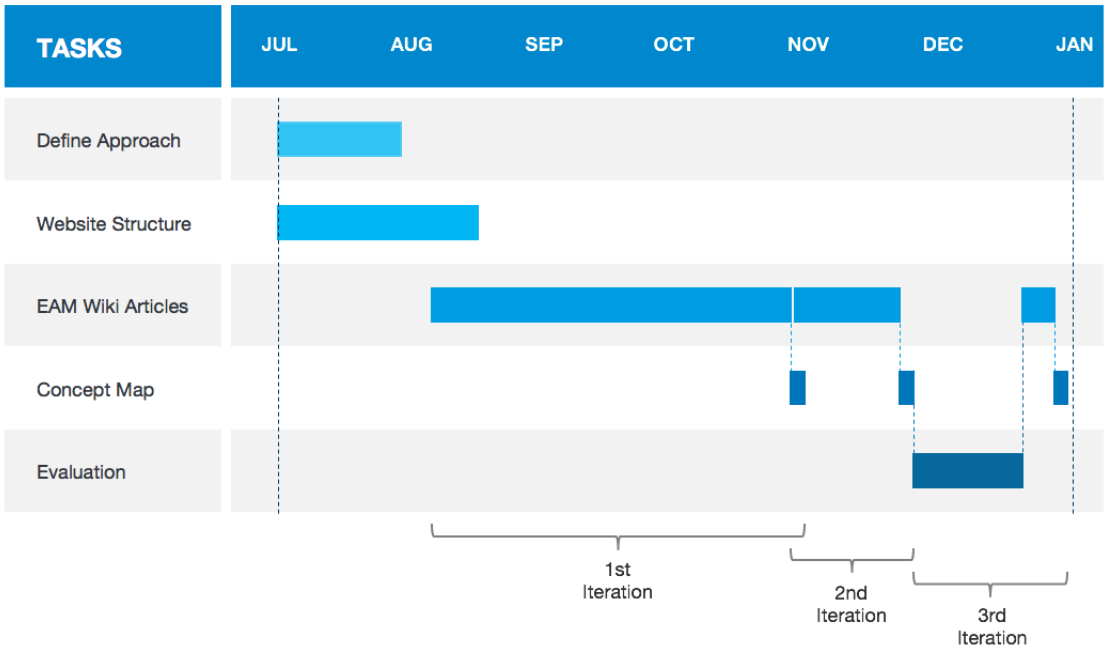

Figure 5.1: Timeline of the thesis approach.

5.2 Website Structure

First a short rationale for the importance of this task is provided. Afterwards the the website structure is described using its underlying information model and the introduced user roles.

5.2.1 Rationale

An important prerequisite for an online community to be successful is to ensure that the underlying technology functions properly [WC00]. Therefore, to enable the eam-initiative.org, a suitable structure of the website needs to be implemented, which meets the initiators and users expectations.

5.2.2 Information Model

The website structure corresponds with the information model of a wiki. For the eam-initiative.org, the information model is developed using a top-down approach, meaning that first a structure is created by a model designer and only after the structure is implemented, the wiki is filled with

the respective information [Mat11]. This approach can be applied because the number of entities is limited and the attribute allocation for each entity type is pretty intuitive (e.g. a file needs to provide all meta data to enable citations).

According to the conceptual outline of the eam-initiative.org in chapter 4, the following entities need to be modeled:

- **Wiki Articles:** The eam-initiative.org is based on a wiki-approach. Each wiki article covers an EAM topic.
- **Documents:** Documents can be uploaded and linked with wiki articles.
- **External links:** Pages describing external links can be created and linked with EAM topics.
- **Community members:** Community members are registered users that have more rights than non-registered users.

To implement this structure, the four basic page types *Topic*, *File*, *Link* and *UserProfile* are defined. The relation between the page types as well as their attributes are depicted as an UML class diagram in Figure 5.2. For the sake of transparency, only attributes relevant in the given context are included.

An instance of the page type UserProfile is created every time a new user registers on the website. To register, the user needs to indicate his name and email address which are stored on the respective UserProfile page. Further, he can add a profile picture, his homepage or his LinkedIn[19] and Xing[20] account. Any instance of the type UserProfile can be linked with instances of the page types Topic, File and Link, e.g. as an author, reader or editor of the page or some of its contents. Nevertheless, a user does not need to be registered to be an author of a contribution uploaded to a File page or link embedded in a Link page, leading to a possible situation where Files or Links are not linked to an existing UserProfile.

The page type Topic represent the wiki articles on the website. Each wiki article has the same structure and consists of the name of the EAM topic, a full text description, and relevant meta data. This meta data comprises the author of the wiki article as well as a German translation of the topic name and related keywords, which are relevant for the proper functioning of the Smart Upload function as introduced in chapter 4 as well as for the convergence of different EAM taxonomies. Moreover, the meta data specifies if a topic is defined as being foundational in the field of EAM. If this is the case, the wiki article is initially authored by the Website team. More

[19]See `https://www.linkedin.com/`.
[20]See `https://www.xing.com/`.

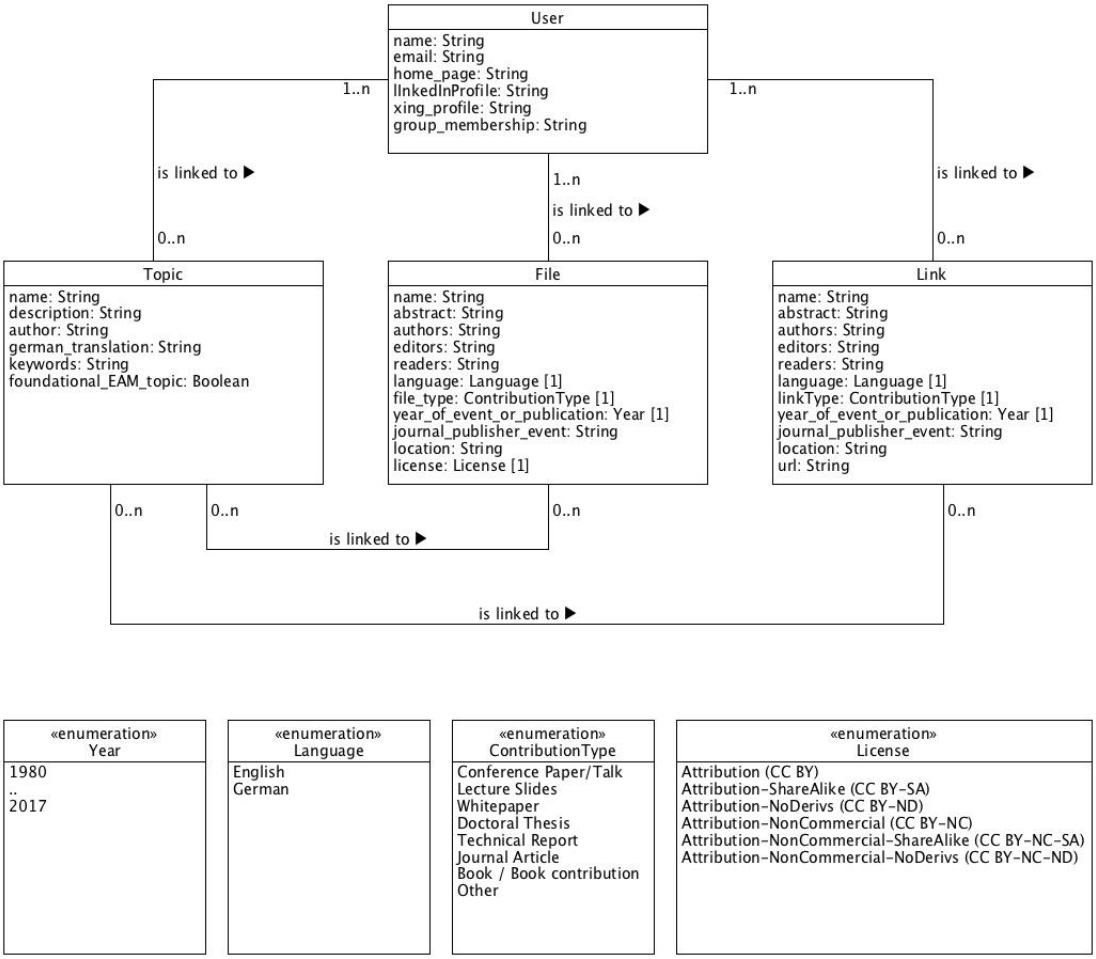

Figure 5.2: Relations and attributes of the page types defined for the eam-initiative.org.

detailed information on the process of how a topic is decided to be a foundational topic and the resulting indications can be found in section 5.3. Finally, a Topic page also links to related Files and Links.

A File page is created for every document that is uploaded to the platform. Each File page contains the name of the document, a summary of the documents content, meta data attributed to it (e.g. author or date of publication), and the file itself. The file itself can be downloaded free of charge.

Finally, a Link page is created for each link pointing at an external source relevant to EAM. These Link pages store the name of the document as well as the URL pointing to its original address. Further, each Link page contains an abstract and relevant meta data, similar to the meta data provided on a File page.

Due to the availability of inverse links in SocioCortex, all links between page types described above are bilateral.

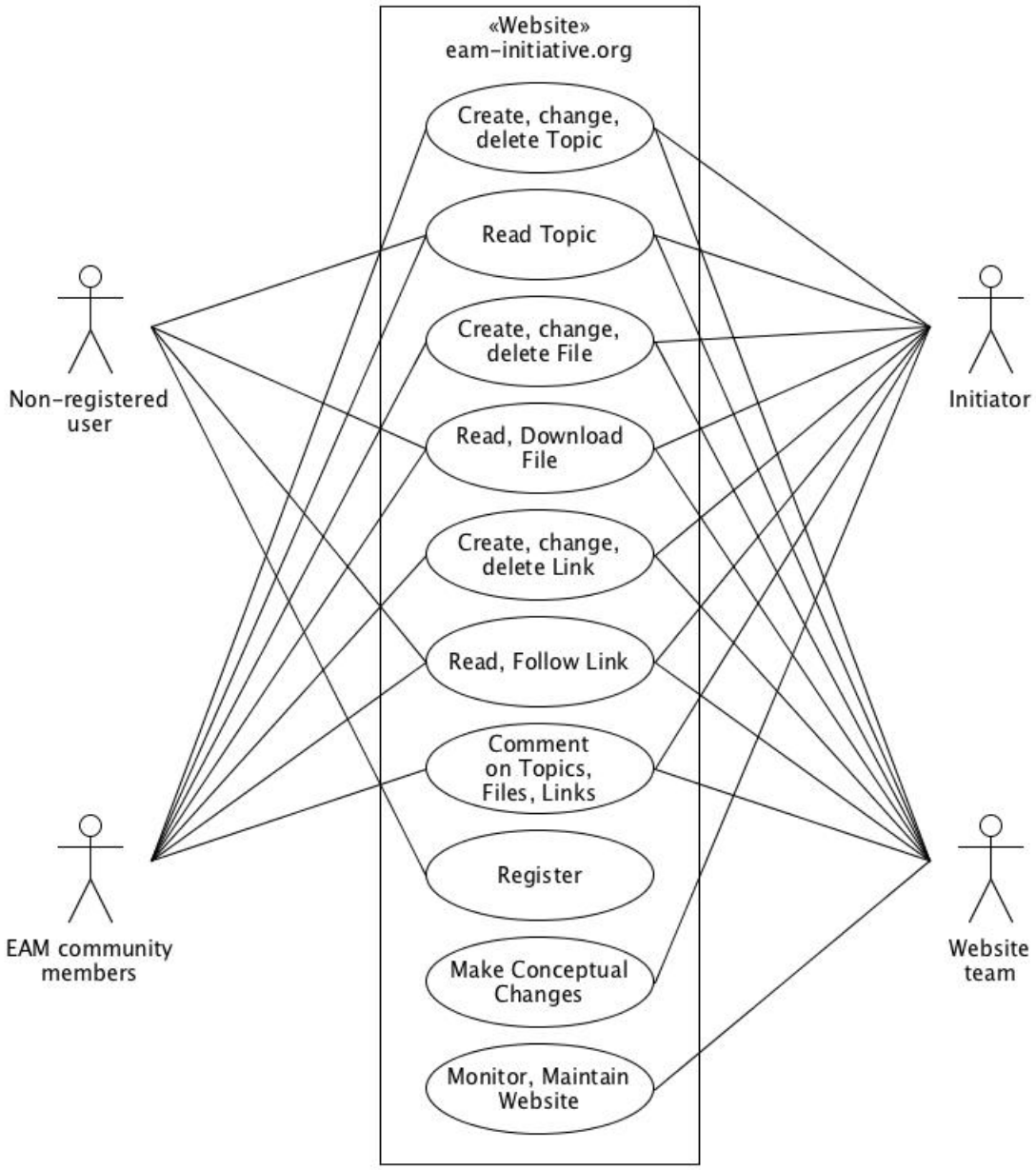

Figure 5.3: Roles and rights defined for the eam-initiative.org.

5.2.3 User Roles

The UML use case diagram depicted in Figure 5.3 shows the rights of each actor who interacts with the eam-initiative.org website. For the sake of transparency, some rights are pooled. Actors can take one of the following four roles: *Non-registered users*, *EAM community members*, *initiators* or *website team*.

Unregistered users have the right to view Topics, Files and Links as well as download documents and follow external links collected on the website. Additionally, they can register themselves to become an EAM community members with more rights.

EAM community members are registered users. These users can access all wiki articles as well as the documents linked to them. Additionally, they can author, change or comment on Topics, Files or Links. Also, they can upload their own content to share it with other users.

The initiators are a closed group, which has the right to decides on fundamental questions with regards to the concept of the eam-initiative.org website. Additionally, they have the same rights as the EAM community members.

Finally, the website team should monitor and maintain the website while at the same time having all rights the EAM community members have, too. The term *website team* is chosen, since the actors additionally provide input for website in the form of wiki articles. Therefore, the role comprises more tasks than the role of a mere *website administrator*.

5.3 EAM Wiki Articles

In the following, first the rationale for providing an initial set of wiki articles is presented. Afterwards, the process of identifying foundational EAM topics and the approach to writing the articles is outlined.

5.3.1 Rationale

A distinctive feature of the eam-initiative.org community is the use of a wiki approach. Since several different authors contribute their knowledge to the same topic by writing and revising wiki articles [SS07], wikis have been recognized to be a successful means for collaboratively collecting and consolidating distributed knowledge [Buc+10c; Mat11; Sch06]. However, in the beginning a wiki has to generate sufficient utility created by power users, in order for normal users to find value in their participation [Kit+07]. This phenomenon has been observed inter alia for Wikipedia, where initially mostly power users contributed content, designed procedures, and developed guidelines [Kit+07]. Nevertheless, over time, a shift in the structure of contributers emerged, showing that the proportion of articles and changes to articles made by novice users increased steadily [Kit+07]. At the same time, the number of power users also increased, showing that the observed trend is not just a result of diminishing contributions by power users [Kit+07]. Summarizing, the indications of this phenomenon are that just like the first pioneers, who built infrastructure in newly discovered land and thereby lowered the migration costs for future

emigrants, power users of a wiki need to provide enough initial utility for normal users to take part in the development of a wiki [Kit+07]. For the purpose of providing this initial utility, foundational EAM concepts are identified using literature review and feedback from experts. For each of these EAM concepts, wiki articles summarizing the respective topic are composed and made available on the website eam-initiative.org.

5.3.2 Creation of Wiki Articles

To provide the maximum amount of utility to the users with a set of initial wiki articles, foundational topics in the field of EAM are identified using literature research and expert feedback. Foundational in this context means, that the set of topics covers the subject areas which are considered to be basic knowledge and form a prerequisite to access the field of EAM. The approach to the creation of the initial wiki articles can be split into three iterations. In the first iteration, a set of EAM topics is identified and wiki articles are authored based on a restricted amount of EAM literature. In the 2nd iteration a more extensive amount of literature is used to extract 30 foundational topics and refine the wiki articles. Finally, in the 3rd iteration, the set of foundational topics is reduced to 23 and the related wiki articles are further improved on the basis of an expert survey.

First Iteration - General Overview

The major goal of the first iteration is to gain a general impression of which topics are relevant in the field of EAM. Therefore, only the files available on the eam-initiative.org website are analyzed. The files on the website comprise 66 documents[21], consisting of white papers, lecture slides, conference papers and talks. A detailed list of all files can be viewed in Appendix A.

First, each file is read completely and topics touched in the content are collected using an excel sheet. This approach results in a list comprising 72 topics. In a next step, the list of 72 topics is cleaned by merging topics that used different topic names but ultimately cover the same topic. This phenomenon is observed quite often, since many different language communities exist in the field of EAM [Lap12]. Additionally, topics which are treated in less then two files are discarded. The deliverable of this first iteration is the list of the 29 topics depicted in Figure 5.4, which are candidates for being foundational topics in the field of EAM due to their frequent discussion in the analyzed files.

[21] As off 09/15/2016.

Furthermore, while reading the files, content is extracted and compiled for each topic. Based on this collected contents, wiki articles summarizing the 29 topics are authored. Each wiki article comprises a short introduction summarizing the major characteristics of the topic, followed by a more extensive discourse split into several sections. Additionally, the German translation and keywords relating to the topic are complied to provide the basis for a proper functioning of the Smart Upload function as described in section 4.6.

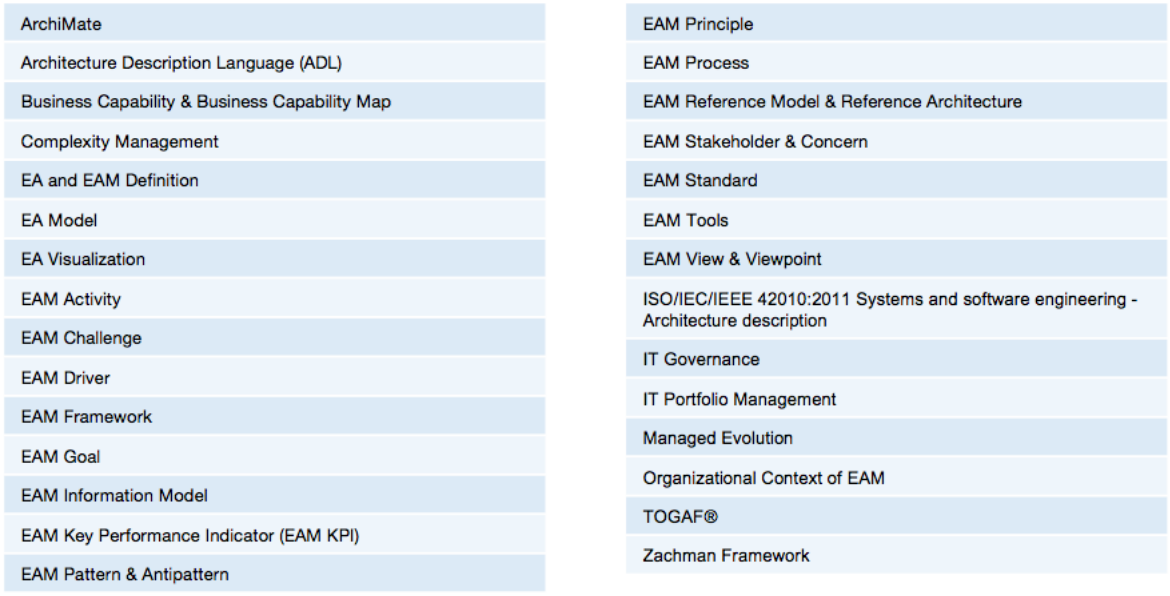

Figure 5.4: Set of EAM topics identified in the first iteration.

Second Iteration - Literature Research

Now that a first set of topics is available, the goal of the second iteration is to identify which of these topics can be categorized as being foundational in the area of EAM. Therefore, as illustrated in Figure 5.5, 140 documents which are composed of foundational EAM papers, sebis publications, books authored by the initiators of the eam-initiative.org and again the 66 files uploaded to the eam-initiative.org, are analyzed. Additionally, the wiki articles are refined.

The foundational EAM papers, are gathered based on a three step process. In the first step, the scientific databases *IEEE Xplore*, *Scopus* and *Web of Science* are searched[22] using the search term *"Enterprise Architecture Management"* and the search fields *article title*, *abstract*, or *keywords*. For a paper to be categorized as foundational in the field of EAM, a minimum threshold of 5 citations is defined. The outcome is a cumulated list of 48 papers, which, in the second step, is cleaned for duplicates retrieved from different data bases, reducing the list to 36 papers. In the last step,

[22] As off 11/08/2016.

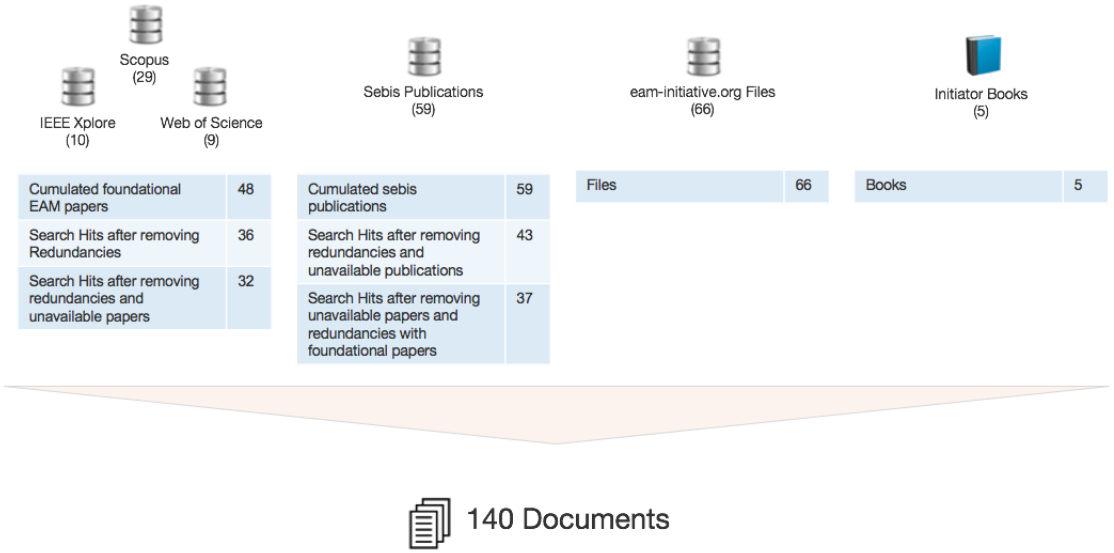

Figure 5.5: Sources of literature for the literature research.

four more papers that cannot be accessed by the author are removed, resulting in a total of 32 foundational EAM papers.

The sebis publications were filtered in a similar way. Within the list of all sebis publications[23], the publications containing the term *"Enterprise Architecture Management"* including journal articles, conference papers, technical reports, book and book contributions, are collected. This produces a list of 59 publications. After removing papers which are not accessible and cleaning the list of papers already covered in the category foundational EAM literature, 37 papers remain.

Further, the initiators have published a cumulative amount of five books on the topic of EAM. Each of these books has been taken into account in its latest version[24].

Finally, the 66 files uploaded[25] to the eam-initiative.org website are analyzed again.

All the 140 sources mentioned above are listed in Appendix B and are analyzed for existing and possible additional foundational topics in the field of EAM. In order to do so, again an excel sheet is used, but this time listing the sources on the vertical axis and the already identified foundational topics on the horizontal axis. The resulting matrix is filled in with check marks every time an already mentioned foundational topic was touched in a source. Further, if new topics emerge in the course of analyzing the sources, they are added to the matrix. As a outcome, a count indicating how often a certain topic is discussed in the considered literature is produced.

[23] See `https://wwwmatthes.in.tum.de/pages/1bcg9q4ds39aa/Publications`. As off 11/09/2016.
[24] As off 11/09/2016.
[25] As off 11/10/2016.

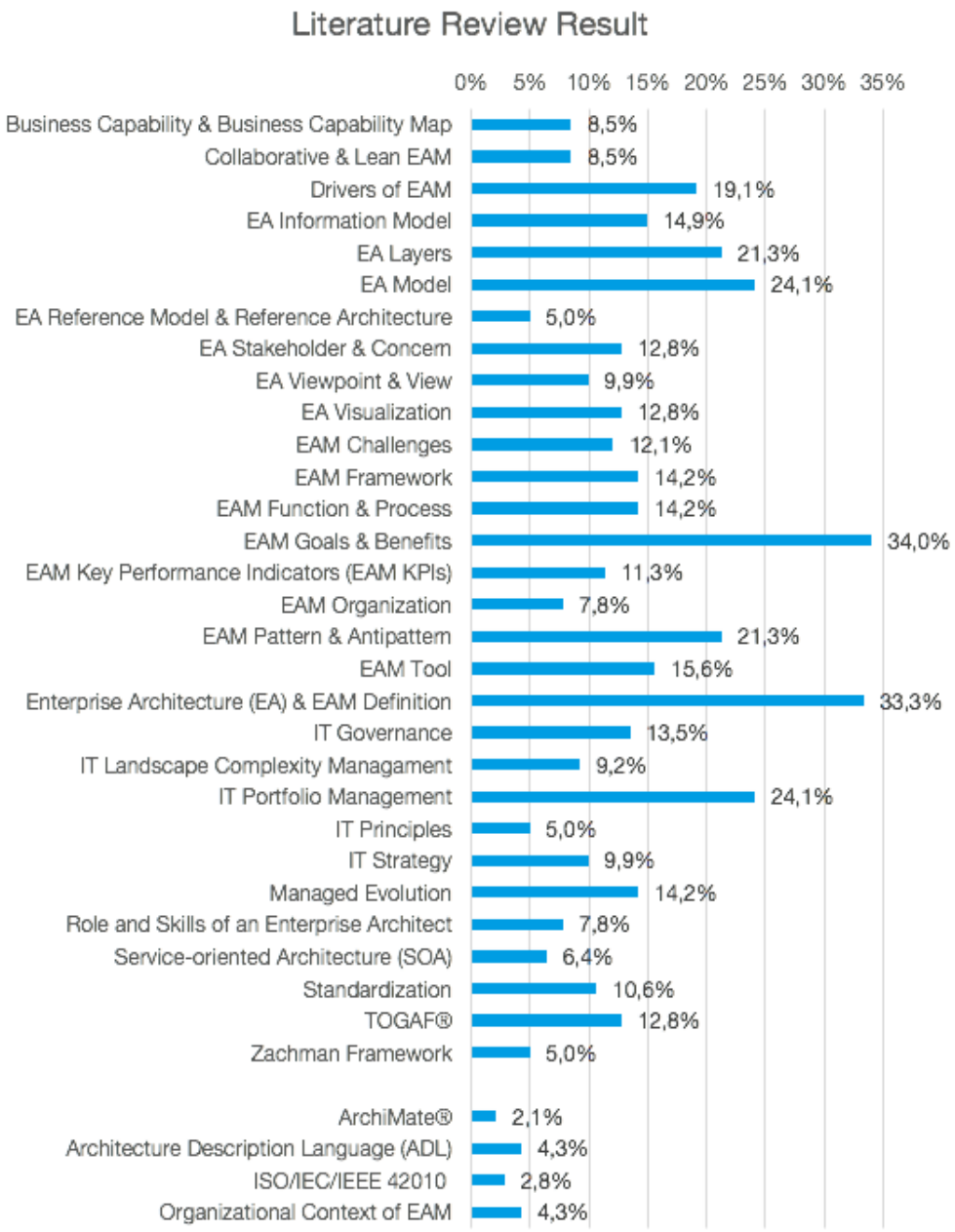

Figure 5.6: Result of the literature research categorizing topics into foundational and non-foundational groups.

For a topic to be categorized as a foundational topic, it needs to be discussed in at least 5% of the considered literature. Applying this threshold, four topics[26] which were discussed in the

[26] *ArchiMate®, Architecture Description Language (ADL), ISO/IEC/IEEE 42010 Systems and software engineering - Architecture description, Organizational Context of EAM.*

previous iteration need to be discarded, while six new ones[27] are identified. Moreover, two topics have been merged[28], resulting in the list of 30 foundational topic illustrated in Figure 5.6.

For each of the foundational topics the related wiki article is written or refined and published on the website eam-initiative.org.

Third Iteration - Expert Survey

Since the literature available is always retrospective, in the third iteration the foundational topics are reviewed on the basis of an expert survey. The goal of this iteration is to capture emerging topics foundational to the field of EAM, which are not yet represented in the literature adequately and to discard topics are frequently found in literature but are not too relevant in practice.

The participants of the expert survey are four out of eight initiators of the eam-initiative.org. Each of the respondents is provided with a list of all topics that were mentioned in the first and in the second iteration of this process. As additional information, for each topic the short description summarizing the subject of the related article is included. Based on this list, each survey participant can select a topic as being foundational by ticking the associated check box. Further, each participant can add notes to each topic and propose additional topics.

To be categorized as foundational, a topic has to be selected by at least two initiators as being foundational. This way a minimum level of consensus is implicated. Applying this threshold, the resulting list of 23 foundational topics is illustrated in Figure 5.7. In detail, nine[29] of the topics which were identified as being foundational in the previous step are discarded, while one concept[30] discarded in the second iteration is reintroduced and one completely new concept[31] is integrated.

Additionally, remarks have been provided via open questions in the survey and emails to the author. These are addressed as follows:

- **Feedback regarding the topic *EA Information Model*: EA Model vs. EAM Information Model?**

[27] *Collaborative EAM, EA Layer, EAM Organization, IT Strategy, Role and Skills of an Enterprise Architect, Service-oriented Architecture (SOA).*

[28] *EAM Activity* and *EAM Processes* have been merged into *EAM Function & Process.*

[29] *EA Reference Model & Reference Architecture, EA Viewpoint & View, EAM Framework, IT Principles, IT Standard, Managed Evolution Approach, Service-oriented Architecture (SOA), The Open Group Architecture Framework (TOGAF®), Zachman Framework.*

[30] *Organizational Context of EAM.*

[31] *EA Data Collection.*

This is a valid point, since the information model can be used as a synonym for the term EA model. The respective wiki articles have been adapted, shifting the focus in the wiki article about the topic *EA Model* more towards a meta level differentiating the information model from models defined in ISO/IEC/IEEE 42010.

- **Proposed additional foundational topic: Standards Management.**

  Standards are generally covered in the wiki article *IT Standard*. Nevertheless, the participant expects more detailed information on how standards are designed in practice and how strictly they are adhered to (strict guideline vs. heuristic). This is valuable information which is based on experience, and therefore can only be provided by community members. Additionally, it is interesting to note, that the topic IT Standards is only categorized as being foundational by one respondent of the survey, excluding it from the group of foundational topics. This again shows the difference in perception in the field of EAM between experts.

- **Proposed additional foundational topic: Role of enterprise architects in the time of digitalization.**

  Again, this is a very interesting topic, which can only to be answered based on experience of community members.

- **Proposed additional foundational topic: Operational EAM / EAM in projects.**

  The topic of EAM in single projects is addressed in the wiki article *Role and Skill Set of an Enterprise Architect*. Sadly, no more information detailing what information the respondent is missing was provided, therefore the wiki article cannot be adapted accordingly.

- **Proposed additional foundational topic: EA Value Proposition.**

  This topic is covered by an existing wiki article, namely *EAM Goals & Benefits*.. Since no further information is provided detailing what kind of additional content is expected, the wiki article is not changed.

Since the analysis of the remarks provided via the open question fields in the expert survey and via email do not result in the emergence of additional foundational topics, the list illustrated in Figure 5.7 represents the final set of foundational topics. The wiki articles for each of the foundational topics is published on the website eam-initiative.org and marked accordingly. Further, also the wiki articles written for topics which were later on defined as being non-foundational are made available on the website to provide the maximum value to the users. All wiki articles covering

foundational as well as non-foundational topics are attached in Appendix C and Appendix D respectively.

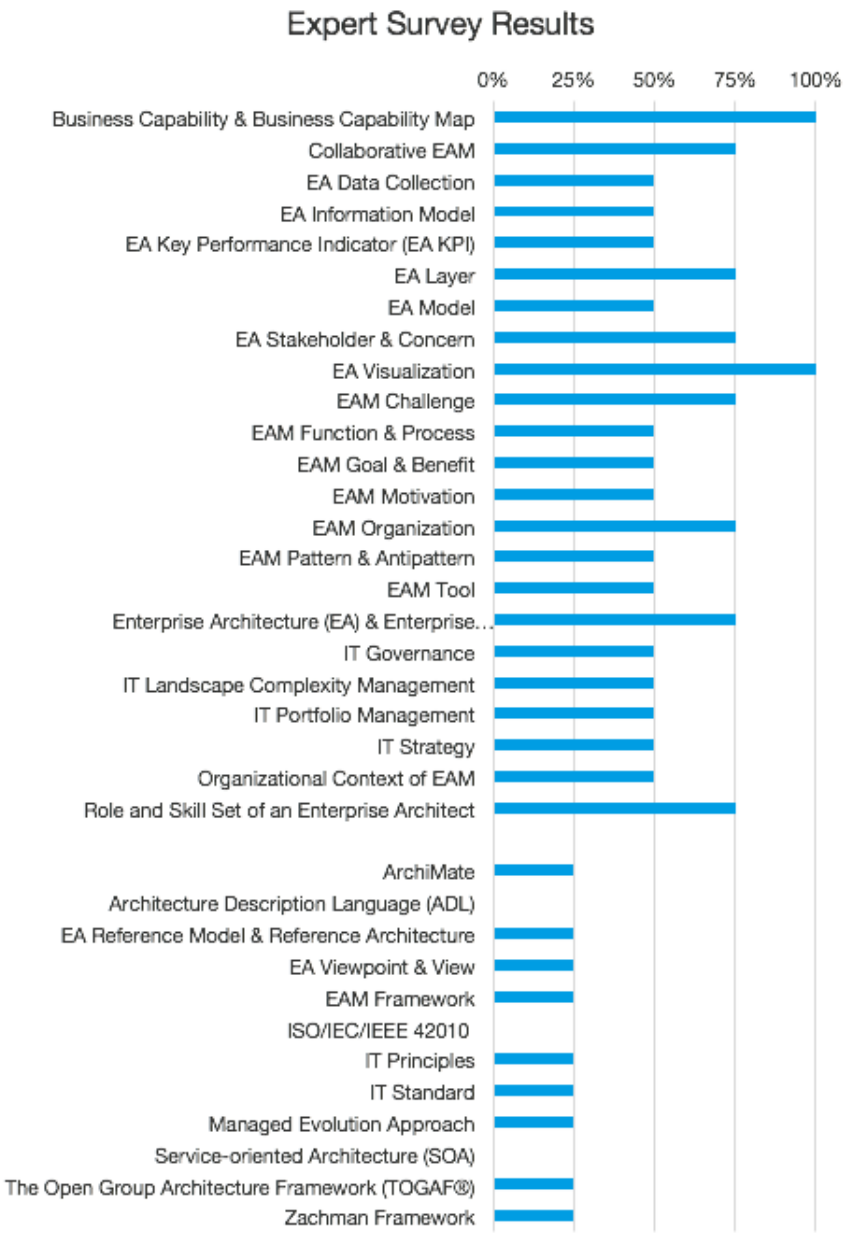

Figure 5.7: Result of the expert survey categorizing topics into foundational and non-foundational groups.

5.4 Concept Map

5.4.1 Rationale

Wikis usually don't have a hierarchical navigation structure, since single pages are connected via multiple links [Mos08]. Therefore, to visualize the content and enable easy navigation of the website, a sequential table of contents is not applicable. As an alternative approach to the organization of the eam-initiative.org website content, a concept map is created. A concept map is an effective means for visualizing and communicating knowledge [Can+04] and can be used to navigate through a particular domain of knowledge [Can+05].

5.4.2 Concept Map Creation

To optimize the process of creating the concept map[32], the step-by-step instruction provided in [NC06] is adhered to. The first step comprises the identification of the concepts of a domain [NC06]. This task was already performed in the previous section, meaning that the topics identified in the three iterations of the wiki content creation are used as input for the concept map. Thus, overall three different versions of the concept map are created. In the next step, the concepts are ranked according to their inclusiveness, with the most general concept being on top [NC06]. Once this ranking is finalized, the last step comprises relating the concepts to each other. In the course of doing so, it is important to recognize that all concepts are related to each other in some way [NC06]. Hence, it is necessary to be selective and only integrate those links that are most relevant for the capturing the knowledge domain [NC06].

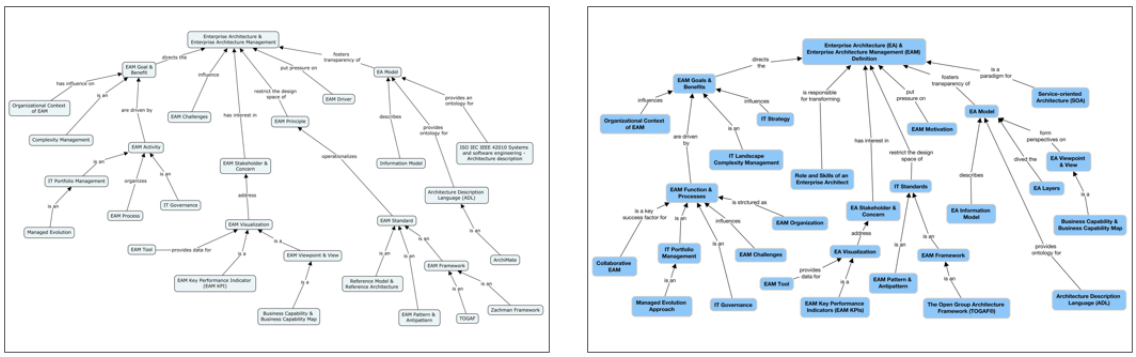

Figure 5.8: The first (left) and second (right) version of the concept map.

To show the evolution of the concept maps resulting from applying this approach, the first and the second version are exemplified in Figure 5.8. The final concept map is provided in Figure 5.9.

[32]The concept map is created using the CmapTools software developed at the Institute for Human and Machine Cognition. See `http://cmap.ihmc.us/`.

This concept map is published on the website integrated with an image map, allowing it to be exploited as a navigation tool. Even though this version of the concept map is now available on the website, it is important to recognize that a concept map is never finished [NC06]. Based on the input of community members and the integration of dynamically emerging topics, the concept map has to evolve along with the community. Therefore, concept maps are not only powerful tools for representing and communicating knowledge, but also to create new knowledge [NC06].

The usefulness of the concept map as a navigation tool for the eam-initiative.org is evaluated in chapter 6.

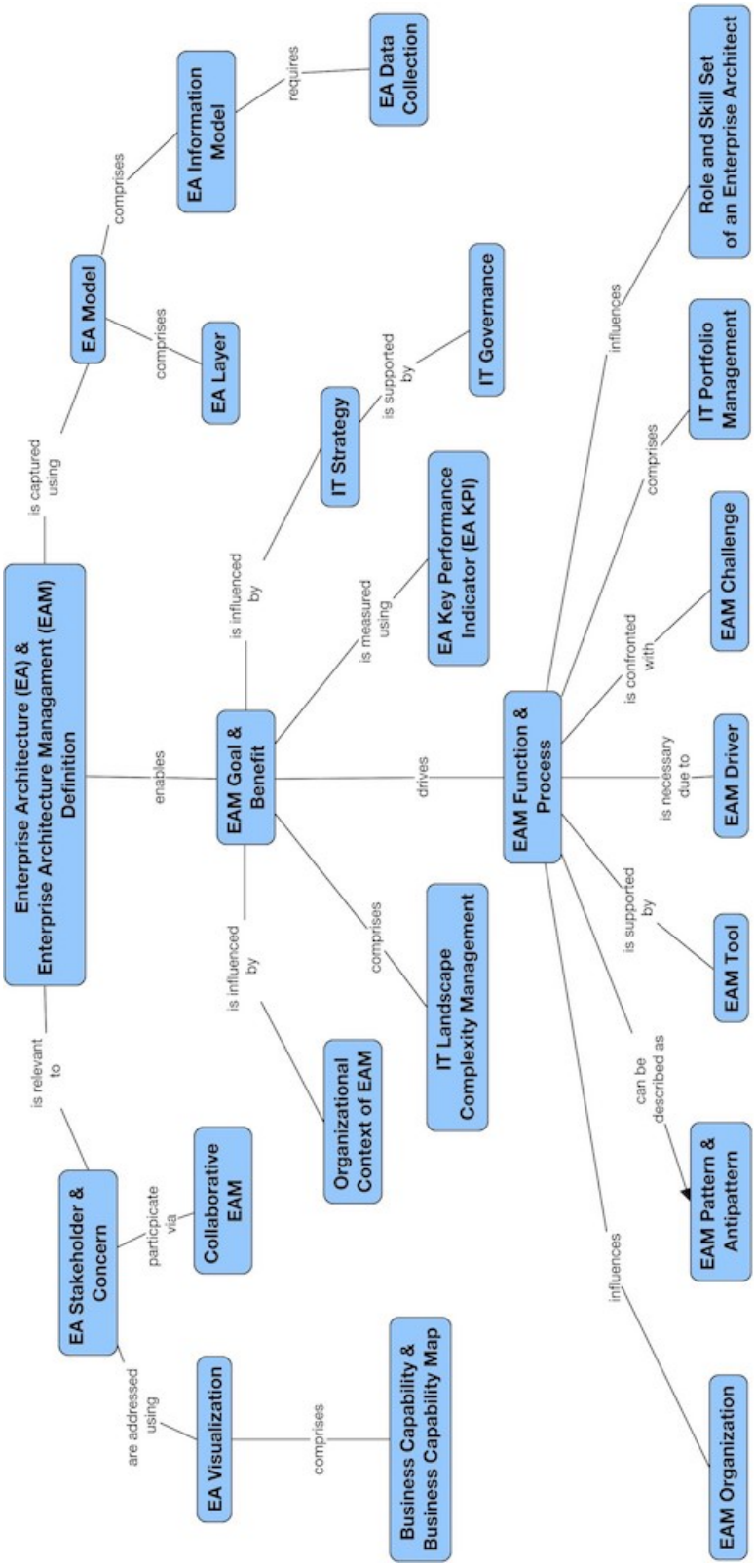

Figure 5.9: Final version of the concept map.

Chapter 6

Evaluation

To evaluate the outcomes of the measures introduced in chapter 5, a survey is conducted as described in section 6.1. Additionally, in section 6.2, the community activity of the eam-initiative.org is analyzed using KPIs for community traffic. Concluding, feedback received in the form of emails to the website team are analyzed in section 6.3.

6.1 User Survey

To measure the reaction of users with regards to the idea of the eam-initiative.org, the structure of the website and the concept map introduced in chapter 5, an online survey is conducted. This survey is composed of two cohorts as illustrated in Figure 6.1. First, in the course of an email campaign performed on the 12/07/2016, 99 persons are asked to fill in a short survey comprising three sections. In the first section, the participants are asked to rate the general idea and structure of the eam-initiative.org. In the second part, their opinion regarding the concept map is prompted. Finally, in the third and last section, some information about the respondents background is inquired. The complete survey can be viewed in Appendix E. The survey was closed at 11:59 pm on the 6. January 2017 with five participants having filled in all mandatory questions.

Additionally, the initiators[33] of the eam-initiative.org receive an invitation to fill in an extended online survey on the 8. 12/08/2016. This second survey is identical with the survey sent to the regular users except that an additional section is included, which is questioning the initiators about the EAM topics they perceive as being foundational to the field of EAM. Due to their expertise in the field of EAM, which is a prerequisite to provide well-founded answers in the additional section, the extended survey is exclusively sent to the initiators of the eam-initiative.org.

[33]Only seven out of the eight initiators were asked to fill in the survey, since Prof. Matthes was involved in its creation and is therefore excluded.

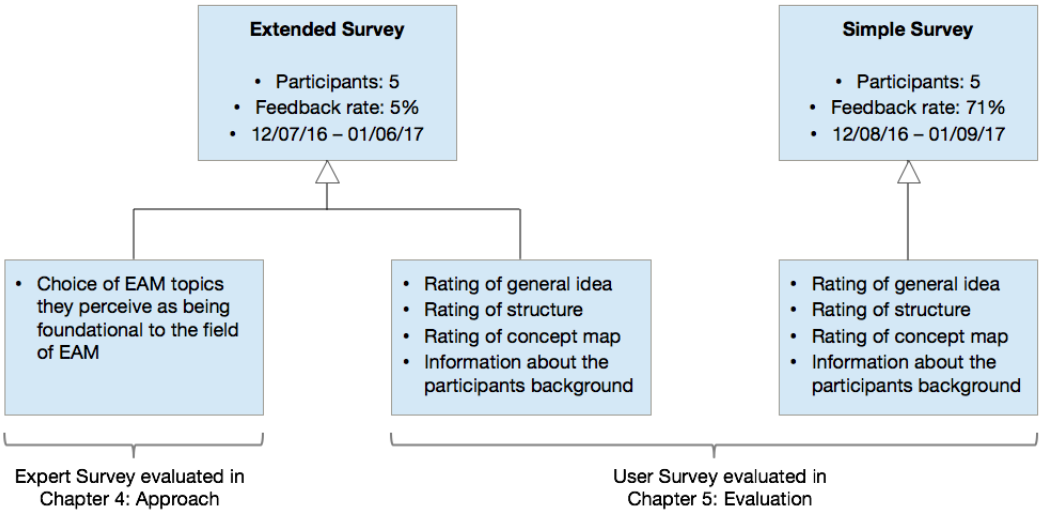

Figure 6.1: Composition of the analyzed data.

The survey is open until the 01/06/2017 at 11:59 pm, at which time four initiators have submitted their feedback. The complete survey is attached in Appendix F.

Since, the results in the additional section of the extended survey concerning the EAM topics are already analyzed in chapter 5 and rather provide input for the creation of the website instead of evaluating it, these results are omitted in this chapter. Instead, the parts of the two survey groups which are identical are combined into a user survey and analyzed.

6.1.1 Descriptive Statistics

This section provides a consolidated overview about the nine participants of the user survey and the companies they currently work for. The analysis of the roles the respondents take within their organization reveals that one head of department business, one project manager, one EAM consultant and interims IT manager, one CIO, one CEO as well as one chief architect completed the survey. Thus, 66% of the participants have a practice-related background, which is an advantage since the target group of the eam-initiative.org is defined as being practice-oriented. In addition, a professor and two survey respondents, who did not provide a role description, participated.

As depicted in Figure 6.2, the amount of experience the participants have in the field of EAM varies a lot. On the one hand, 44% of all respondents have less than one year of EAM experience, while on the other hand 22% have acquired professional knowledge over a time span of more than 20 years. This variation is beneficial to the validity of this survey, since the eam-initiative.org

wants to enable an easy access to EAM for unexperienced users as well as to provide a possibility for experienced EAM professionals to dive deeper into certain topics.

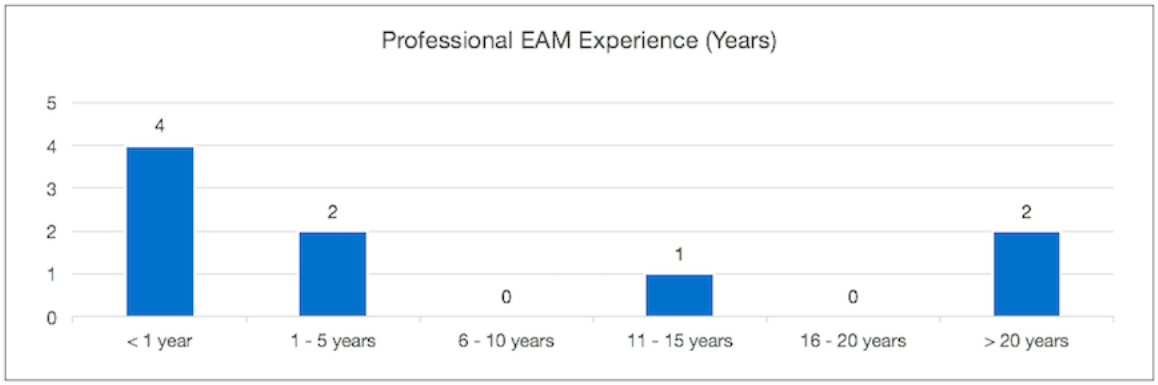

Figure 6.2: Experience of survey participants.

The industries in which the participants of the survey are employed are illustrated in Figure 6.3. The majority is evenly distributed across the technology and the education industry representing 33% of the participants each. Furthermore, professionals with a background in the manufacturing as well as in the finance industry took part in the survey. Finally, one participant chose other industries, explaining that he is concerned with many industries but especially with health and care. Again, the multitude of differing answers is of advantage, since this allows to gain input from professionals with different views on the topic of EAM.

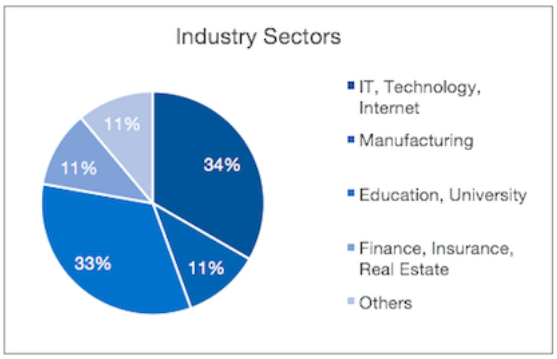

Figure 6.3: Distribution of survey participants across industries.

Analyzing the geographical focus of the respondents organizations depicted in Figure 6.4 shows that all organizations have their headquarters in Germany. While 56% of the organizations operate on an international level, the rest exclusively covers national business. The indication of this analysis result is that mainly a nationally focused perspective is captured by the survey. Since the eam-initiative.org aims at creating an international EAM community, future surveys should try to include more internationally distributed participants.

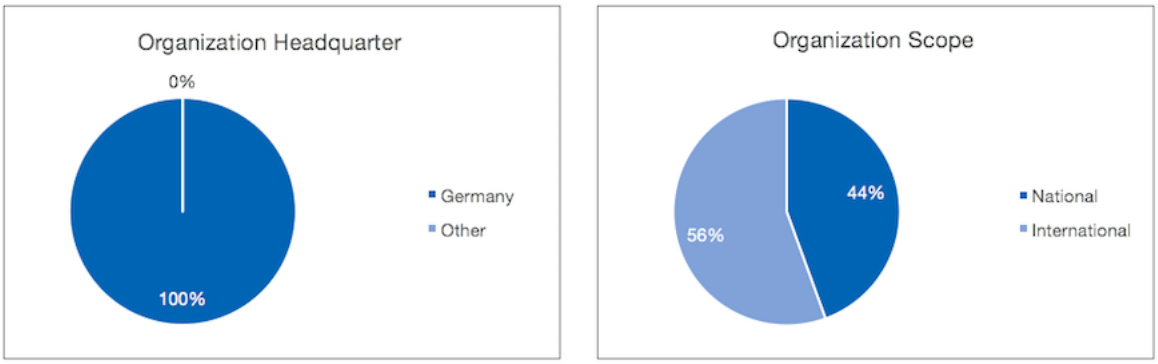

Figure 6.4: Organizational headquarters and geographic scope of organizations.

Lastly, the organizations size is analyzed based on the number of employees and revenue as illustrated in Figure 6.5. The analysis shows that a the biggest share comprising 45% of all organizations only occupies up to 50 employees, pointing at a over representation of smaller organizations. Additionally, 45% of all organizations are non-profit oriented which indicates a high participation of academic organizations. This contradicts the basic idea of the eam-initiative.org of being practice-driven. Therefore, in future surveys especially bigger companies and non-academic organizations should be targeted.

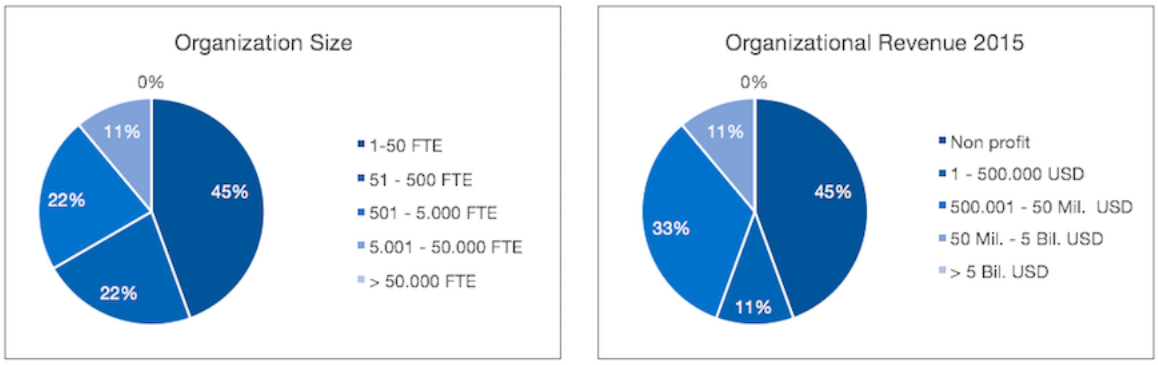

Figure 6.5: Organization size and revenue.

Summarizing, the survey represents the opinion of a majority of practice-oriented participants with different levels of EAM experience, which adds to the validity of the survey. Nevertheless, the significance of the survey is inhibited with regards to the geographic distribution of participants as well as the size of enterprises, since mainly small and nationally operating enterprises are represented.

6.1.2 User Survey Results

To measure the participants perception of the general idea of the eam-initiative.org, the structure of the website, and the usefulness of the concept map, ten five-point[34] Likert items each representing a hypothesis are used. An overview of the results is provided in the form of a staggered bar graph in Figure 6.6.

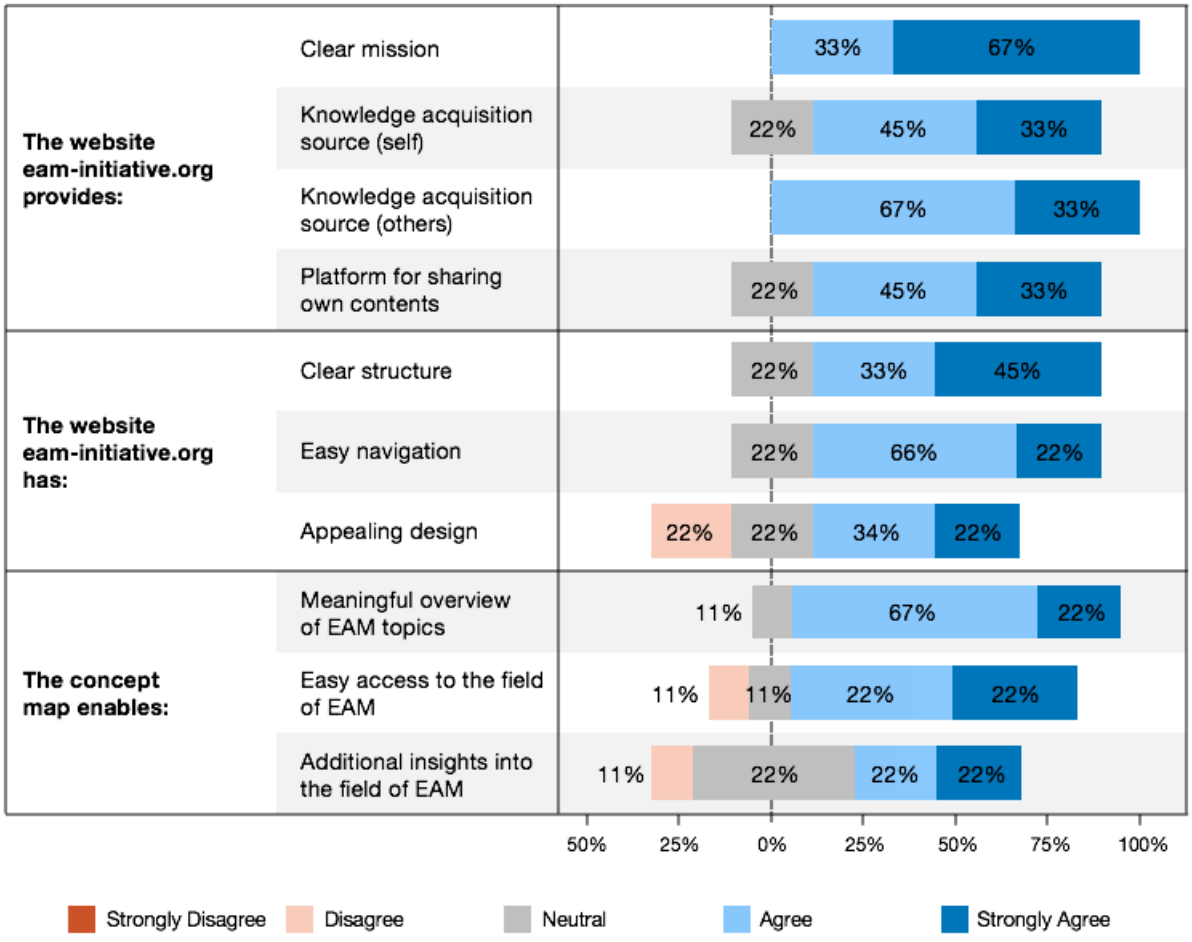

Figure 6.6: Overview of the user survey results.

Since Likert item data is ordinal data, meaning that the distance between the points is not necessarily the same [Boo12], they are evaluated using the minimum (Min), first quartile (Q1), median (Q2), third quartile (Q3) and the maximum (Max). In the following, if the first quartile reaches a value of four or higher, this is interpreted as positive feedback, since it indicates that more than 75% of the participants agree or strongly agree with the respective hypothesis.

The survey also includes open questions for each of the sections mentioned below, but since no responses were provided via these fields, they will not be discussed any further.

[34]The scale of each Likert item comprised the following items: *Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree.*

Table 6.1: Survey results concerning the general idea of the website eam-initiative.org.

The website eam-initiative.org provides:	Min	Q1	Q2	Q3	Max
Clear mission	4	5	5	5	5
Knowledge acquisition source (self)	3	4	4	5	5
Knowledge acquisition source (others)	4	4	4	5	5
Platform for sharing own content	3	4	4	5	5

User survey results concerning the basic concept of the eam-initiative.org

First, the results regarding the participants perception of the general idea of the eam-initiative.org is evaluated as depicted in Table 6.1. This set of Likert items starts with the question if the mission of the eam-initiative.org is understood by the respondents. Looking at the metrics, the minimum is four indicating that the worst feedback provided for this item is *"Agree"*. Further, the first quartile has a value of 5, expressing that at least 75% of all participants provided the rating *"Strongly Agree"*. Therefore, it is safe to say that the feedback regarding this question is very positive.

When asked if the participants would use the eam-initiative.org to acquire new knowledge, the minimum value is three, meaning that the worst feedback provided is *"Neutral"*. Nevertheless, the first quartile has a value of four, which classifies the feedback as positive.

Interestingly, when asked if they would recommend the eam-initiative.org website to other people for acquiring knowledge, the feedback of the participants is overwhelmingly positive again with the worst rating being *"Agree"*. Therefore, also the first quartile has a value of four.

The last question of this section is concerned with the willingness of the respondents to share their own contents on the website. The results are identical with the results of the penultimate item with the first quartile being four. Again, this can be classified as a positive feedback.

User survey results concerning the website structure

In this section, the results of the survey regarding the structure of the website is evaluated based on the metrics provided in Table 6.2. The first Likert item is concerned with the clearness of the structure of the website. For this item, a first quartile value of four is reached, which indicates that the participants agree that the website is clearly structured.

The second statement aims at uncovering the respondents opinion with regards to the ease of navigation of the website. The examination of this Likert item shows, that the first quartile has a value of four again, meaning that 75% of the respondents agree or strongly agree with the given hypothesis.

Table 6.2: Survey results concerning the structure of the website eam-initiative.org.

The website eam-initiative.org has:	Min	Q1	Q2	Q3	Max
Clear structure	3	4	4	5	5
Easy navigation	3	4	4	4	5
Appealing design	2	3	4	5	5

Table 6.3: Survey results concerning concept map of the website eam-initiative.org.

The concept map enables:	Min	Q1	Q2	Q3	Max
Meaningful overview of EAM topics	3	4	4	4	5
Easy access to the field of EAM	2	4	4	5	5
Additional insights into the field of EAM	2	3	3	4	5

In the last statement of this section, the participants are asked if they think the website is designed in an appealing way. Here the first quartile only reaches a value of three, implying that the website design could be improved.

User survey results concerning the concept map

In this last section of the survey analysis, the results concerning the concept map[35] used for navigating the eam-initiative.org are presented. The first item of this section examines if the respondents think that the concept map provides a meaningful overview of the identified EAM topics. The first quartile value of four can be interpreted as a very positive feedback.

The second statement covers the question if the concept map provides easy access to the field of EAM. Here, the first quartile value of four shows that most participants agree with this statement.

Lastly, the participants are confronted with a statement asking if the concept map enables additional insights into the topic of EAM. The analysis results of this item are less positive with a first quartile value and a median of three. This implies that less than half of the participants rated the item positively, meaning that possibilities for improvement should be investigated.

6.1.3 Summary of User Survey

Summarizing, the results of the user survey suggest that the mission of the eam-initiative.org is clearly understandable. Also, the participants confirm, that they would use the website for

[35] Please note that during the time of the survey the second version of the concept map as indicated in section 5.4 was available on the website eam-initiative.org.

knowledge acquisition themselves and recommend it to others with the intention of obtaining EAM knowledge. Moreover, the willingness of survey respondents to contribute content is high. Therefore, it can be stated that the general idea of the eam-initiative.org is understood and accepted. Also, the website structure and navigation appeal to the respondents. However, a need for improving the design of the website is identified. Finally, the concept map can be interpreted as providing a meaningful overview of EAM topics, which provides easy access to the topic. This result is very good, since it confirms that the concept map can be used as a navigation tool on the website.

Nevertheless, Likert items and Likert scales are subject to the central tendency bias and the acquaintance bias [JDW84]. The central tendency bias represents the avoidance of using extreme response categories [SC98], while the acquaintance bias expresses the tendency to agree with statements as they are presented [KM85]. To account for that fact, additionally objective measures will be analyzed in the next section.

6.2 Community Activity Metrics

The prerequisite for a successful virtual knowledge sharing community is sufficient community activity, which predicts community loyalty [KK04]. Community activity is characterized by the amount and quality of knowledge posting and viewing activities [KK04]. Therefore, community activity can be directly measured using KPIs such as sessions or number of repeat visitors and activities on a website [Han96]. Such simple measures are recognized to be accurate indicators for the health of a virtual community [KK04].

6.2.1 Metrics for Knowledge Posting

To measure the amount of knowledge postings, the changes or creation of wiki articles, new contributions, comments and new registrations on the website eam-initiative.org are analyzed. The analysis is conducted for the second half of 2016[36], and the information is taken directly form the website log. Within the time frame of the analysis, neither changes or the creation of wiki articles nor new contributions or comments were made by users other than the initiators and the team of the website. Nevertheless, a total of 40 new registrations was recorded over the time span of six month, increasing the total number of registered users from 34 to 74. If the initiators and the team of the eam-initiative.org are excluded from the number of total users, the amount of unaffiliated users almost quadruples from 18 to 58. This development is graphically represented

[36]The analysis time frame covers calendar week 29 to calendar week 52 in 2016.

in Figure 6.7. Please note that the sharp increase in registered users in calendar week 43 is caused by a promotional email campaign, which took place on the 10/21/2016. In the course of this campaign, 828 persons were contacted and made aware of the eam-initiative.org. Another email campaign was launched on the 7. December 2016, when additional 99 persons were reached out to.

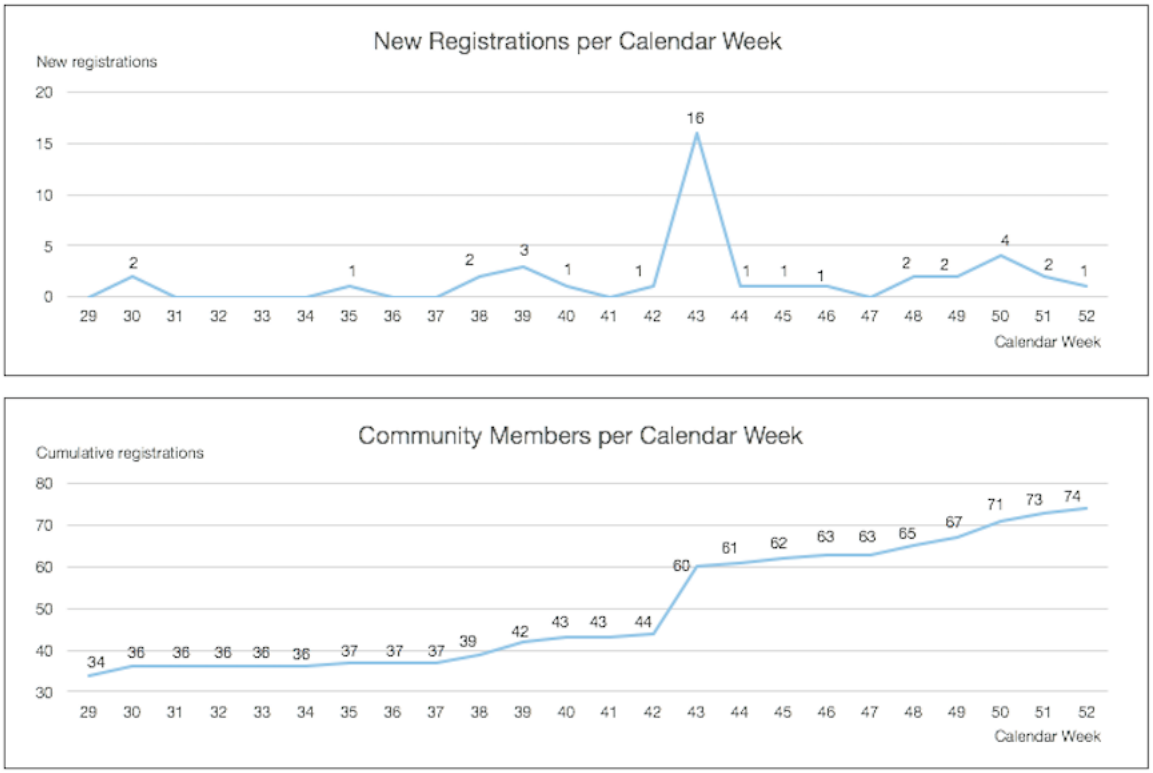

Figure 6.7: The upper graphic represents new user registrations for each calender week. The lower graphic plots the cumulative amount of all registered users.

6.2.2 Metrics for Viewing Activities

Since users don't need to register on eam-initiative.org to view wiki articles and download files, additionally metrics capturing viewing activities of users are analyzed. These metrics are obtained via Google Analytics[37] for the time slot between calendar week 29 to calender week 52 in 2016. Specifically, the number of session per week as well as the amount of visitors are considered. Please note that even though filters for traffic created by the website team as well as for ghost spam and crawler spam have been implemented, not all kind of internal traffic or spam can be filtered at any time [Mar]. This results in the data provided by Google Analytics being good approximations of the real traffic, but never being perfectly correct [Mar].

[37]For more information see urlhttps://www.google.de/intl/de/analytics/.

A session is defined as being a group of interactions of a user with a website within a given time frame [Ana]. Such interactions cover multiple page views, downloads of files, and more [Ana]. Therefore, the amount of sessions indicates how many people visit the website independently of how long they stay, or if they have visited the website before [Ana]. For the eam-initiative.org, the development of sessions is depicted in Figure 6.8. The graphic shows a steadily increasing amount of sessions, which is also reflected by the upwards sloping trend line. This suggests that the website is gaining in popularity. As already mentioned above, strong fluctuations during calendar week 43 and 49 are caused by promotional activities of the eam-initiative.org team.

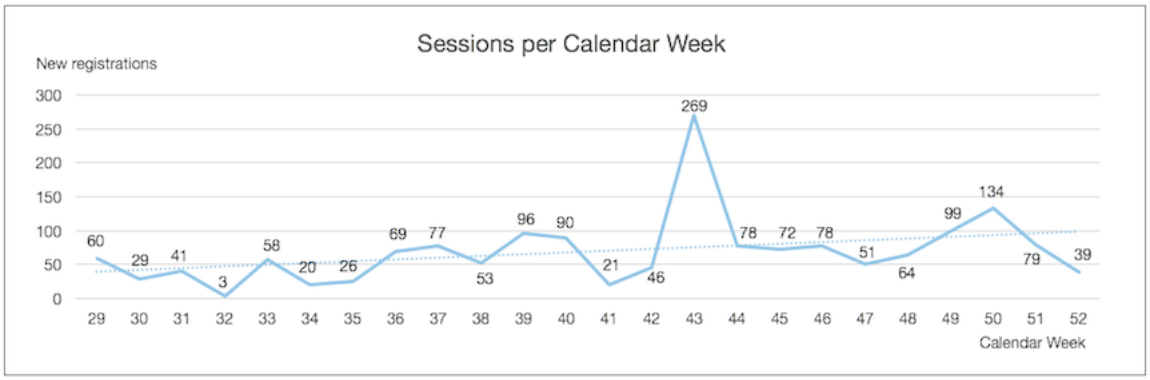

Figure 6.8: The graphic represents the amount of sessions on the website eam-initiative.org between the 29th and 52nd calendar week in 2016.

The second metric analyzed is the amount of visitors of a website split into new and returning visitors. A visitor is defined as being a unique fingerprint produced by a software hardware combination [Aca] and a returning visitor is identified based on a User ID or browser cookies [Dat]. Of course, an increasing number of visitors is desirable, since more new visitors indicate that a website is popular and new visitors can be converted into returning visitors [Spa]. A high number of returning visitors suggests that the website provides enough utility to the visitors for them to return [Lam+10]. As shown by the trend lines in Figure 6.9, the number of new visitors as well as the amount of returning visitors increased during the time of analysis, suggesting that new visitors are attracted and that they are transformed into returning visitors. Again, deviations in calendar week 43 and 49 can be attributed to the promotional campaigns which took place during that time.

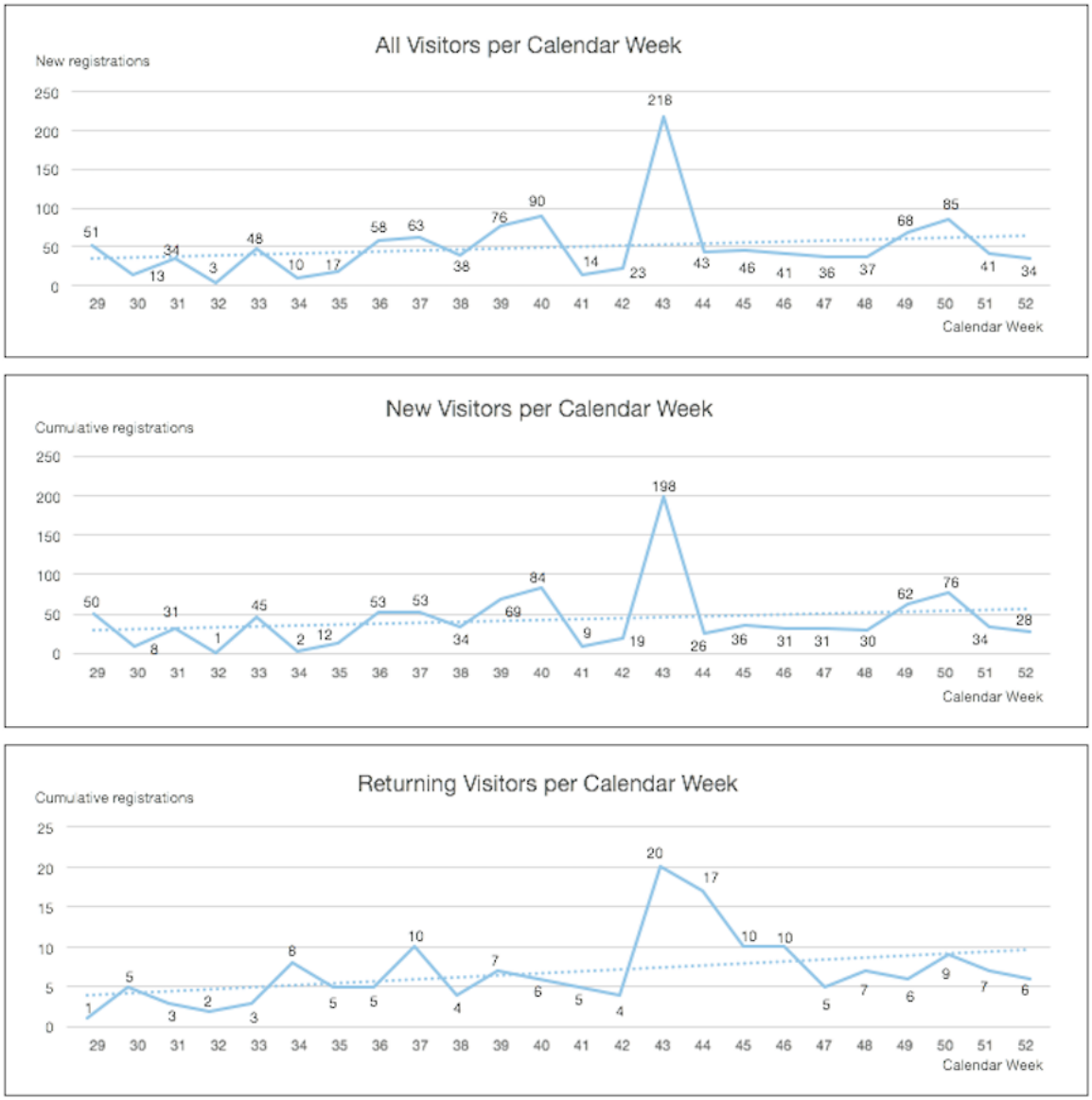

Figure 6.9: The three graphs plot the development of visitor numbers of the website eam-initiative.org. The upper graphic depicts all visitors, the middle graphic the represents the new visitors and the lower graphic plots the returning visitors.

6.2.3 Summary of Community Activity Metrics

When analyzing the development of the number of session per week and the amount of visitors on the website of the eam-initiative.org, an upwards trend can be observed. This proves that viewing activities are increasing and therefore that the community is gaining in popularity. Further, these results correspond with the increase of registered users on the website. Nevertheless, at the same time active participation other than user registration is missing. This is a deficit, which needs to be investigated upon.

6.3 Email Feedback

Even though no additional information was provided via the open questions on the basic concept, the structure and the concept map of the eam-initiative.org in the course of the user survey, three emails containing such feedback were sent to the website team.

6.3.1 Received Email Feedback

The major statements provided in the feedback emails can be summarized as follows:

- **Overall picture:** Generally, the implementation of the website received positive feedback by three feedback providers.
- **Topics:** While on the one hand the topic structure is considered as fitting by two feedback providers, one respondent claimed that the topics are to fine-grained.
- **Website navigation:** One feedback provider claims that a tree-like structure like the concept map is not fitting for the representation of the field of EAM. Instead a network structure would be preferable. Another respondent mentioned that integrating some basic topics in the navigation bar could make the navigation easier.
- **Website Content:** According to one respondent, the website should address the current issues and the self-image of EAM. Additionally, another feedback provider said that the expectation of clients should be the focus of the website.
- **Community involvement:** One major request of the feedback providers is that the community needs to be involved more. This comprises the interaction of user with the website (e.g. comments, evaluations of content) as well as the gathering of further feedback.
- **Website Design:** Again, the design of the website received negative feedback.
- **Initiator visibility:** The people behind the website should be highlighted.
- **Promotion:** More advertisement should be done to raise the awareness of the EAM community regarding the eam-initiative.org.

6.3.2 Summary of Email Feedback

Summarizing, while the general approach to of the website received positive feedback, especially the community involvement, the website design and the integration of current topics can be improved. Solutions on how to approach these issues will be presented in section 7.4.

Chapter 7

Conclusion & Outlook

7.1 Summary

The objective of this thesis is to create the initial utility for the eam-initiative.org and therefore to enable the success of the knowledge community. In order to do so, first the underlying theory on EAM, wikis and concept maps are discussed. In the next step, existing online communities concerning EAM are evaluated and implications for the success of such communities are derived. Afterwards, the eam-initiative.org, a knowledge community based on a wiki-approach, is described. Subsequently, three fields of action are outlined, which enable the creating of the initial utility of the eam-initiative.org. One field of action comprised the set up of an underlying website structure enabling the emergence of a wiki-based community. Additionally, 23 foundational EAM topics are identified based on literature review and expert feedback. For each of these foundational topics, wiki articles are authored and published on the website. Lastly, a concept map organizing the foundational topics is created and made available on eam-initiative.org. The idea of this concept map is to provide a tool for easy navigation through the wiki articles.

After having provided this first content of the eam-initiative.org, the website is evaluated using a user survey as well as community activity metrics gained via the website log and Google Analytics[38] and feedback provided via email. All three evaluations provide positive results indicating that the research objectives are fulfilled.

7.2 Results

Coming back to the research questions formulated in section 1.3, they can be answered as follows:

[38]See `https://www.google.com/analytics/`.

RQ 1: Is the general idea of the eam-initiative.org accepted by the EAM community?

As shown in the evaluation of the user survey in section 6.1, the general idea of the eam-initiative.org is understood and accepted by the respondents of the survey. This is further confirmed by positive trends in the development of viewing activities, which were extracted using community activity metrics.

RQ 2: What is a suitable structure for the website eam-initiative.org?

The website structure is implemented according to the information model presented in section 5.2 which is developed in a top-down approach. Afterwards, the structure is evaluated based on the user survey presented in section 6.1. The results of the evaluation demonstrate that the structure appeals to the respondents.

RQ 3: What are foundational EAM topics?

To generate an initial set of wiki articles, first topics need to be defined that the articles should cover. To provide the maximum amount of utility to the users with a limited set of initial wiki articles, it is decided that a set of foundational topics is identified using literature research and expert feedback. Foundational in this context means, that the set of topics covers the subject areas which are considered to be basic knowledge needed to access the field of EAM. The complete list of 23 defined foundational topics can be looked up together with their wiki articles in Appendix C.

RQ 4: Does a concept map provide a useful tool for easy navigating through the topics?

To answer this research question, first literature research is conducted to determine relevant characteristics of concept maps. Based on the outcome of this literature research and the foundational topics identified in this thesis, a concept map is created. This concept map is made available on the home page of the eam-initiative.org providing an overview of the EAM topics. Further, it is enriched by an image map, turning it into a navigation tool. The results of the user survey show that the participants agree on the concept map providing easy access to the topic and a good navigation tool for the website.

Summarizing, all research questions are positively answered and the overall goal of providing the initial utility to enable the success of the eam-initiative.org community is achieved.

7.3 Limitations

Two major limitations of the results of this thesis can be identified. These are concerned with the validity of the set of identified foundational EAM topics as well as with the validity of the user survey.

The validity of the set of identified foundational EAM topics is restricted due to the fact that it is defined based on a limited amount of literature. As explained in subsection 5.3.2, in the second iteration of the used approach the foundational EAM papers as well as the sebis publications were searched using only the term *"Enterprise Architecture Management"* which excludes search hits that would have occurred using search terms like *"Enterprise Architecture"* or *"EAM"*. Additionally, due to the inclusion of the files published on the eam-initiative.org website, the sebis publications and the books authored by the initiators of the eam-initiative.org, the choice of topics is biased towards the respective language community. Finally, also the manual extraction of keywords or topics is never completely objective. Nevertheless, the major goal of the thesis is to provide an initial set of wiki articles, that provide utility to the users and form a basis for refinement by EAM community members. Therefore, the identification of a perfectly objective set of foundational topics based on manual topic extraction is not just impossible [Zha08], but also not the claim of this thesis.

As presented in subsection 6.1.1, the survey conducted in the course of this thesis covers the opinion of a limited amount of participants, with a majority of respondents being employed at small and nationally operating enterprises. Further, in addition to the conceptually induced central tendency and acquaintance bias, the initiators of the eam-initiative.org were included into the group of participants, leading to a potential upwards shift of the results. Therefore, in the future, more surveys need to be conducted, including a higher number of neutral and geographically distributed participants from enterprises of different size.

7.4 Future Work

Now that the website is set up and the initial content is created, community building should be fostered for the eam-initiative.org knowledge community. Many of the tasks that are related to this goal are ongoing and not just executed once. In detail, these measure comprise:

- **Improvement of website design:** As already indicated by the results of the user survey, the design of the website needs to be improved. For this purpose e.g. a student assistant with website design experience could be employed.

- **Initiator Meetings:** Regular initiator meetings should be organized to discuss feedback regarding the concept of the eam-initiative.org.

- **One-on-one promotion:** The community needs to be directly promoted to potential members [WC00]. Approaches to such promotions are email or phone campaigns as well as presentations at expert gatherings [WC00]. This means, the initiators have to identify and directly approach prospective members, inviting them to join the community and to provide content. Additionally, presentations promoting the eam-initiative.org can be held and flyers can be issued at at conferences or similar occasions.

- **Member feedback:** It is important to regularly seek feedback from the community members, since the needs of the members and the members themselves change over time [WC00]. Feedback can include direct measures like asking users to rate the website or to provide suggestions for improvement [WC00]. Additionally, indirect measures derived from community activity metrics can be used [WC00]. Community activity metrics can be easily checked on a regular basis using automatically created weekly monitoring reports, while conducting surveys or interviews is a lot more laborious and should only be performed for certain milestones. The gained feedback is used to drive changes to the communities look, feel and functionality and needs to be acted upon in a timely manner, since otherwise users will stop providing feedback [WC00].

- **Newsletter:** Regular email newsletters keep the members up to date on the most important developments in the community [WC00]. This way, the attention of members who haven't visited the website in a while is drawn to new contents [WC00]. On the other hand, it is important not to spam the members with too much emails, since this could lead to them unsubscribing from the newsletter. Here, the community provider needs to choose one of the following two approaches: either community newsletters are sent at regular intervals, e.g. quarterly, or they are triggered by special events, e.g. new features.

- **Technology performance:** An important prerequisite for an online community to be successful is to ensure that the underlying technology functions properly [WC00]. This includes the availability of all important features as well as the adequate performance of the website (e.g. page loading times) [WC00]. Therefore, the functionality and performance of the website will be monitored in regular intervals, e.g. once a week, using a check list like the one provided in Figure 7.1.

- **Creation of trust:** An important success factor for an online community is the establishment of trust between the members and the community provider. A lack of trust, e.g. caused by the fear of misuses of posted information, inhibits the free dissemination of knowledge and therefore the success of a community [APW03]. Measures to ensure trust should be investigated upon in future research.
- **Identification of community hubs:** Once the community is growing and community members are regularly engaging with the website, it makes sense to identify individuals who play leading roles in the community. These individuals can be approached for feedback or cooperation on community building if community organizers know how to cultivate such community leaders. [WC00]

Checklist

- Functionality and Performance of the eam-initiative.org -

Date:

Conducted by:

Features	Checked
Concept map links are functioning	
Newsletter subscription is functioning	
Smart Upload button is functioning	
Topic Cloud is functioning	
RSS Feed is functioning	
Newly created topics are compliant	
Newly uploaded files are compliant	
Newly created links are compliant	
Newly created comments are compliant	
Deletion of content is compliant	
Page loading times ok	

Figure 7.1: Exemplified Checklist for monitoring the functionality and performance of the eam-initiative.org.

Appendices

Appendix A

Literature First Iteration

A.1 Examined Literature 1

Literature examined in the first iteration in section 5.3.

A.1.1 eam-initiative.org Files[39]

- Keller, W. (2012). TOGAF 9.1: Quick Start Guide for IT Enterprise Architects. Wolfgang W. Keller, Berlin.
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Appendix B

Literature Second Iteration

B.1 Examined Literature 2

Literature examined in the second iteration in section 5.3.

B.1.1 Foundational EAM papers[40]

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Appendix C

Foundational Wiki Articles

The wiki articles covering topics identified as being foundational to the field of EAM are listed in the following.

C.1 Business Capabilities & Business Capability Maps

A business capability is a functional building block of the business architecture that supports the business model and the business strategy. It defines the organization's capacity to successfully perform an unique business activity. Based on business capabilities, business capability maps can be created, which enable the assessment of capabilities and support the identification and communication of EA demands [Man12].

Business Capability & Business Capability Maps Foundations

A business capability is an abstraction of a business function, answering the question what a company needs to be able to do to be successful [Man12; Fuh11c]. Each business capability is independent from other business capabilities [Ale+15] and realized by combining different elements of the EA which are related via their functionality [Man12]. In more specific terms, business processes, human resources as well as IT applications and technical resources are combined to fulfill one functionality as illustrated in Figure C.1 [Man10]. The combination of these elements is independent of organizational silos like product, channel or client categories [Fuh11c].

After the business capabilities of an enterprise are defined, they can be organized into a business capability map. An example of a business capability map is illustrated in Figure C.2. Based on such a map, enterprises can identify those business capabilities, which are essential for their success and therefore should be optimally supported, and those which are commodities. But not

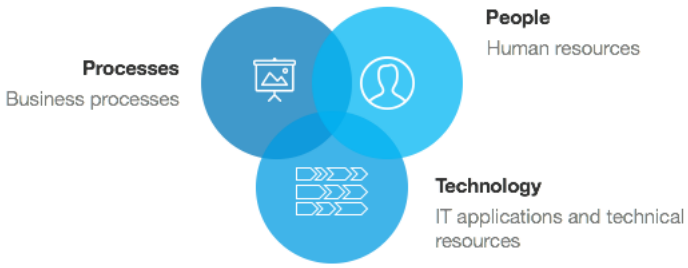


Figure C.1: Elements of a business capability [Man10].

only existing business capabilities can be analyzed, also new business capabilities required to support the business strategy can be revealed [Man12].

In a next step, business capabilities are related with the applications supporting them. While doing so, several applications can be mapped to a certain business capability [Man10] and an application can be used to support several business capabilities [Man10; Fuh11c]. This procedure creates a visualization of the links between enterprise architecture and IT architecture [Fuh11c].

Advantages of using Business Capabilities & Business Capability Maps

The business capability map can be used as a basis for analyzing, how the IT landscape can be transformed to optimally support the business [Fuh11c]. This means transparency is created with regards to which business capabilities are badly supported by available applications. If such a deficit is recognized for an important business capability, measures can be taken.

Additionally, business capability maps provide a common communication basis to illustrate transformation needs to the business since IT can structure and formulate its requirements in a functional, not a technical way [Fuh11c; Fuh13b]. Further advantages of the usage of business capability maps are a better alignment between business and IT as well as an uncovering of redundant planned investments into equal functionalities [Fuh11d].

Concluding, business capability maps can support a more efficient and effective IT Portfolio Management.

C.2 Collaborative EAM

Collaborative EAM fosters and moderates participation of different stakeholders in the EAM process using lean, agile and Enterprise 2.0 approaches [BBL12].

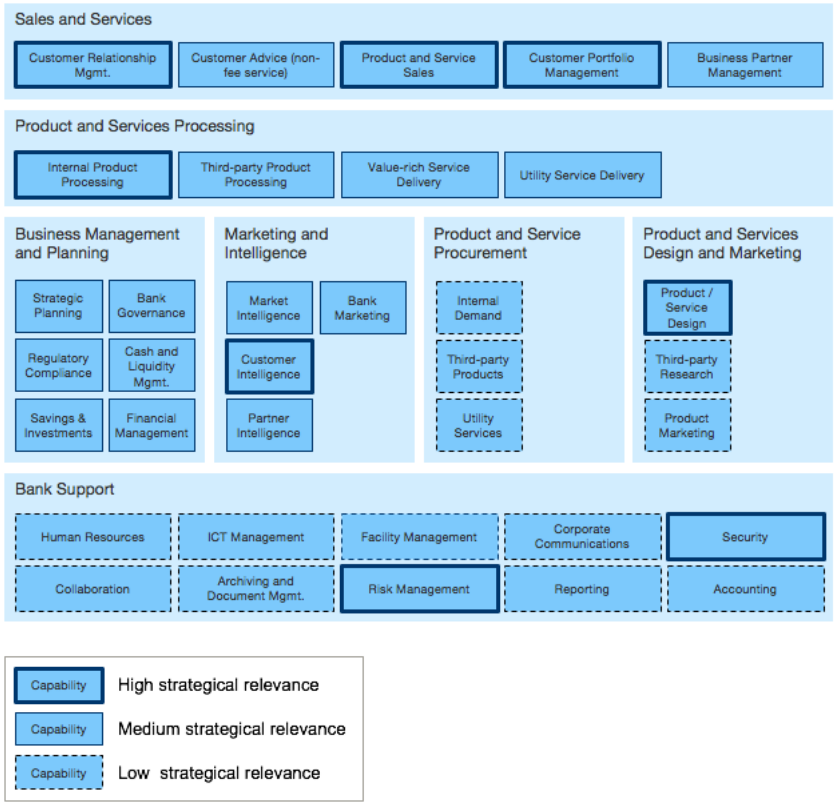


Figure C.2: An example of a Business Capability Map including an assessment of strategic relevance of capabilities.

Collaborative EAM Foundations

One key success factor for EAM initiatives is the collaboration of EA stakeholders [BBL12], since they have to provide their knowledge and participated in the transformation of the EA [RHM13]. According to [BBL12], collaborative EAM is based on three guidelines:

- *"Establish a lean set of processes and rules instead of overloading the stakeholders with bureaucratic processes and unsolicited artifacts."*. This first guideline aims at fostering a lean EAM practice [BBL12].
- *"Adopt evolutionary problem solving instead of blueprinting the whole future rigidly on a drawing board"*. This second guideline aims at applying agile software development approaches to EAM [BBL12].
- *"Foster and moderate open participation instead of relying on experts and top-down wisdom"*. This third guideline aims at promoting the use of Enterprise 2.0 technologies [BBL12].

Lean Approach

The goal of applying a lean approach to EAM is to establish a demand-driven EAM process. This means, a lightweight approach is chosen by eliminating heavy bureaucratic governance concept, over-processing and other types of waste [BBL12].

Agile Approach

In software development, agile principles like Scrum and Extreme Programming are increasingly adopted by organizations [Hau+14a]. The advantages of those approaches are an increased flexibility to react to changes as well as regular communication between parties and clear assignment of responsibilities [BBL12]. Since software development as well as EAM have to handle frequently changing requirements while ensuring a close collaboration among the stakeholders, these principles should also be applicable to both [Hau+14a].

A method to enable agile EAM processes is the application of Adaptive Case Management (ACM). In contrast to traditional workflow management, ACM enables the EA stakeholders to adapt their processes at run-time. This way the highly dynamic processes of EA can be easily adapted to changing situations [Hau+14c].

Enterprise 2.0 Tools

The basic idea of Enterprise 2.0 tools is to enable the creation of a living community of knowledge workers using technological advancements. This approach can help avoiding an Ivory Tower Syndrome, meaning a breach between high-level vision and ground-level reality [BBL12].

An example for a Enterprise 2.0 Tool are wikis. Wikis are tools for collecting and consolidating distributed knowledge. The most prominent example of such a wiki is the website Wikipedia [44]. On a smaller scale, also a lot of enterprises have established wikis as tools for collaboration and knowledge exchange, since they are characterized by fast access to information and low maintenance costs [Mat11]. An examples of such wiki software is SocioCortex[45] developed at the Chair for Software Engineering of Business Information Systems at Technische Universität München.

[44] See `https://www.wikipedia.org/`.

[45] See `http://www.sociocortex.com/`

C.3 Enterprise Architecture (EA) & Enterprise Architecture Management (EAM) Definition

The Enterprise Architecture (EA) is a model of the enterprise's most important elements and their relationships [ARW08]. Enterprise Architecture Management (EAM) is the process of creating and using the EA [Nie08].

EA and EAM Definition

Even though a multitude of publications is available on the topics EA and EAM, there is no one single definition of these terms which represents the consensus of the overall research and expert group [ARW08; Sch09; BBL12; BMS10b].

A very broad definition of the term EA was given by Aier, Rieger and Winter (2008), stating that it is a model representing the elements of an enterprise with regards to its strategy, its organization as well as its IT landscape including applications and infrastructure [ARW08]. The model aims at depicting the most important elements and their relationships to each other. Based on this model, the current state of the enterprise can be analyzed and documented. Additionally, possible future states can be explored and plans for transforming the enterprise into a desirable future state can be derived.

A further frequently cited definition of EA is provided in ISO/IEC/IEEE 42010:2011, e.g. cited in [Buc+10d; BMS10b; WS08; 11b; Buc+09c; BBL12]. According to the standard, a system architecture constitutes the *"fundamental concepts or properties of a system in its environment embodied in its elements, relationships, and in the principles of its design and evolution"* [11a]. In the context of EAM, the system comprises the whole enterprise [BBL12]. To give some examples, the elements of an EA are e.g. *organizational units, stakeholders, locations, business processes* while the relationships between them can be e.g. *supports, hosts, is responsible for* [Buc+09c]. The principles which guide the evolution of an EA could be e.g. *profit, continuity, innovation* [Buc+09c].

Summarizing, EA aims at providing a picture of the holistic structure of an organization, including all its business, organization, application, information, infrastructure and data aspects [MRM13; Mat+12]. The use of this picture is to enable the understanding of the elements of an EA, which contribute to its utility, cost, time and risk within its environment [11a]. Based on this understanding the EA is transformed towards a target state [Man12; Myk+11].

Even though EA and EAM are sometimes used as synonyms [BBL12; BMS09b; BMS10b], a distinction will be made in this article. Generally, EAM can be viewed as the structured approach

of creating, managing and utilizing the models provided by EA [BBL12; Nie08]. This means, EAM is the process of capturing and transforming an EA [Nie08].

An EAM function can be organized in many different ways. This comprises what roles and processes are implemented as well as where the EAM team is placed within the organization.

Further topics related to EA & EAM

To further dive into the topic of EA & EAM, the following topics are recommended:

- EA models capture the EA with the purpose of making it transparent and thus enabling informed decision making and effective EA development. More information on EA models can be found in section C.8.
- A high quality EA provides a lot of functions and benefits to IT leaders [Han12a]. Most of all, it enables a good alignment between business and IT. This is based on the fact that EAM constitutes a commonly accepted instrument to support and guide enterprise transformations which are necessary due to frequently changing business needs [BMS10b]. A list of further benefits of EAM is available in section C.13.
- An Enterprise Architect has to have many different skills. These can be EA related skills like IT portfolio management, management related skills like communication skills and leadership as well as operational IT skills which are needed to accompany IT projects [Kel11]. More information on EAM frameworks can be found in section C.23.
- The EAM function can be implemented as an independent department or as part of the organizations' IT or business department [Man12]. More information on EA models can be found in section C.15.
- An EAM function can adhere to one or more architecture frameworks [11a]. An EAM framework comprises a predefined set of methods and tools for developing EAs and EA practice [11b]. More information on EAM frameworks can be found in section D.5.
- The acceptance of the EAM activities by EA stakeholders is a critical factor for the success of an EAM endeavor [RZM14]. EA stakeholders are all the people who have any kind of concern with regards to an organizations EA [11b]. These concerns need to be addressed by models provided trough EAM. A more detailed definition of EA stakeholders and their concerns can be found in section C.9.

C.4 EA Data Collection

To create an EA model, data from different sources needs to be collected and integrated [PTS10]. This is a non-trivial process.

EA Data Collection Foundations

Data necessary as input for the EA model of an organization is spread throughout the enterprise [PTS10]. This data needs to be collected and integrated, which is usually done using an EAM repository [PTS10]. The data to be collected is defined in the EA information model of the organization [Bus+12]. Based on this information, the sources of the data need to be identified [PTS10]. Project management tools, enterprise resource planning systems as well as network monitoring utilities can be such data sources [PTS10]. Manual integration of data into the EAM tool is error prone, expensive, and time consuming, therefore as much as possible of the data collection and integration should be automated [Bus+12].

Moreover, it is not sufficient to collect information on the current status of the EA and use it as a basis for future decision making [Buc+08a]. Instead, the data collection process should be designed in a manner, that ensures the availability of up-to-date data [Buc+08a]. Therefore, appropriate rules enforcing data collection need to be set up [Buc+08a].

Challenges of Data Collection

The documentation of EA information constitutes as major challenge for many organizations [Far+13]. First of all, it is difficult to determine which information is really needed by the EA stakeholders and what quality it needs to have [Bus+12]. Further, the complexity of the EA and its frequent changes make it cumbersome to keep the information basis up-to-date [Far+13]. Even though it is widely agreed that automation of data collection could solve this problem, only few enterprises really have automated data integration processes between information systems and their EAM tool in place [Far+13]. The main reasons for this deficit are the data granularity mismatch between data source and the EA information model, the high implementation cost and the low data quality of source data [Far+13]. Therefore, data collection remains a mainly manual and event-driven process, which is very time consuming and error prone [Far+13].

C.5 EA Information Model

An EA information model is a simplified representation of the elements of an enterprise architecture, their attributes and their relations to each other [RZM14]. A good information model can reduce the complexity of an enterprise architecture and supports informed decision making [11b].

EA Information Model Foundations

In the context of enterprise architecture, an information model provides a conceptual model of the enterprise architecture elements, their attributes and their relations to each other [RZM14; 11a; Buc+09c]. An overview of possible information model elements is provided by the TOGAF Architecture Content Framework [11b]. Figure C.3 illustrates an example of an enterprise architecture information model which was created in accordance with the TOGAF Framework.

Even though many different information models have been introduced by literature and tool vendors [Bus+12], no overarching information model has been established in the field of EAM [BMS11a]. Therefore, some researchers claim that such models are enterprise-specific design artifacts [Buc+09d].

Besides general modeling languages like Unified Modeling Language (UML) and Business Process Modeling and Notation (BPMN), architecture description languages (ADLs) like ArchiMate can be used for modeling enterprise architectures.

Advantages and Challenges of an EA Information Model

A good information model allows to structure elements of an enterprise architecture in a consistent way, which reduces the complexity of a system [11b]. Additionally, information about the system can be stored systematically, e.g. in a repository [Buc+09b], which enables advanced query and analysis opportunities [RZM14; 11b]. The results of such queries can be used as a basis for informed decision making [11b].

A main challenge when establishing an information model is to choose the best level of abstraction. On the one hand, if an information model collects too elaborate descriptions of the provided interfaces of the EA elements, it may lose its focus. Further, the data quality will decrease, because keeping all information up-to-date is connected with high effort. On the other hand, the collected information needs to detailed enough to provide a useful basis for decision making [Wit+07].

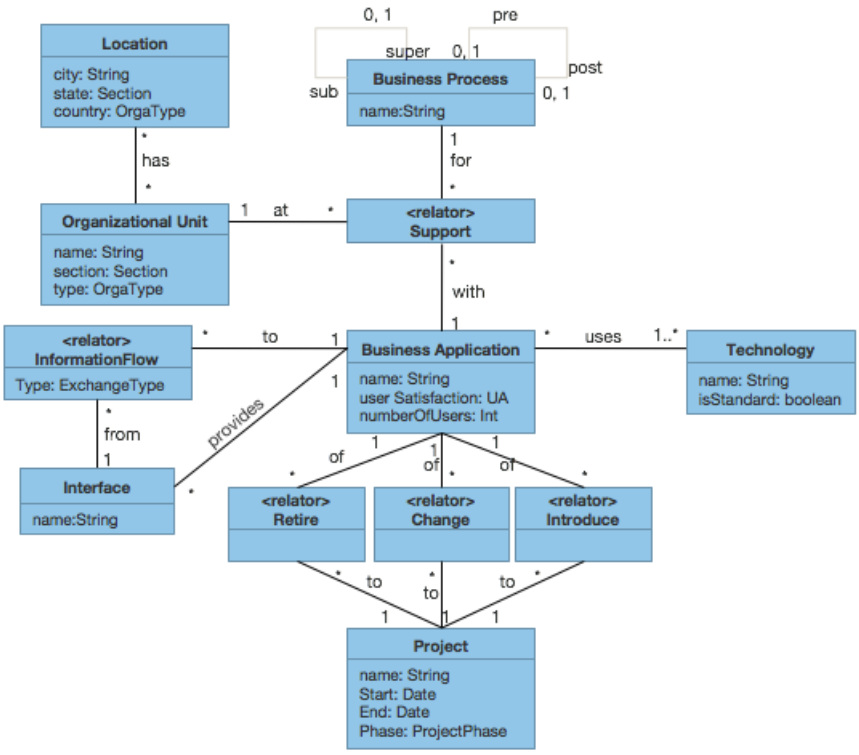


Figure C.3: Example of an information model.

Approaches to Developing an EA Information Model

As indicated in Figure C.4, there are two approaches to obtain an information model. On the one hand, an information model can be gained bottom-up [MNS11]. This means, the information model of a system is gained by extracting it from existing information about a system [MNS11]. One advantages of this approach is, that a system can grow freely and without having any structure forced on it right away [MNS11]. Naturally emerging structures, processes and roles can be extracted and captured by the information model as soon as they surface [MNS11]. Once captured, these commonalities of elements can be enforced to foster consistency of new EA elements [MNS11]. Nevertheless, emerging information models are not always of high quality.

On the other hand, a top-down approach can be used [Mat11]. This approach starts with the generation of an information model, which is created by a model designer. Once the model is constructed, the system is built up or adapted accordingly [Mat11]. The advantage of this system is that proven reference architectures can be used for the design of the information model [11b]. Also, a higher quality of the overall architecture of the system is fostered at any time.

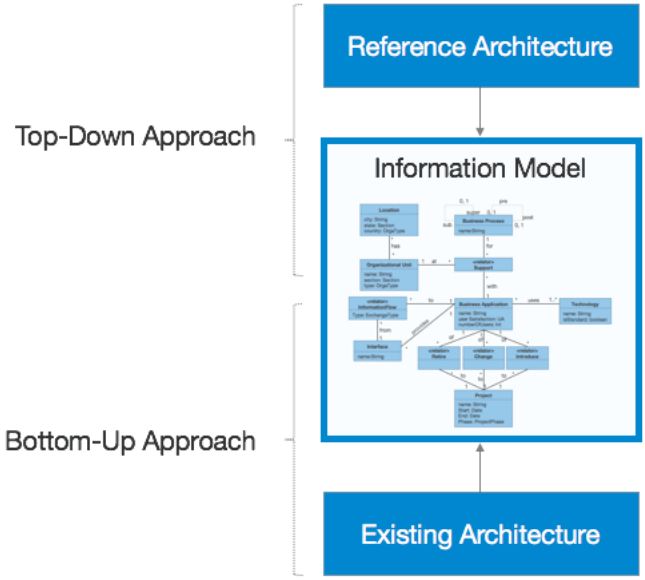


Figure C.4: Approaches for creating an information model.

C.6 EAM Key Performance Indicators (EAM KPIs)

EAM Key Performance Indicators (KPIs) are used to measure EAM goal achievement [Mat+12].

KPI Foundations

EAM goals are the starting point for deciding which EAM activities to conduct. To validate the success of such activities, their impact on the goal fulfillment needs to be measured. A prominent means to enable this measurement is the use of key performance indicators (KPIs) [Mat+12].

More precisely, KPIs can be used to quantify the performance and the complexity of enterprise architecture landscape [Ale+15]. By comparing a metric before starting and after finishing an EAM initiative, the initiative's impact on the goal achievement can be measured. Additionally, benchmark values for metrics can be used to assess the current status of an enterprise architecture and to reveal if there is any need for action.

Together with each defined KPI, also the measurement frequency, a target, planned and tolerated value as well as clear escalation rules need to be determined. It is the enterprise architects task to ensure that the relevant data needed to compute these KPIs is available [Ale+15].

In summary, KPIs enable controlling of EAM activities [Mat+12].

Examples of KPIs

An example of a KPI taken from the EAM KPI Catalog create at the Technische Universität München is *"Business applications compliant with IT architecture and technology standards"*. EAM goals that can be measured using this metric are the insurance of business application compliance as well as an increased transparency of the application landscape. The calculation of the KPI is depicted in Figure C.5 [Mat+12].

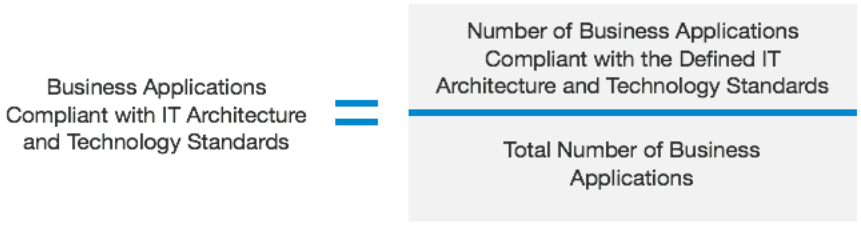


Figure C.5: Calculation of the KPI "Business applications compliant with IT architecture and technology standards" [Mat+12].

Further examples of KPIs are the Total Cost of Ownership (TOC) of an application [BBL12], Strategic Fit (SF) of an application [BBL12], Value Contribution (VC) of an application [BBL12], Fan-in and Fan-out of an application [BBL12], Degree of Standardization [Man10], Function Redundancies [Man10] and Total Number of applications [Man10].

An extensive list of 52 literature-based and practice-proven EAM KPIs can be found in [Mat+12].

C.7 EA Layers

An EA model can be conceptually divided into different architectural layers. The reason for splitting the model into different layers is to reduce complexity and enable manageability, since instances of conceptual entities assigned to each of these layers are manifold. While in the literature usually five architectural layers are differentiated [WS08], in practice often only three layers are distinguished [LM11].

Foundations

An EA model consist of various entities like processes, applications or data objects [LM11] which are defined by the implemented information model. To be able to manage the big amount of instances of these entities in practice, EA information models are split into architectural layers.

On the highest level these layers can be separated into the business architecture describing the business structure of an organization and the IT architecture characterizing its IT structure [SFS14; Han12b].

Different frameworks using different EA entities and different EA information models also apply different EA layers to their EA model [LM11]. An often cited source[46] when talking about the subject of EA layers is [WS08], who analyzed The Open Group Architecture Framework version 8.1 (TOGAF), the Federal Enterprise Architecture Framework version 1.1 (FEAF) and the ARIS Framework, with regards to the EA layers employed. [WS08] identified and consolidated the five architectural layers listed here:

- The business strategy layer comprising goals and success factors, products/services, targeted market segments, core competencies and strategic projects
- The organization/business process layer comprising organizational units, business locations, business roles, business functions, business processes, metrics and service flows, business information objects and aggregate information flows
- The integration layer comprising applications and enterprise services
- The software/data layer comprising software components and data resources
- The IT infrastructure layer comprising hardware units and network nodes

In this case, the business architecture would cover the business strategy layer as well as the organization/business process layer. The IT architecture subsumes the remaining layers.

Even though no uniform naming and content rules can be found in literature, the concepts expressed by the layers are very similar [PTS10]. Further EA models including EA layers can be found in [Fuh11a; 11b; Man10; Han12b; Wit07; Kel06; 16; Intb]. This enumeration in non-exhaustive.

Crosscutting Functions

In addition, in some frameworks crosscutting functions are defined, that refer to entities which exert influence on the concepts in all EA model layers [BMS10a]. An example for an EA model with such crosscutting functions is illustrated in Figure C.6.

The EA model in Figure C.6 is split into the three layers business & organization, application & information and infrastructure & data. Additionally, crosscutting functions influence entities in

[46] cited e.g. in [LM11; ARW08].

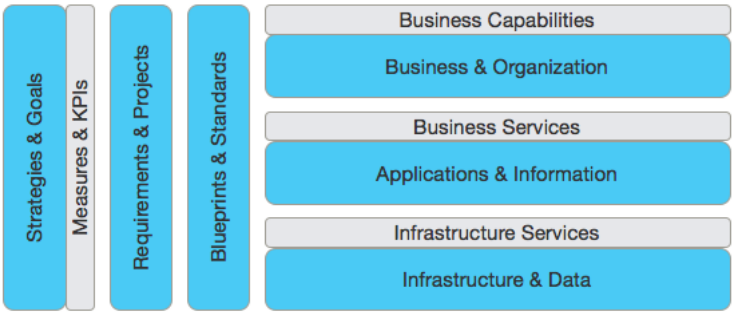


Figure C.6: Layers and crosscutting functions of an enterprise architecture [BMS11b].

all three of the aforementioned layers are depicted [RZM14]. These crosscutting aspects are the vision & goals, which are operationalized using strategies & projects [Mat+12]. The projects & strategies are used to transform EA entities. Further, principles & standards are guidelines and rules which restrict the design space of EA entities when they are transformed [Mat+12]. Finally, the questions & key performance indicators (KPI)s are used for controlling the entities and their transformation on different layers [Mat+12].

Findings from Literature Research

In [ARW08] 54 publications are analyzed with regards to how much their EA models cover each of the layers introduced by [WS08]. One result of this analysis is that strategic entities are often not or only scarcely represented in the respective EA models. Similarly, also the entities on the infrastructure layer are less intensively considered compared to entities placed in the organization/business process, the integration or the software/data layer.

Empirical Findings

In [LM11] the findings from semi-structured interviews with 16 EA experts are presented. According to the interviewed experts, in practice most organizations only distinguish between the business, application and infrastructure layer. Merely about one fourth of the participants in the study have an additional separate data layer in place. This means business architecture and process architecture as well as software architecture and integration architecture are merged into one layer respectively.

Further findings of [LM11] are that the interviewed experts expect the infrastructure layer to become less important over time, ultimately being a commodity that should be highly standardized. Additionally, the link between business and application layer is identified as being the most

challenging, since most of the participating organizations have difficulties connecting goals and business processes as well as business processes and applications. A possible approach for solving this missing alignment between business and IT is also presented, proposing the introduction of an additional alignment layer linking business and IT.

C.8 EA Model

EA models capture the EA with the purpose of making it transparent and thus enabling informed decision making and effective EA development.

EA Model Foundations

Generally, models are abstractions of reality created for a certain purpose. Therefore, they only represent those aspects of reality, which are relevant for the corresponding purpose and neglect other, irrelevant details [BBL12].

In the context of EAM, we need to distinguish between two types of models. First, there is the EA model which constitutes a conceptual model of the whole EA [BKS10]. In accordance with ISO/IEC/IEEE 42010:2011, this model is called the architectural description, but sometimes it is also referred to as a *"mental model"* [11a] or the information model of an EA [BMS11a]. The architectural description consist of various architecture elements like processes, applications or data objects [LM11] which are defined by the implemented information model. These architecture elements are spread over all architectural layers, from business down to technology, and their relationships [BBL12].

Different viewpoints can be applied to the architecture description, addressing concerns of certain EA stakeholders [11a]. Each of the resulting views comprises one or more architecture models, which are the second type of models [11a]. These models are work products like e.g. business capability maps or business support maps relating business application architecture elements with IT architecture, showing that EA models in this case constitute a synonym for EA visualizations. Each model is specified by its model kind [11b] and can be part of one or more views [11a; BKS10]. Both types of models introduced here have the purpose to make the EA transparent and thus enable informed decision making and effective enterprise architecture development [BBL12].

Models are not only purpose bound, but they also have a time dimension. As illustrated in Figure C.7, three general kinds of models can be distinguished with regards to time: the current state (as-is), the future desired state (to-be), and the planned transition states along the way

(planned) [BBL12; Myk+11]. The as-is model reflects the actual architecture of the organization at a certain point in time [Wit+07]. The target/ to-be / envisioned state model describes the ideal state of the organizations architecture according to strategies and architectural principles [Wit+07]. This state cannot actually be achieved, but helps to decide which projects should be realized. Finally, the planned state model depicts the architecture of the organization when all currently planned and budgeted projects are finalized [Wit+07]. Therefore, they constitute states that can actually be achieved [Wit+07].

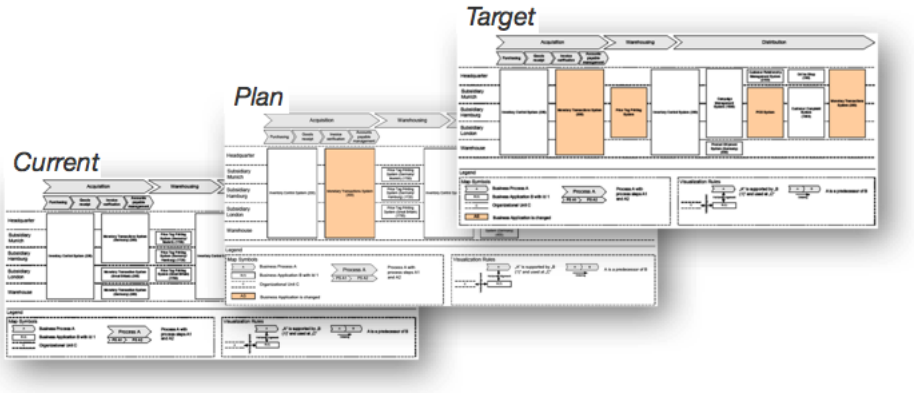


Figure C.7: Possible time horizons for EA models.

Advantages and Challenges of EA Models

In addition to making the EA transparent and therefore enable informed decision making and effective enterprise architecture development, the visualization of the EA using models makes it more accessible for stakeholders. Possible topics that can be addressed using these visualizations are the identification of gaps between as-is and to-be, the explanation and motivation of changes or the determination of the impact of incidents and changes [BBL12].

On the other hand, a downside of using an EA model is that it is laborious and expensive in its making and maintenance. Therefore the benefit-cost ration needs to be carefully considered when choosing the level of detail of a model [BBL12].

C.9 EA Stakeholder & Concerns

EA stakeholders are all the people who have any kind of concern with regards to an organizations EA [11b]. These concerns need to be addressed by models provided trough EAM.

EA Stakeholder & Concern Foundations

A definition for the term EA stakeholder is provided in TOGAF Version 9.1 developed by the Open Group. According to the framework an EA stakeholder is [11b]: "An individual, team, or organization (or classes thereof) with interests in, or concerns relative to, the outcome of the architecture. Different stakeholders with different roles will have different concerns". This means, that stakeholders are people who deal with the creation, evolution, operation or removal of elements of the EA [BBL12]. A great number of stakeholders can be identified in literature and practice [Nie07]. Unfortunately, differentiating terms for the same roles and vague or overlapping role descriptions make it impossible to provide a full list of all possible stakeholders [Nie07]. Nevertheless, for better understanding a non-exhaustive list is provided in Figure C.8.

The interest of these stakeholders is expressed as concerns [11a]. These concerns cover interest in the system itself as well as interest in the environment influenced by the system, including developmental, technological, business, operational, organizational, political, economic, legal, regulatory, ecological and social influences [11a]. As illustrated in Figure C.8, the association of concerns with stakeholders is many-to-many [11a].

EA Stakeholder & Concern and EAM

An architecture model should identify the most important stakeholders of an EA and address their fundamental concerns [11a]. By using viewpoints to frame one or more concerns, a separate treatment of concerns is enabled allowing the stakeholders to focus on the topics relevant for themselves [11a]. This fosters management support, stakeholder buy-in and proactive stakeholder engagement which is of high importance for the success of an EAM endeavor [RZM14].

C.10 EA Visualization

Visualizations enable effective communication with stakeholders [RZM14].

EA Visualization Foundations

Communication with stakeholders is critical for the success of EAM initiatives. A good basis for communication can be created using visualizations of the EA [RZM14].

Views, reports and metrics are the types of visualizations that can be created if the necessary information is available [Ale+15]. A view represents a stakeholders perspective on the architectural description and comprises one or more architecture models [11a]. Reports are defined as being

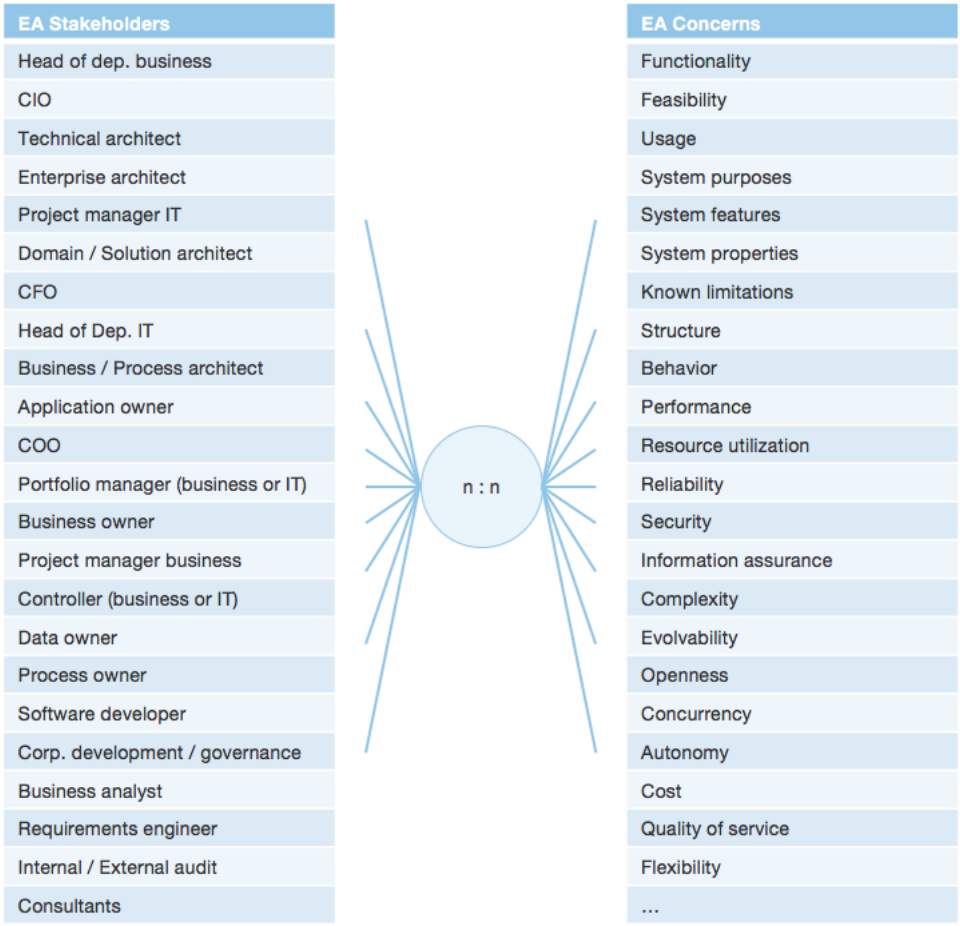


Figure C.8: Non-exhaustive list of EA stakeholders [Ale+15] and of EA concerns [11a].

textual documentations, supporting the Enterprise Architect with his tasks. Finally, metrics are used to quantify the performance and the complexity of an EA [Ale+15].

The information needed for creating visualizations can be collected using an EAM tool [Fuh12]. Since value is only created when the information is processed into stakeholder oriented visualizations, these tools usually also provide features enabling the automatic generation of those visualizations [Fuh11b].

Advantages of EA Visualization

The advantages of visualizations are that they support the communication and analysis of complex information, that they increase transparency of the EA and that they promote EAM stakeholder involvement [RZM14]. Additionally, visualizations promote the usage of a common vocabulary between the EA team and stakeholders [Fuh11b].

List of Visualization Types

An extensive list of visualization types, their stakeholders, their usage, their usage domain as well as examples of each visualization type is provided in the Enterprise Architecture Visualization Tool Survey 2014 created at the Chair for Software Engineering of Business Information Systems at the Technische Universität München. The 26 visualization types are illustrated in Figure C.9 [RZM14].

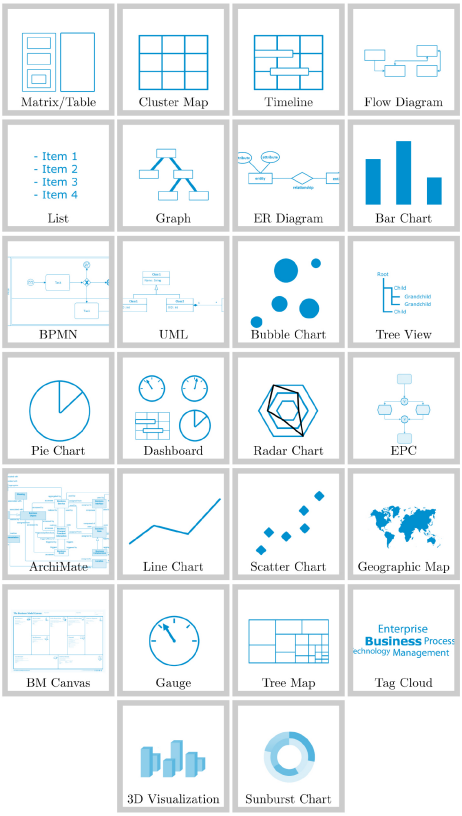


Figure C.9: Overview of 26 visualization types identified in the Enterprise Architecture Visualization Tool Survey 2014 created at the Chair for Software Engineering of Business Information Systems at the Technische Universität München [RZM14].

C.11 EAM Challenges

Challenges of EAM are manifold. Often mentioned examples are ad-hoc EAM demands [Hau+13], unclear business goals [Hau+13] and the ivory tower syndrome [RSV08].

Figure C.10: Non-exhaustive list of possible EAM challenges [Hau+13].

EAM Challenges Foundations

Enterprise Architects face many challenges while conducting their EAM activities. An overview of possible challenges identified in [Hau+13] is provided in Figure C.10. The most practice relevant challenges are ad-hoc EAM demands, unclear business goals, difficulties finding experienced enterprise architects, EA demands that are unclear for EAM team and enterprise environment that change too quickly [Hau+13].

Anti-Pattern

Anti-pattern constitute approaches that have proven to be unsuccessful in practice [BMS10b; BBL12]. Just like patterns, anti-pattern have catchy names and use a clear, accessible, and informal language. An anti-pattern frequently perceived in EAM is the so-called "Ivory Tower Syndrome" [RSV08]. This anti-pattern describes the development of a too detailed EA model which possesses the wrong level of abstraction [RSV08]. This behavior can surface, if a decoupling of the actual EAM activities and the stakeholder concerns occurs.

More anti-patterns are described in [BBL12]. Here, eight anti-patterns are categorized along the four dimensions Perspective, Governance, Strategy and Transformation. The first dimension *Perspective* captures the focus of the Enterprise Architect with regards to his tasks. Since the role of an Enterprise Architect comprises a spectrum of tasks reaching from strategic activities down to operational tasks like the support of single projects, he can take a more holistic or a more hands-on approach to EAM. The two ends of this range can be described using anti-patterns. *"Living in Cloud Cuckoo"* means that the Enterprise Architect has taken a too high perspective

on the EA and is decoupled from the community of project architects and developers, loosing insight on their challenges. The opposite phenomena is called *"In the Chief Mechanic's Workshop"* describing a situation, where the Enterprise Architect is too involved with technical issues and projects architectures, neglecting the holistic view of the EA [BBL12].

The second dimension is concerned with the strictness of the Enterprise Architect with regards to the adherence of governance rules. Even though a standardization of the IT landscape enables decision support and cost reduction, a too rigid approach to enforcing the rules can lead to an implementation of suboptimal solutions and to a lot of energy wasted in political fights. This anti-pattern is called *"The Guardian of the Wisdom"*. On the other hand, *"The Overstrained Technical Advisor"* is the anti-pattern which results from a laissez-faire approach to IT governance [BBL12].

The dimension *Strategy* looks at the time horizon of the strategic planning of the EA function. One extreme is an EA function without any long-term planning. In this context, the anti-pattern *"Sweeping Up the Change Requests"* emerges, which means that the Enterprise Architect merely records the change requests of the business instead of working towards an EA target state. Nevertheless, choosing a planning horizon which reaches too far into the future is also counter productive, since within a few years both the business as well as the IT situation may change dramatically. This anti-pattern is called *"A Deep Look into the Crystal Ball"* [BBL12].

Finally, the last dimension is *Transformation*, which deals with the speed of change of the business and IT landscape dictated by the Enterprise Architect. Constantly driving change at a very high speed can lead to a anti-pattern called *"The Permanent Construction Site"*. In such a scenario the stakeholders are left behind and the proper functioning of the IT is at stake. But again, also the opposite approach *"The Ever-Growing Backlog"* has negative consequences. In this case, the EAM function merely documents change instead of driving it, completely neglecting EAM driven change programs in the IT landscape. This approach results in EAM being a documentation graveyard which doesn't provide any benefits to the organization [BBL12].

C.12 EAM Functions & Processes

EAM comprises a multitude of functions and activities. Which functions are implemented in an enterprise depends on the goals which are chosen to be accomplished as well as the organizational context in which they are to be executed [Mat+12].

EAM Functions

Even though very important, modeling the EA and supporting the enterprise transformation are not the only activities covered by EAM. EAM functions need to address various concerns of multiple stakeholders by using EAM methods [Ale+15]. Which EAM functions to implement depends on the EAM goals, which are to be fulfilled, as well as on organization specific in influence factors [Ale+15]. A non-exhaustive list of frequently mentioned EAM activities is provided in Figure C.11.

Figure C.11: Possible activities of EAM.

The dependencies between EA measures and effects are very versatile. Based on the activities mentioned in Figure C.11, a couple of possible outcomes will be exemplified in the following.

Modeling and communicating the current as well as the future EA creates transparency and therefore enables informed decision making [BBL12; Nie08; FS12]. The support of the evolution of the IT landscape fosters an alignment of business and IT [BBL12; Nie08; Man12]. The assessment of business capabilities helps identifying critical gaps in the application landscape and additionally creates a common language between business and IT [BBL12]. Further, the development of standards and principles reduces the design space of possible future EAs in a useful way and promotes a consolidation of the IT landscape [BBL12; Kel11]. This, in return, leads to a decrease of the complexity. Supporting the definition of the IT strategy, again, enables a better alignment between business and IT [BBL12; Kel11]. Finally, the management of risks involved in IT facilitates for example compliance or better disaster tolerance [BBL12]. All these measures ultimately lead to an increase in IT performance or a decrease of IT cost.

EAM Processes

A process is defined as a sequence of connected logical functions [Buc+09b]. An EAM process should provide a simple guideline for implementing and executing EAM functions [BMS10b]. The EAM process needs to be integrated with other management processes of an organization like e.g. demand management, strategy and objective management and synchronization management [Wit+07].

According to Keller (2006) [Kel06], six IT enterprise architecture processes can be distinguished. These are the IT strategy process, which derives the IT strategy from the business strategy as well as the IT application portfolio management process, which manages the transformation of the IT landscape [Kel06]. Further, a modeling process enabling the development of an EA model and a process for defining and communicating standards should be part of the overall EAM function [Kel06]. Finally, a monitoring process, which evaluates and plans the IT project portfolio and monitors the project progress as well as a process for consulting projects should be established [Kel06].

Approaches to Defining an EAM Practice Using a Framework

There is no commonly accepted step-by-step guidelines for organizing the EAM activities of an enterprise [BMS10b]. Instead, a multitude of competing solutions exists in the form of EAM frameworks developed in academia and practice [BMS10b].

One example of such a framework is TOGAF. It provides the Architecture Development Method (ADM), a generic method describing the activities and artifacts necessary to transform an EA from a current state towards a target state [11b]. Those activities consist of the processes visioning, architecture definition, transformation planning, and architecture governance [11b]. This method focuses on the activity of capturing and transforming an EA, but not on other EAM tasks, like developing an IT strategy or managing the application portfolio [Kel11]. Further, TOGAF offers the Architecture Capability Framework, which explains how to establish an EAM capability using the ADM [11b], without mentioning what tasks are comprised in an EAM capability.

An alternative approach to establishing EAM activities is the use of patterns. This approach accounts for the organization specific factors, that influence the implementation of an EAM function [Har97]. Instead of providing one generic method, a handful of solutions are identified which are to be applied in certain situations of an organization [BMS10b].

C.13 EAM Goals & Benefits

EAM Goals & Benefits Foundations

Some of the most prominent goals of EAM are IT cost reduction [BBL12; Fuh11b; Fuh11d], alignment of business and IT [BBL12; Nie08; Man12; Fuh11c; Fuh11b], and reduction of IT landscape complexity [BBL12; Man12; Han12a].

There is a multitude of possible goals, which are derived from the business and IT strategy. The definition of EAM goals is the starting point for initiating EAM activities, since they provide both, guidance as well as a rationale for EAM endeavors. To measure the degree of goal achievement, key performance indicators (KPI)s should to be defined, which enable Enterprise Architects to plan, forecast, benchmark, and assess the EA activities with regards to their contribution to goal fulfillment [Mat+12].

Empirical Results regarding EAM Goals & Benefits

Lange&Mendling (2011) [LM11] identified EAM goals based on literature research and on semi-structured interviews with 16 industry experts. The results of both approaches are indicated in Figure C.12. The goals are ordered hierarchically with the most often mentioned goals on the top of the table.

For each of the goals mentioned in the research paper, a short description is provided. According to [LM11], the goal business and IT alignment aims at bringing business needs in line with the underlying IT implementation. This is supposed to provide a strategic advantage over competitors because of shorter reaction times and higher cost efficiency with regards to enterprise transformation [RZM14]. The cost reduction aims at reducing IT-related and business process related costs [LM11]. Standardization and consolidation efforts are supposed to reduce EA complexity, which, together with management and governance, improves the decision making [LM11]. An increased agility improves both process as well as IT flexibility, that enable the organization to adapt quickly to new market situations [LM11]. Finally, miscellaneous goals support business functions such as risk management and business continuity management while regulatory compliance ensures adherence of external regulations [LM11].

One striking feature is that in the results provided by the industry experts, *cost reduction* is not mentioned as a goal. This is explained with the statement, that it is inherently included in all other goals. Further, the goal *innovation* emerges in practice, which was so far not covered in literature. Finally, the experts state that the goal *regulatory compliance* is a lot less relevant in practice than

EA Goals (Literature Review)
Business-IT-Alignment
Regulatory Compliance
Cost Reduction
Miscellaneous (e.g. Risk)
Standardization/ Consolidation
Management / Governance
Agility

VS.

EA Goals (Semi-structured Interviews)
Transparency
Complexity Management
Governance or Transformation / IT Management
Business / IT Alignment
Agility
Innovation
Regulatory Compliance
Other Business Support (e.g. Risk Management)

Figure C.12: EAM goals identified by Lange&Mendling (2011) [LM11] in a literature review and in semi-structured interviews with 16 industry experts. The goals are ordered hierarchically with the most often mentioned goals on the top of the table.

assumed in literature. This is explained by the circumstance, that regulatory compliance is usually not a part of the EAM function [LM11].

C.14 EAM Motivation

Fast changing environments lead to the need for continuous business transformation. EAM is a good measure to cope with need [Mat+12].

Motivational Factors

In today's world, enterprises are under continuous pressure to keep up with a fast changing environment [Mat+12]. An overview of possible influence factors is given in Figure C.13.

Influence factors like globalized markets [Myk+11; Mat+12; BMS10b; Han12a], specialized customer demands [Myk+11; Ale+15] and emerging legal requirements [Myk+11; BMS10b; Man12; Han12a; Fuh11d; Ale+15; Mat+12] force the business to steadily adapt to new realities. Moreover, shorter innovation cycles [Han12a], new technologies and business models [BBL12; BMS10b; Man12; Ale+15], M&As [Man12; Fuh11d; Ale+15], a shorter time to market as well as collaborative networks create pressure on enterprise. A prominent means to support the resulting need for enterprise transformation is EAM [Myk+11; Ale+15].

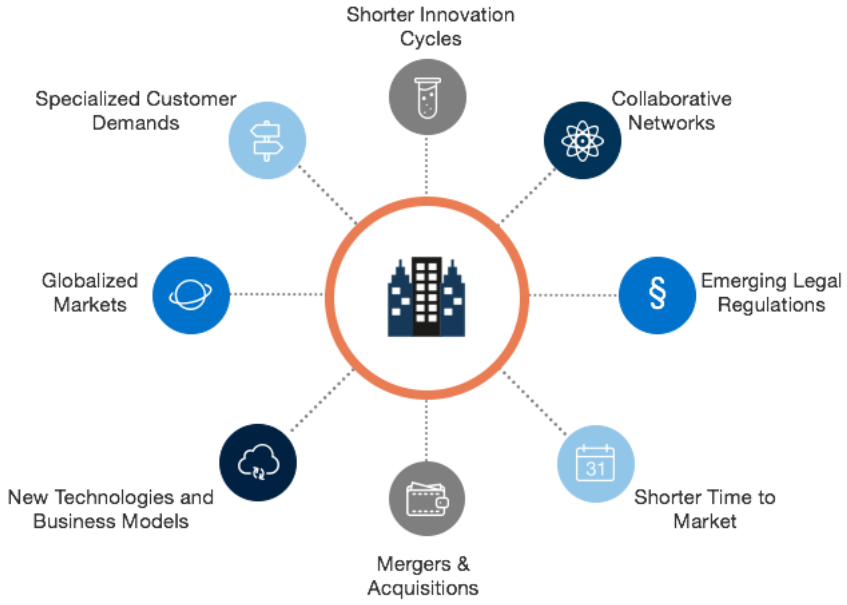


Figure C.13: Non-exhaustive list of EAM drivers.

C.15 EAM Organization

The EAM function can be implemented as an independent department or as part of the organizations' IT or business department [Man12].

Organizational location of the EAM Function

An EA function can be implemented as its own department or as part of already existing devisions in an organization. An advantage of the first option is that a holistic view is fostered, reducing the risk of neglecting single EAM functions. Additionally, an organizational proximity to the business executive management is established. On the other hand, setting up an independent EAM department can also cause a *"Ivory Tower Syndrome"* due to the detachment of the EAM function from operative business and IT activities [Man12].

The decision of integrating the EAM function into an existing department has the advantage that the organizational structure does not need to be changed. However, it needs to be determined where in the organization the function is located. In this context, the two most reasonable options are the IT department and the business units. Reasons for placing the EAM function in the IT department are the increasing value of information systems with regards to the acquisition and optimization of business capabilities. Furthermore, the IT staff is usually already trained in holistic thinking and modeling, which are important skills for the role of an Enterprise Architect. On

the downside, locating the EAM function in the IT department can favor a one-sided, technology focus view on EAM activities [Man12].

The alternative approach is to place the EAM function in the business department. The benefit of this approach is a high business orientation in terms of a improved business processes and results [Man12]. Nevertheless, in practice the EAM function is usually located in the IT department [LM11], also because EAM initiatives are traditionally initiated there [Man12].

C.16 EAM Pattern & Antipattern

Enterprise architecture patterns are general, reusable solutions to standard problems encountered in EAM [Ern08]. They are extracted from real world situations [BBL12].

EAM Pattern & Antipattern Foundations

The idea of patterns is based on situational method engineering [Har97]. This approach argues that there is no method, which can address and solve all problems related to EAM [Har97]. Instead, a handful of methods are identified which are suitable for specific situations [Har97]. These methods can be called patterns and they define general, reusable solutions to standard problems of a certain domain, here EAM [AIS77]. In contrast, anti-pattern constitute approaches that have proven to be unsuccessful in practice [BMS10b; BBL12].

Patterns have catchy names and use a clear, accessible, and informal language. This way practitioners can easily identify relevant patterns within their companies and apply related measures. Nevertheless, currently there are several pattern catalogs available, partially with different names for similar patterns.

Approaches for the Discovery of EAM Pattern

Enterprise architecture patterns make tacit knowledge of experts explicit by collecting information about working solutions that are in place in organizations. This means, patterns are discovered in working solutions rather than being invented or hoped for. An approach for retrieving patterns from practice on a scientific basis is the Pattern-based Design Research (PDR) approach [Buc+08b; Buc+13].

EAM Pattern Catalogs and Methods

The Enterprise Architecture Management Pattern Catalog V2 (EAMPC V2) was compiled by the Software Engineering for Business Information Systems (sebis) chair at Technische Universität

München. The EAMPC V2 captures an extensive list of patterns, which were identified in literature and validated by practitioners [Ale+15].

Also developed at the Software Engineering for Business Information Systems (sebis) chair at Technische Universität München, the Building-blocks for Enterprise Architecture Management solutions (BEAMS) method provides a collection of re-usable and practice-proven building blocks that allow Enterprise Architects to tailor the EAM function to the specific organizational context, the specific goals of EA management and the concerns of an enterprise [Buc+10a].

C.17 EAM Tool

EAM Tools enable the storage and visualization of enterprise architecture related information [RZM14].

Functionality of EAM Tools

The basic functionality provided by an EAM tool is the organized storage of enterprise architecture related information. Tools providing this functionality are also called enterprise architecture repositories [RZM14]. The collected information is structured according to an underlying information model, which enables advanced querying of the data. The data can be entered into the tool manually or sourced from other applications like project management tools, ERPs or knowledge sharing portals [BBL12].

Another possible functionality of EAM tools is the generation of visualizations based on the stored data [RZM14]. Which kind of visualizations are created is defined by the Enterprise Architect.

Usually, the functionalities storage of EA data and generation of visualizations are integrated into one tool [RZM14; Kel11].

Advantages of EAM Tools

First of all, to create an enterprise architecture model a lot of data which is spread out throughout the whole enterprise needs to be collected and structured [Fuh11b]. The use of an EAM tool facilitates this task by providing a data repository based on an EAM information model [RZM14]. Additionally, it can automate parts of the data collection by directly sourcing data from other applications [Far+13]. The resulting information collection provides a basis for quick decision making to the Enterprise Architect and other stakeholders [Fuh12].

Challenges of EAM Tools

One challenge connected with using an EAM tool is that often a certain information model is dictated [RZM14]. Therefore, first the organizations information model needs to be made explicit, if this is not the case already. Afterwards, the information model of the organization has to be mapped to the information model provided by the tool [Buc+09c].

List of EAM Tools

A non-exhaustive list of EAM tool products and their vendors can be found in Table C.1.

C.18 IT Governance

IT governance comprises the entirety of structures, processes and roles used to ensure that IT supports the company strategy [Nie08; Han12a]. Effective implementation of such a governance requires the availability of EA models provided by EAM [Nie08].

IT Governance Foundations

IT governance aims at ensuring that IT supports the business strategy and goals and at providing an appropriate risk management [Nie08]. Further, it institutionalizes best practices for planning, acquiring, implementing, and monitoring IT operations and transformation [11b]. In order to realize its functions, IT governance comprises processes for decision making and measurement of IT performance as well as structures like steering committees or quality boards and clear definitions of roles and responsibilities [Nie08].

IT governance is heavily influenced by the structural organization of the IT of an enterprise. For example, an outsourced IT department with a responsible manager acts different to an IT department, in which also the business departments have decision rights. At the same time, IT governance also influences the evolution of the structural organization of the IT.

IT Governance Archetypes

Generally, six IT governance archetypes can be identified within enterprises. These archetypes are classified according to the IT / business distinction and have provocative political names, since most managers identify with these stereotypes. The archetypes and their descriptions are listed in Table C.2 [WR04].

Table C.1: A non-exhaustive list of EAM tool products and their vendors [RZM14; MHK14].

EAM Tool	Vendor
ABACUS	Avolution
adaptive EAM	adaptive Inc.
ADOit	BOC AG
ARIS	Software AG
BiZZdesign EA Tool Suite	BiZZdesign
Corporate Modeler Suite	Casewise
Essential Project	EAS
Embarcadero EA/Studio	Embarcadero TechnologiesInc.
Enterprise Architect	SparxSystems Ltd
Envision VIP	Future Tech Systems
iteraplan	iteratec GmbH
Layer8	Layer8-Solutions GbR
leanIX	LeanIX GmbH
MEGA	MEGA International
OpenText	OpenText Corp.
planningIT	alfabet
PowerDesigner	Sybase/SAP AG
process4.biz	process4.biz Softwareentwicklungs- undVertriebs GmbH
QPR EnterpriseArchitect	QPR Software
QualiWare Enterprise Architecture	QualiWare
Rational System Architect	IBM
SAMU Repository	Atoll Technologies Ltd
SAP Sybase PowerDesigner	SAP
Troux	Troux Technologies
Txture	QELaB Business Services GmbH

Table C.2: Six IT governance archetypes [WR04].

Archetype	Description
Business Monarchy	Top managers make IT-related decisions.
IT Monarchy	IT specialists make IT-related decisions.
Feudal	Each business unit of the organization makes its own IT decisions.
Federal	The decision making is done by the corporate center together with the business units. IT people may be involved or not.
IT Duopoly	The IT group together with one other group, e.g. business unit leaders or top management, decide on IT related topics.
Anarchy	Decisions are made by isolated individuals or small groups within the organization.

IT Governance Framework

Probably the most renown framework for IT governance is the Control OBjectives for Information and related Technology (COBIT) framework, developed by ISACA and currently available in its 5th edition [Inta].

Further, TOGAF provides the Architecture Governance Framework, which constitutes a framework for architecture governance. According to TOGAF, architecture governance is *"[...] the practice and orientation by which enterprise architectures and other architectures are managed and controlled at an enterprise-wide level."*. This includes for example the implementation of a system to ensure compliance with internal and external standards and the development of practices that ensure accountability of stakeholders actions [11b].

Relation between IT Governance and EAM

To implement IT governance effectively, a model of the enterprises IT needs to be available. Such a model, which documents and relates all enterprise architecture elements, is maintained by the EAM team. Additionally, Enterprise Architects can support the analysis and the planning of an effective design of the IT governance function [Nie08].

C.19 IT Landscape Complexity Management

High complexity due to uncontrolled growth makes it difficult to manage IT landscapes efficiently [SM14]. One major goals of EAM is to consolidate the IT landscape using portfolio management, standards, and a clear assignment of responsibilities [Han12a].

Reasons for IT Landscape Complexity

The complexity of a system is determined by its elements, their heterogeneity, their dynamic changes and their relationships to each other and the environment [Han12a]. An application landscape is such a system, where applications constitute the elements and data flows constitute the relationships connecting them with other applications and the environment.

Back when IT solutions were first used to support the daily business of enterprises, the amount of applications and their data flows were relatively limited and therefore easy to manage. Over the last decades, IT became a corporate asset and application landscapes grew rapidly and uncontrolled. As a result, IT landscapes of modern organizations comprise up to thousands of business applications and tens of thousands of interfaces. Additionally, drivers fostering the increasing complexity of application landscapes are manifold. Amongst others, those are the speed of technological innovation, the increasingly complex and fast changing business operations, the high amount of new legal requirements as well a local or tactical decision making [BBL12].

Consequences of IT Landscape Complexity

Due to this complexity, IT landscapes are difficult to manage. This again leads to higher IT maintenance and project costs, higher error rates, higher skill dependency, and a lower flexibility of the IT landscape when adapting to new needs of the business [SM14].

Complexity Management and EAM

EAM provides several means to address complexity and to support the consolidation of the IT landscape [Mat+12]. These measures comprise the creation and monitoring of standards, the use of reference architectures, a target-oriented portfolio management, a clear assignment of responsibilities and the use of modular IT landscapes [Han12a]. An extensive survey on standardization efforts with 47 experts has been conducted by the Chair for Software Engineering of Business Information Systems at Technische Universität München in the course of the CALM3 project [SGM15].

To quantify application landscape complexity and to measure the impact of EAM initiatives on the IT landscape complexity, metrics should be applied [Ale+15]. Possible metrics for measuring application landscape complexity are the number of applications, the number of information flows, the standard conformity of applications, the number of infrastructure elements, the functional scope of applications and functional redundancy within the IT landscape [Sch+15].

C.20 IT Portfolio Management

The goal of portfolio management is to decide which projects with an impact on the EA should be implemented based on their expected benefits [Nie08].

IT Portfolio Management Foundations

Portfolio management can take three different forms [Kel11]. One form is the classical project portfolio management, which constitutes a process for deciding which projects to implement [Kel11]. The second kind is the application portfolio management which aims at optimizing the application portfolio of an enterprise [Kel11]. The last form is the infrastructure portfolio management [Kel11]. This kind of portfolio management aims at optimizing the available infrastructure the applications run on [Kel11]. Note that projects chosen by the project portfolio management have impact on the future application and infrastructure portfolio [Buc+09b]. All forms of portfolio management are reoccurring processes.

Portfolio Management is a wicked problem to be solved collaboratively between business and IT [Nie08]. Since Enterprise Architects have a good overall-picture of the enterprise, they should take a role as advisors and assessors [BBL12]. This way they can, for example, identifying common IT needs across the business units and prioritize projects based on architectural fit [BBL12].

Project Portfolio Management

During the project portfolio process a prioritization schema is applied to the list of proposed projects yielding a set of approved projects [Kel11]. A generic example of a project portfolio management process is illustrated in Figure C.14.

The starting point of project portfolio management are the project proposals, which can be motivated based on business requirements or based on possible shortcomings of the current application portfolio. Usually, a template needs to be filled in for each project proposition, containing a short description, the expected benefit, risks, costs and other information to enable an overview over and a comparison of the projects [Wit+07]. Based on these proposals, a

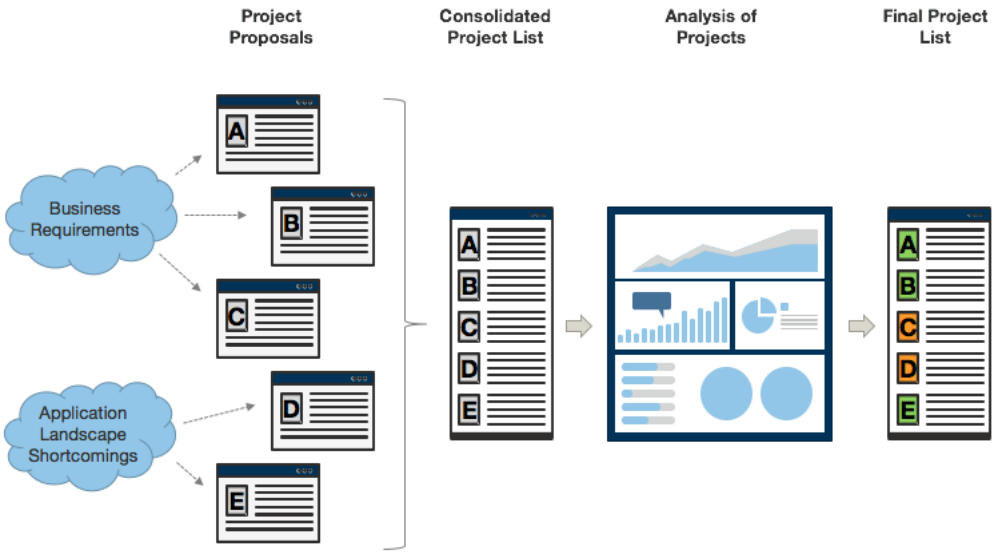


Figure C.14: Generic Portfolio Management Process.

consolidated list of all proposed projects is created, which summarizes similar projects and highlights dependencies between them and with ongoing projects.

Since usually there is not enough budget available to finance all projects, in the next step, projects are analyzed and prioritized. They can be evaluated regarding their monetary and strategic importance for the business or with regards to improved quality of the application portfolio. This prioritization process should be based on a consistent framework applied to all project evaluations [BBL12].

In the last step, the projects with the most benefit for the company are chosen by allocating budget and resources [Nie08]. The goal is to maximize the efficiency of investments into the application portfolio. One possible approach supporting the choice of projects to be implemented is the managed evolution approach.

Application Portfolio Management

A business application can be defined as being a deployment of a software system in a certain version at a distinct location and hardware with a clear relationship to at least one business process of the organization [Buc+08a]. The entirety of employed business applications and their relationships make up the application portfolio of an organization, which is an important asset providing critical support functions for the business [BMS09a]. Sometimes the terms *software city* or *IT application landscape* are used as synonyms for application portfolio [Hes+07]. The management of the application portfolio is an important task which can be addressed using EAM processes [BMS09a].

Due to its importance, a couple of different approaches to application portfolio management have been developed in practice and academia [Buc+09b]. A renown approach is the use of a categorization matrix proposed by Ward & Peppard (2016), which classifies the applications of an application portfolio according to their impact on the current and the future business [WP16]. Depending on which category they are assigned to, the applications are treated in different ways [Kel11]. The matrix is illustrated in Figure C.15.

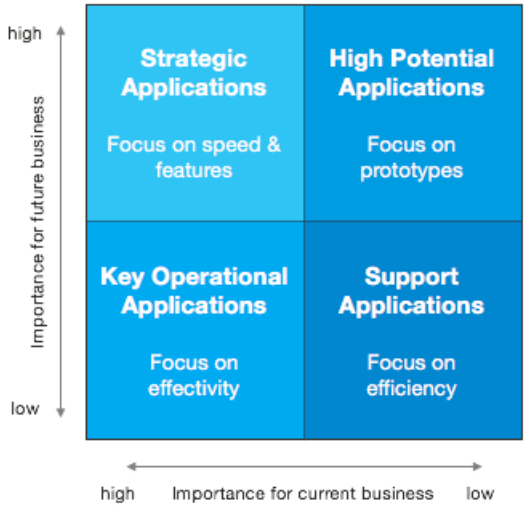


Figure C.15: Classification matrix for business applications [WP16].

An application is categorized as being a support application if it provides little contribution to the current or the future bottom line of the business. Those applications are commodities, and therefore strategies focusing on efficiency should be applied. Examples for such strategies are standardization or outsourcing. If an application provides high value to the current business but does not provide a strategic fit in the future, is is classified as being a key operational application. Those applications are usually large systems, that the current business relies on and where down-time is costly. Therefore, the focus should lie on strategies fostering effectiveness of these applications. Strategic applications are applications which support products that will be future cash cows. The emphasis for those applications is still on speed and on features and not so much on effectiveness or efficiency. Finally, applications supporting new products in the development and test phase are high potential applications. Those applications are usually still in their prototype phase [WP16].

Infrastructure Portfolio Management

Similar to the application portfolio management, infrastructure portfolio management is usually approached by categorizing infrastructure elements according to their impact on the current and future business. The major difference is that infrastructure usually isn't a matter of competitive advantage. Thereby infrastructure portfolio management efforts mostly aim at reducing heterogeneity and complexity with the goal of enabling lower your maintenance and administration costs [Kel11].

C.21 IT Strategy

The IT strategy is derived from the enterprises' business strategy and is one of the major influence factors of EAM, since the enterprise architecture aims at optimally supporting the IT strategy at any time [Kel06].

Definition of the Term Strategy

In the context of IT strategy, one of the most prominent definitions for the term strategy is provided by the Gartner Group stating that *"A strategy takes a vision or objective and bounds the options for attaining it."* [MF02]. Simplified, this means the starting point for developing a strategy is a goal or a vision [Kel11]. Based on that goal, a couple of possible ways, meaning certain series of activities to reach that goal, are derived [Kel11; Buc+10b]. The final step of deciding on a strategy is to choose which of those possible ways to take [Kel11].

IT Strategy Foundations

IT strategy is the strategy defined for managing the IT resources of an enterprise [Kel11]. The IT strategy should be derived from the enterprises business strategy to ensure that the IT operation optimally supports the business [Kel06]. This requires that a business strategy is explicitly stated, which is rarely the case in reality [MF02; Kel06].

Approaches to IT Strategy Development

One possible approach for defining an IT strategy is the *management by maxims* process developed by Broadbent & Weill (1997) [BBL12] [Kel06]. The idea is to organize a one day workshop with the business and the IT leaders of the enterprise [BW97]. The goal of the workshop is to define a set of business and IT maxims, where a maxim is defined as a *"statement that specifies a practical*

course of conduct" [BW97]. More precisely, up to six business maxims are defined and afterwards up to five IT maxims are derived from each of those business maxims [BK05]. These maxims are used as input for defining an IT strategy.

An alternative approach to formulating strategies is provided by the Gartner Grid [BBL12; Kel06]. This approach is more of a checklist ensuring the completeness of an IT strategy than a step-by-step description detailing how to develop an IT strategy [BBL12].

Approaches to Monitoring IT strategy Achievement and Alignment

Once an IT strategy is defined, it is important to monitor the IT strategy achievement and the alignment of IT strategies and planned projects. The monitoring of IT strategy achievement can be done using predefined key indicators that are suitable for measuring the chosen IT strategy. The alignment of strategies and projects can be ensured by assigning globally defined indicators of strategic impact to each proposed project. The indicators should be globally defined to ensure comparability. The value of this indicator is taken into account when prioritizing the projects that will be implemented in the future. This way only projects with high strategic impact will make it into the portfolio of approved projects. Additionally, traceability of the strategic impact of finished projects is enabled, meaning that it can always be reconstructed, which IT strategies have been addressed by a certain project [Wit+07].

Interaction between IT Strategy and EAM

One of the major factors influencing the EAM practice of an organization is the chosen IT strategy [Kel11]. The enterprise architecture aims at optimally supporting the IT strategy [Kel06] and needs to quickly adapt to changing strategic orientations of the enterprise [Fuh13b]. Further, the IT strategy has implications especially for the IT governance [Kel11] as well as the for the IT portfolio management, as detailed in C.21 [Wit+07].

Even though the IT strategy has a lot of influence on the EAM of an enterprise, Enterprise Architects are usually not responsible for its definition [BBL12]. The definition of the IT strategy is traditionally a task of the CIO of an enterprise [Kel11]. Nevertheless, the Enterprise Architects often support the strategy development by providing relevant information [Han12b] or by taking the role of a moderator between business and IT [BBL12].

C.22 Organizational Context of EAM

Organizational factors like IT organization and budgeting need to be taken into account when establishing an EAM process [BMS10b].

Organizational Context of EAM Foundations

Enterprises seeking to establish an EAM function can choose from a variety of approaches. To determine how to design an EAM function for a certain enterprise, the organizational context in which the function will be embedded needs to be considered. The reason for that is, that most available approaches are explicitly or implicitly tailored to certain organizational contexts, in which they can be successfully applied [BMS10b].

The relevance of organizational influence factors manifests itself in the availability of pattern catalogs. The basic idea of pattern catalogs is to provide solution pattern for certain issues given the organizational context in which the solution will be applied. For example, mature organizations can select much more sophisticated EAM patterns, while smaller enterprises can focus on a small set of simple patterns which create value quickly [Ale+15].

List of Organizational Factors influencing the EAM Function

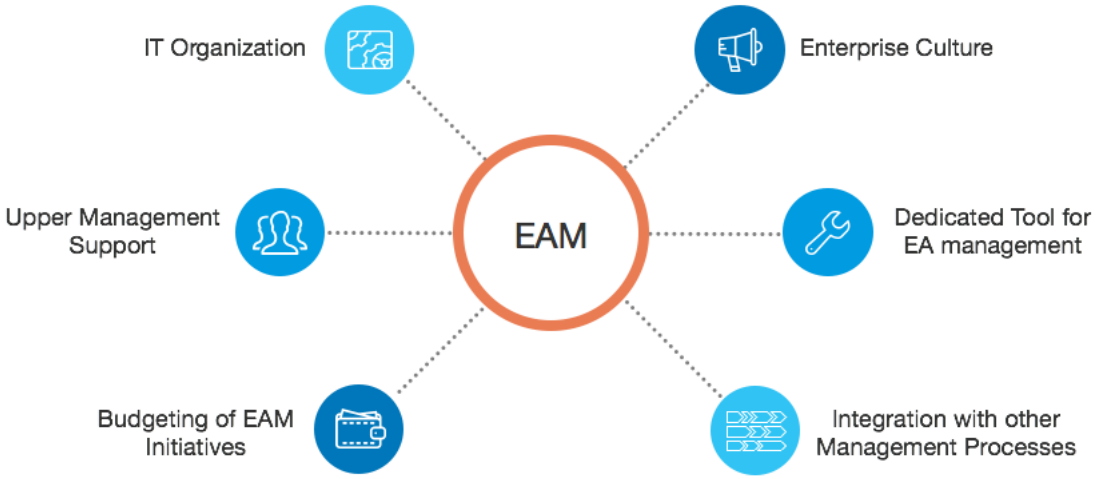


Figure C.16: A non-exhaustive list of organizational factors influencing the choice of an EAM function. [BMS10b]

A non-exhaustive listing of possible organizational factors influencing the choice of an EAM function can be taken from Figure C.16. First of all, the IT organization within an enterprise needs

to be taken into account when selecting an EAM function. The IT organization could be structured in a centralized, a decentralized or a federate way. Additionally, the upper management support for the EAM function needs to be considered. Here it can be differentiated between a bottom-up initiative, where the EAM team initiates an EAM process, or a top-down initiative, where the upper management itself requests to establish an EAM function. Likewise, the budgeting of the EAM initiative constitutes an influence factor. The enterprise culture also affects the possible choices of EAM processes, since it can differ tremendously with regards to innovation management, communication style or the acceptance of formal models. Finally, the availability of a dedicated tool for EAM and the integration of the EAM function with other management functions and processes needs to be taken into account when selecting an EAM process [BMS10b].

C.23 Role and Skills of an Enterprise Architect

An Enterprise Architect has to have many different skills. These can be EA related skills like IT portfolio management, management related skills like communication skills and leadership as well as operational IT skills which are needed to accompany IT projects [Kel11].

Definition of the Term Role

According to [11b] a role is defined as:

> *"1. The usual or expected function of an actor, or the part somebody or something plays in a particular action or event. An Actor may have a number of roles.*
>
> *2. The part an individual plays in an organization and the contribution they make through the application of their skills, knowledge, experience, and abilities."*

Skills necessary for the Role of an Enterprise Architect

In the context of EAM, many different skills can be identified for the role of an Enterprise Architect. A couple of them will be exemplified in the following.

According to TOGAF the generic role of an Enterprise Architect comprises the understanding and interpretation of requirements, the creation of a useful model, the validation, refinement and expansion of this model as well as the management of the architecture [11b]. More roles related to EAM and the skills related to those roles are detailed in the TOGAF Architecture Skills Framework explained below.

In [Kel11], three different types of tasks are identified, which the role of an Enterprise Architect needs to be able to perform. The first type are strategic tasks comprising the support of the IT strategy development, the IT portfolio management and the strategic planning. The second type of tasks are the operational tasks comprising the communication management, the architecture governance and the accompaniment of interesting projects. Finally, basic EAM tasks are part of the role of an Enterprise Architect. These are the operation of an enterprise architecture tool, the development of a meta model and the development of standards.

[Man12] identifies a couple skills that are important for the role of an Enterprise Architect. These skills are for example the ability to create a holistic integrated view on the enterprise as well as the ability to model. Furthermore, skills like the understanding of the business model, process knowledge, knowledge of foundational IT architectures and technologies, experience in project management, leadership skills and communication skills are important for an Enterprise Architect as well. Finally, it is emphasized, that the role of an Enterprise Architect is more of a management and leadership role, and not merely the role of a technical specialist.

According to [Lap12], the skills which are important for the role of an Enterprise Architect change depending on the understanding of what EAM is in a certain organization. The first option is, that enterprise architecture is understood as being the glue between business and IT (Enterprise IT Architecting). In this case, the Enterprise Architect should have technical competencies and engineering knowledge. Another option is, that enterprise architecture is understood as being the link between strategy and execution (Enterprise Integrating). If this is the case, Enterprise Architects should be able to facilitate small-group collaboration and to apply systems thinking. Finally, if enterprise architecture is understood as being the means for organizational innovation and sustainability (Enterprise Ecological Adaptation), the Enterprise Architect should have skills related to fostering dialogue, applying system and system-in-environment thinking and facilitating larger-group collaboration.

The previous paragraphs show that there is not one overarching definition of skills for the role of an Enterprise Architect, but many slightly differing ones. Nevertheless, all definitions agree, that Enterprise Architects need skills in the management as well as in the technical field.

TOGAF Architecture Skills Framework

A very extensive list of roles and skills related to EAM is presented in the TOGAF Architecture Skills Framework. The most important roles for EAM mentioned in the framework are the Enterprise Architect, the Business Architect, the Data Architect, the Application Architect and the

Technology Architect. Also, further roles related to EAM like the Architecture Board Member, the Architecture Sponsor and the IT Designer are listed [11b].

Additionally, seven categories of EAM skill sets are detailed. These skill sets comprise generic skills (e.g. leadership, team working, etc.), business skills and methods (e.g. strategic planning, budget management, etc.), enterprise architecture skills (e.g. modeling, applications and role design, etc.), program or project management skills (e.g. managing business change, project management methods and tools, etc.), IT general knowledge skills (e.g. brokering applications, migration planning, etc.), technical IT skills (e.g. software engineering, security, etc.) and skills related to the legal environment (e.g. data protection laws, contract law, etc.). A table is provided for each category of the skill sets, indicating which level of proficiency a role should display for each skill. The proficiency of a skill can reach from background to expert knowledge as indicated in Figure C.17.

Level	Achievement	Description
1	Background	Not a required skill, though should be able to define and manage skill if required.
2	Awareness	Understands the background, issues, and implications sufficiently to be able to understand how to proceed further and advise client accordingly.
3	Knowledge	Detailed knowledge of subject area and capable of providing professional advice and guidance. Ability to integrate capability into architecture design.
4	Expert	Extensive and substantial practical experience and applied knowledge on the subject.

Figure C.17: Levels of proficiency a role should display for each skill [11b].

An example of such a skill table for the skill set *"Generic Skills"* is provided in Figure C.18. In this example, the person occupying the role of the Enterprise Architect should have expert knowledge with regards to all skills listed, while someone in the role of a Technology Architect only needs expert knowledge in teamwork skills, inter-personal skills, oral communications skills, written communications skills and logical analysis skills [11b].

Roles	Architecture Board Member	Architecture Sponsor	Enterprise Architecture Manager	Enterprise Architecture Technology	Enterprise Architecture Data	Enterprise Architecture Applications	Enterprise Architecture Business	Program/ Project Manager	IT Designer
Generic Skills									
Leadership	4	4	4	3	3	3	3	4	1
Teamwork	3	3	4	4	4	4	4	4	2
Inter-personal	4	4	4	4	4	4	4	4	2
Oral Communications	3	3	4	4	4	4	4	4	2
Written Communications	3	3	4	4	4	4	4	3	3
Logical Analysis	2	2	4	4	4	4	4	3	3
Stakeholder Management	4	3	4	3	3	3	3	4	2
Risk Management	3	3	4	3	3	3	3	4	1

Figure C.18: Skill proficiency table for the skill set "Generic Skills" [11b].

Summarizing, the TOGAF Architecture Skills Framework lists EAM roles, the skills required by each of those roles and the level of knowledge each role should have regarding theses skills. This way, the TOGAF Architecture Skills Framework aims at simplifying the training and recruiting of Enterprise Architects in an organization [11b].

Appendix D

Further Wiki Articles

The wiki articles covering topics which are not part of the final list of foundational topics are listed in the following.

D.1 ArchiMate®

ArchiMate® provides an architecture description language which defines core concepts of an EA model as well as their graphical illustration. The core of ArchiMate® is the ArchiMate® framework, which allows to categorize elements along two dimensions [16].

ArchiMate® Foundations

ArchiMate® is an Open Group standard maintained by the Open Group ArchiMate Forum. Successive versions are published at regular intervals, with the latest release being ArchiMate® 3.0 published mid 2016. It comprises an enterprise architecture modeling language specification as well as the ArchiMate® Framework [16].

In ArchiMate® a model is defined as being a *"collection of concepts"* and a concept as *"either an element or a relationship"*. The enterprise architecture modeling language specification provides a precise definition and illustration of the concepts specific to the domain of enterprise architecture. This modeling language can be used to represent enterprise architectures as well as to describe their changes over time [16].

The ArchiMate® Framework

The ArchiMate® Framework is depicted in Figure D.1. It enables a categorization of the core entities defined by the ArchiMate® modeling language. The framework categorizes these core entities along two dimensions [16].

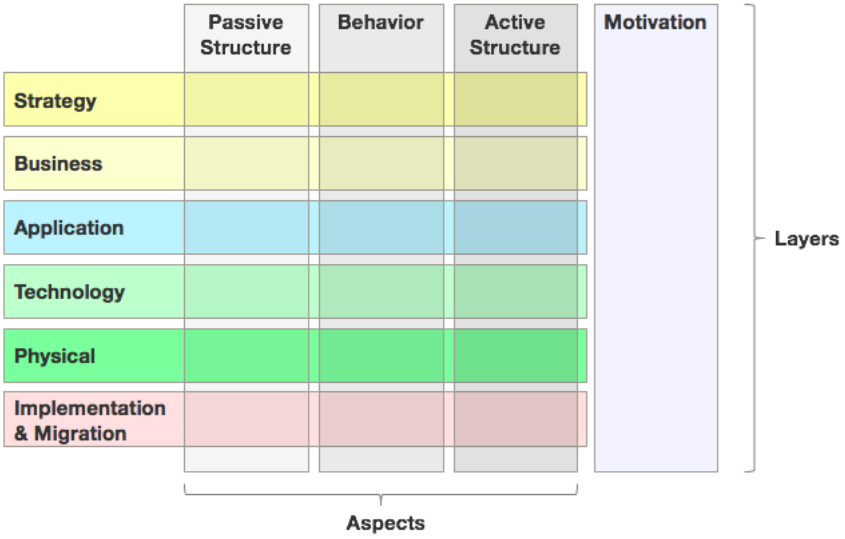
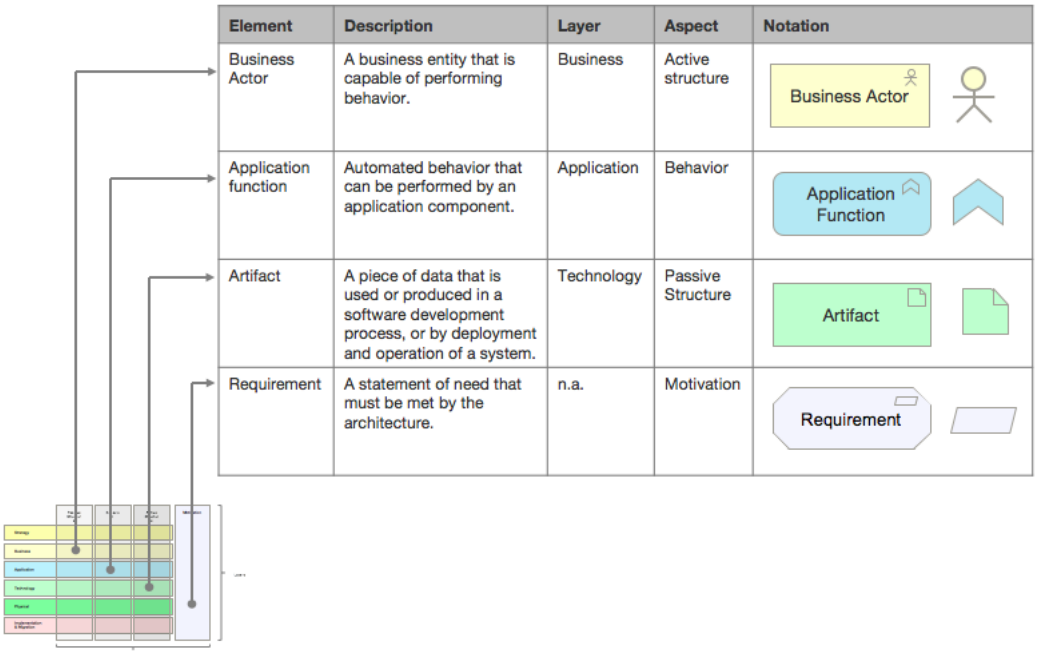


Figure D.1: Excerpt of the language notation for entities of the ArchiMate® modelling language with their definitions, their assignment to layers and aspect and their assigned icons [16].

The first dimension core entities are assigned to are the different layers of an enterprise architecture model. In the new ArchiMate® Version 3.0, the enterprise architecture model is split into the Strategy (e.g. capability), the Business (e.g. business actor), the Application (e.g. application function), the Technology (e.g. artifact), the Physical (e.g. facility) and the Implementation & Migration (e.g. deliverable) layer. With regards to the graphical representation of single entities, the layer an entity belongs to is indicated using different colors [16].

The second dimension is made up of four aspects, which the core entities are allocated to. In the graphical representation of elements, the assignment of an element to an aspect is visualized using different shapes. The first aspect represents active structures, capturing subjects that display actual behavior (who?). These active structures are represented using boxes with square corners and an icon in the upper-right corner. The behavior aspects represent behaviors of active structures (how?) and are visualized using boxes with round corners and an icon in the upper-right corner. Passive structures are the objects behavior is performed on (what?). There is no global way to visualize them with regards to the shape. Finally, motivation constitutes the fourth aspect in the ArchiMate® Framework (why?). Elements assigned to this aspect are depicted using boxes with diagonal corners but are also color coded, indicating that it also constitutes a layer [16].

An excerpt of the language notation for elements of the ArchiMate® modelling language together with their definitions and an assignment to a layer and aspect is displayed in Figure D.2 [16].



Element	Description	Layer	Aspect	Notation
Business Actor	A business entity that is capable of performing behavior.	Business	Active structure	Business Actor
Application function	Automated behavior that can be performed by an application component.	Application	Behavior	Application Function
Artifact	A piece of data that is used or produced in a software development process, or by deployment and operation of a system.	Technology	Passive Structure	Artifact
Requirement	A statement of need that must be met by the architecture.	n.a.	Motivation	Requirement

Figure D.2: Excerpt of types of relationships in ArchiMate®, their definitions and their icons [16].

Relationships between these elements can be categorized and visualized using a set of connector icons. General types of relationships defined in ArchiMate® are structural relationship, dependency relationships, dynamic relationships and other relationships. An excerpt of these types of relationships, their definitions and their icons is available in Figure D.3 [16].

Category	Relationship Type	Description	Notation
Structural Relationship	Composition	Indicates that an element consists of one or more other elements.	
Dependency Relationships	Serving	Models that an element provides its functionality to another element.	
Dynamic Relationships	Flow	Transfer from one element to another.	

Figure D.3: Mapping of the the ArchiMate® Framework to the TOGAF® ADM [16].

Relation between ArchiMate® and TOGAF®

ArchiMate® is closely related to the TOGAF® standard and provides the modeling language that can be applied to the models created in TOGAF®. The ArchiMate® Framework can be mapped to the TOGAF ADM as illustrated in Figure D.4 [16].

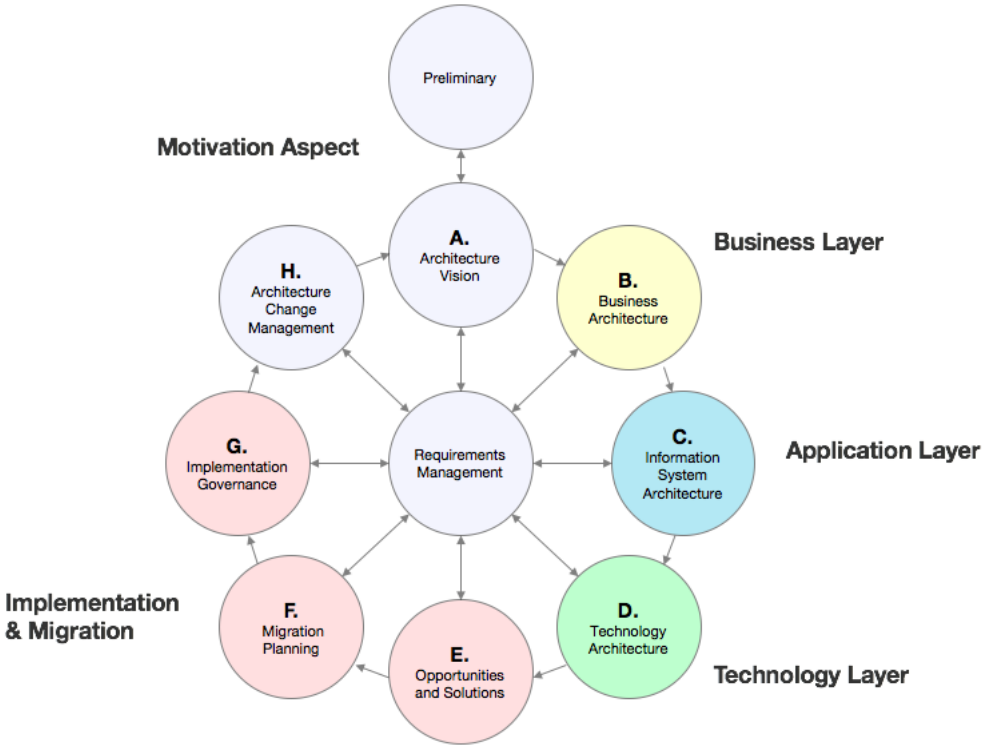


Figure D.4: The ArchiMate 3.0 Framework [16]

Advantages & Disadvantages of ArchiMate®

One advantage of ArchiMate® is that it enables the visualization of architectures on separate layers but also allows the depiction of cross-layer relationships, as illustrated in the examples in Figure D.5 [16].

Additionally, ArchiMate® provides extensive list of enterprise architecture entities, a predefined meta-model, some simplified standard views and publicly available, comprehensive documentation. Also, tool support for modeling the enterprise architecture using this architecture description language is available [BBL12].

A downside of ArchiMate® is that there is a limited extensibility of the modeling language. Further, some concepts are ambiguous [BBL12] and modelers need training to apply the framework successfully. Finally, when implementing ArchiMate®, a terminology mapping assigning existing concepts to the ArchiMate concept needs to be conducted.

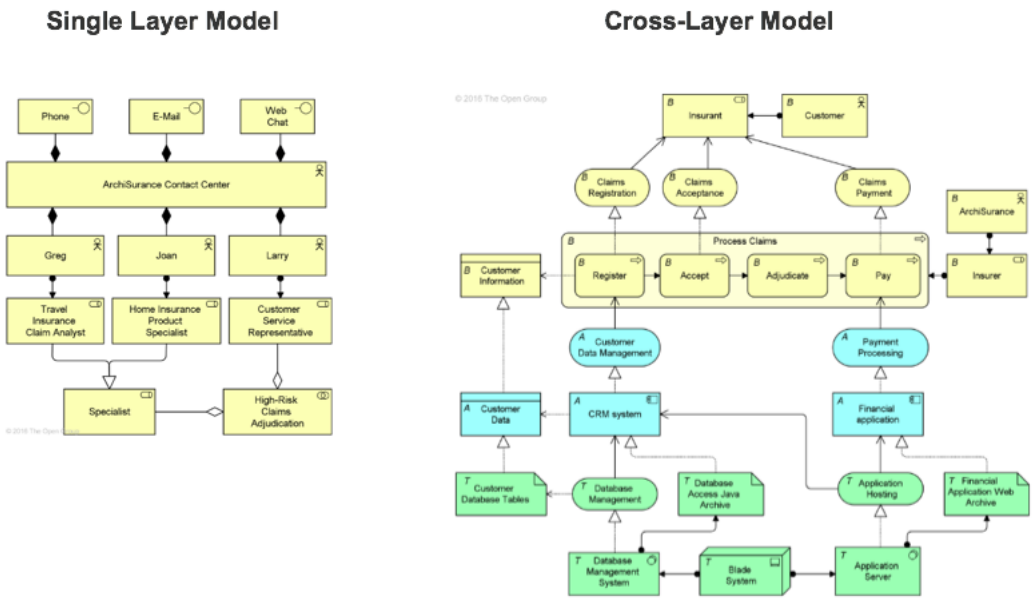


Figure D.5: The ArchiMate 3.0 Framework [16].

The ArchiMate® 3.0 Specification can be downloaded or viewed online.

D.2 Architecture Description Language (ADL)

An Architecture Description Language (ADL) is domain-specific modeling language for EAM.

ADL Foundations

Architecture description languages (ADLs) are any kind of modeling language, that can be used to express system architectures. That means, ADLs provide a set of rules and common practices for the creation of visualization like e.g. flow diagrams or organization charts. The resulting visualizations address concerns of EAM stakeholders and can be grouped into views [11a].

ADLs are often supported by EAM tools to aid the creation, use and analysis of its models and visualizations.[11a]

List of ADLs

Examples of ADLs are ArchiMate® developed by the Open Group [16], RM-ODP as defined in ISO/IEC 10746:2009 and ISO/IEC 15414:2015 [15], Rapide developed at Stanford University [Luc+95], Wright developed at Carnegie Mellon University [All97], and SysML developed by the Object Management Group [Obj15].

D.3 EA Reference Model & Reference Architecture

A reference architecture is a technological solution pattern for the design of a system.

EAM Reference Model & Reference Architecture Foundations

Reference models and reference architectures are abstract solution patterns for the design of systems in a specific domain [16]. They define the infrastructure as well as the skills and procedures needed for the implementation of the respective system [Nie08]. Additionally, they can contain heuristics to determine development costs, time lines, and risks, which are based on prior experiences [Nie08].

The difference between a reference architecture and a reference model is the same as between an architecture and model. While the reference architecture provides a generic solution pattern, the reference model constitutes its organization-specific configuration [11b].

Advantages of using Reference Architectures

The goal of reference architectures is to limit the heterogeneity of system environments in use and therefore to decrease complexity of the IT landscape. Furthermore, experiences and lessons learned from prior projects can be captured, utilized and used to deduct measures for the usefulness of architectural drafts [Nie08].

TOGAF Reference Architectures

In TOGAF, two reference architectures are provided [11b]. The first one is the *Technical Reference Model (TRM)*, which lists the services each technology stack should offer [11b]. An important contribution of this reference architecture is the provision of terminology and checklists [Kel11].

The second reference architecture is the *Integrated Information Infrastructure Reference Model (III-RM)* [11b]. This reference architecture is composed of a long list of application components and services necessary to enable the services defined in the TRM. Again, this reference architecture fosters a common vocabulary [Kel11].

D.4 EA Views & Viewpoints

Viewpoints define conventions on how to address the concerns of stakeholders with regards to an enterprise architecture. Views result from the application of viewpoints to a system [11b].

EA Views & Viewpoints Foundations

The concept of views and viewpoints is best explained using an example taken from TOGAF® Version 9.1. The starting point is an arbitrary system-of-interest, e.g. some kind of business application, and a stakeholder group, namely the users of the business application [11b]. Since the users have to use the business application in the daily business, the users have concerns like the availability or response time of the business application [11b]. These concerns are a subset of the concerns of all stakeholders of the system. For example, users of a system don't care about cost or compliance of the application, which the owner of the application would be interest in.

This means, the users have a certain perspective on the system, called a viewpoint. The viewpoint identifies which concerns are relevant to the stakeholder group *"users"* and which collection of models of the system architecture is used to address these concerns [11a]. To clarify the distinction between view and viewpoint, a very helpful comparison is introduced in the ISO/IEC/IEEE 42010:2011 standard [11a]: *"a view is to a viewpoint as a program is to a programming language"* [11a]. The viewpoint comprises the basic rules (languages, notations, model kinds, design rules, etc.) defining how a certain view is constructed, interpreted and used independently of the underlying system the view is constructed for [11a]. The actual application of the viewpoint to a system yields a view [11a]. Thus, a view can be seen as an instance of applying a viewpoint to a specific system [11a]. Every view should comply with its governing viewpoint [11a]. The user view on the business application is unlikely to completely describe the system architecture, since aspects which are irrelevant to the respective stakeholders' concerns are not captured [11b].

As already mentioned, views comprise one or more architecture models [11a]. Each model is specified by its model kind, just like each view is specified by its governing viewpoint [11b]. A model can be part of one or more views [11a; BKS10].

Moving away from the example introduced above, Figure D.6 shows the conceptual model of an architecture description proposed by the ISO/IEC/IEEE 42010:2011 standard.

Approaches to the Construction of Views

The choice of which architecture views to create is an important decision an architect has to make. Once it is decided which views to develop, the architect can use one out of two approaches for the construction of views, the synthetic or the projective approach [11a]. If the synthetic approach is chosen, the Enterprise Architect first constructs the views and later on mergers them into an architecture description [11a]. On the other hand, if the projective approach is chosen, views are created based on data stored in an EA repository [11a; Fuh12].

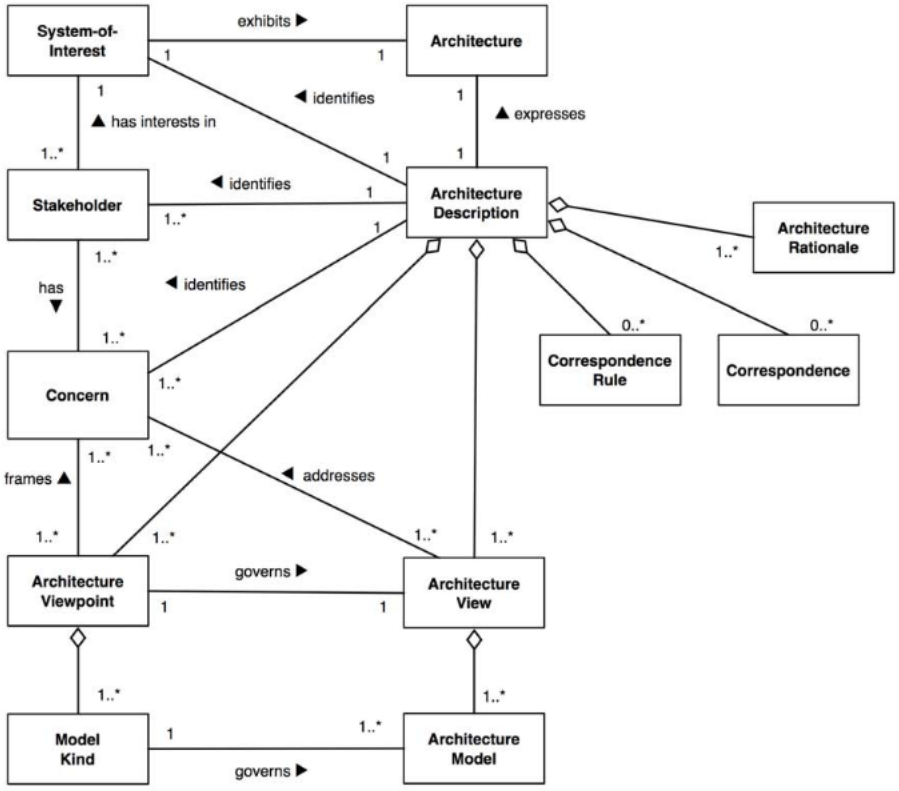


Figure D.6: conceptual model of an architecture description proposed by the ISO/IEC/IEEE 42010:2011 standard [11a].

Advantages and Challenges of EA Views & Viewpoints

The usage of different views with regards to enterprise architecture allows the Enterprise Architect to ensure that the concerns of all stakeholders are addressed and balanced when developing or evolving an architecture [16]. Further, it facilitates clear communication with stakeholders of a system [Fuh12]. Due to these advantages, the concept of viewpoints and views forms an integral part of many EAM frameworks like TOGAF, the "4+1" view model, DoDAF and RM-ODP.

Moreover, if views are developed for the current and the target architecture, a gap analysis can be used to identify required action on the enterprise architecture [11b]. Nevertheless, this procedure is also connected with additional effort.

D.5 EAM Framework

An EAM framework comprises a predefined set of methods and tools for developing enterprise architectures and enterprise architecture practice [11b].

EAM Framework Foundations

According to the ISO/IEC/IEEE 42010:2011 an architecture framework is defined as being a *"Predefined set of concerns, stakeholders, viewpoints, and viewpoint correspondence rules; established to capture common practices for architecture descriptions within specific domains or user communities"* [11a]. This means, frameworks offer approaches supporting the maintenance and transformation of enterprise architectures as well as methods facilitating other EAM tasks like establishing processes to foster communication between projects [11a].

Two topics closely related with EAM frameworks are viewpoints and architecture description languages. Often, frameworks provide a predefined set of viewpoints, that can be adapted to the specific enterprises' needs [11a]. Architecture description languages can be used as a starting point for modeling the EA [11a].

Advantages and Challenges of EAM Frameworks

One advantage of using frameworks is that they provide proven approaches to EAM. Also, most of the frameworks are publicly available and well documented. On the downside, training is usually necessary to successfully apply the framework in an enterprise, since the models offered are often complex and modeling techniques need to be learned. Additionally, the approaches are very abstract and generic, making it difficult to derive enterprise-specific adaptations.

List of EAM Frameworks

There are a great many of different EAM frameworks [Sch04]. Some more renown ones are listed in Table D.1.

D.6 ISO/IEC/IEEE 42010:2011 Systems and software engineering - Architecture description

ISO/IEC/IEEE 42010:2011 provides an ontology defining architecture elements, architecture frameworks and architecture description languages [11a].

Foundations of the ISO/IEC/IEEE 42010 Standard

The international standard ISO/IEC/IEEE 42010 (formerly IEEE 1471) defines a set of concepts as well as their properties and relations, that should be used when creating an architecture description of a system. It is currently available in version ISO/IEC/IEEE 42010:2011 [11a].

Table D.1: Non-exhaustive list of EAM frameworks.

EAM Framework	**Abbreviation**
The France DGA Architecture Framework	AGATE
ArchiMate	n.a.
Architecture of Integrated Information Systems	ARIS
Building-blocks for Enterprise Architecture Management Solutions	BEAMS
The US Department of Defense Architecture Framework	DoDAF
Federal Enterprise Architecture Framework	FEA
Generalised Enterprise Reference Architecture and Methodology	GERAM
International Defence Enterprise Architecture Specification (IDEAS) Group	IDEAS
Integrated Architecture Framework	IAF
Information FrameWork	IFW
The UK Ministry of Defence Architecture Framework	MODAF
The NATO Architecture Framework	NAF
The Pragmatic EA Framework	PEAF
Quasar Enterprise	n.a.
The Open Group Architecture Framework	TOGAF
Zachman Framework	n.a.

The meta model of concepts provided by the ISO/IEC/IEEE 42010 Standard

The core concepts and relations specified in the standard are illustrated in Figure D.7. The goal of applying this standard is to create an architecture description, which provides a basis for creating, analyzing and evolving the actual architecture of the system [11a]. An architectural description can be understood as being the conceptual model of the architecture, more precisely a specification of a conceptual model of the architecture [BKS10].

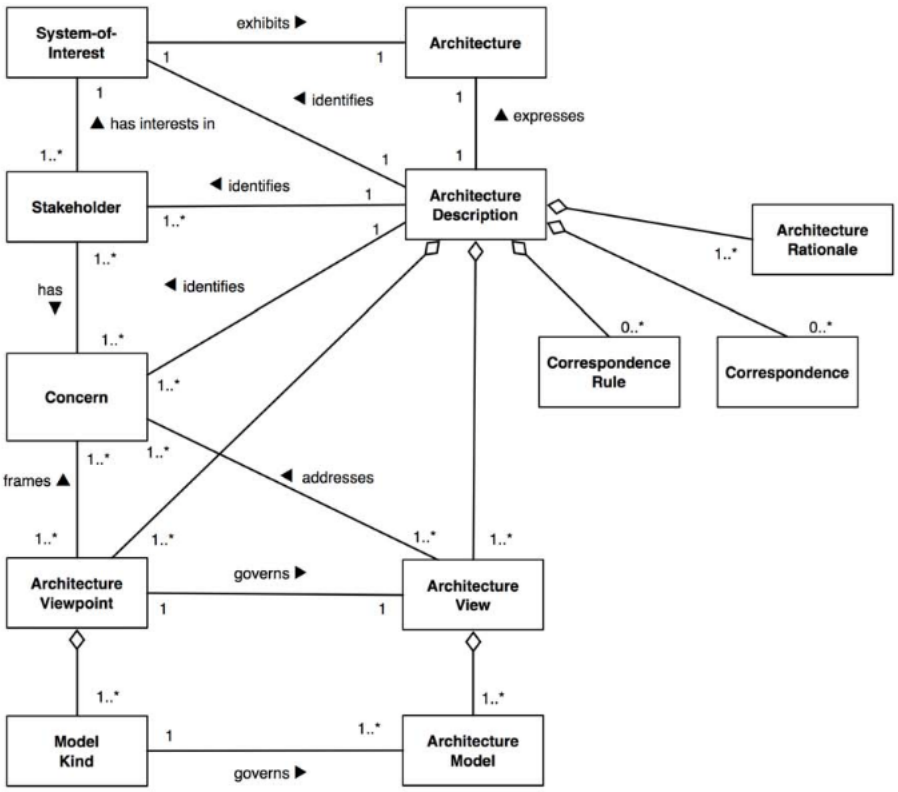


Figure D.7: Conceptual model of an architecture description proposed by the ISO/IEC/IEEE 42010:2011 standard [11a].

The process of creating an architecture description usually starts with identifying stakeholders of the respective system and their concerns. Afterwards, views addressing these concerns are defined. Views are governed by their viewpoints and consist of sets of models. Correspondences describe the dependencies between the architecture elements (stakeholders, concerns, views, etc.) as well as between whole architecture descriptions. Architecture rationales are used to record architecture decisions and the reasoning behind them. The standard does not define specific architecture descriptions, views, viewpoints, models or model types, but rather the properties identifying elements as such [11a].

Further concepts of the ISO/IEC/IEEE 42010 Standard

According to the standard, architecture frameworks and architecture description language should be based on the provided ontology. Additionally, further characteristics of architecture frameworks and architecture description languages are specified [11a].

Advantages of the ISO/IEC/IEEE 42010 Standard

The added value of this standard is the provision of a coherent practice for developing architecture descriptions, architecture frameworks and architecture description languages [11a].

D.7 IT Principles

EA principles constitute generally valid guidelines for the development of an EA [11b].

EA Principle Foundations

EA principles constitute generally valid guidelines for the use of EA elements [11b]. These principles are independent of a specific EA and self-restraint instead of externally obliged, e.g. by law in terms of compliances [Buc+10b]. They are formulated as short but comprehensive statements [Fuh13b]. Examples for principles are *"Loose coupling of systems or services"* or *"Buy before make"* [Ale+15].

The EA principles constrain the design space, which comprises all accepted states of an EA [Buc+10b]. This way it constitutes a basis for consistent, goal-oriented decision making [Buc+10b; Fuh13b]. Figure D.8 shows a visual example of how EA principles restrict the design space in the context of the managed evolution approach for EA development.

EA Principles and IT Standards

EA principles and IT standards are located on different levels of abstraction [Buc+10b]. The EA principles provides an underlying rationale, which is operationalized by IT standards [Buc+10b]. This link can be illustrated using an example taken from [Buc+10b]. The basic assumption is that an organization has an EA principle in place, which obliges the IT department to concentrate development competences. This EA principle can be operationalized by establishing an IT standard stating that only a restricted set of programming languages can be used in future projects [Buc+10b].

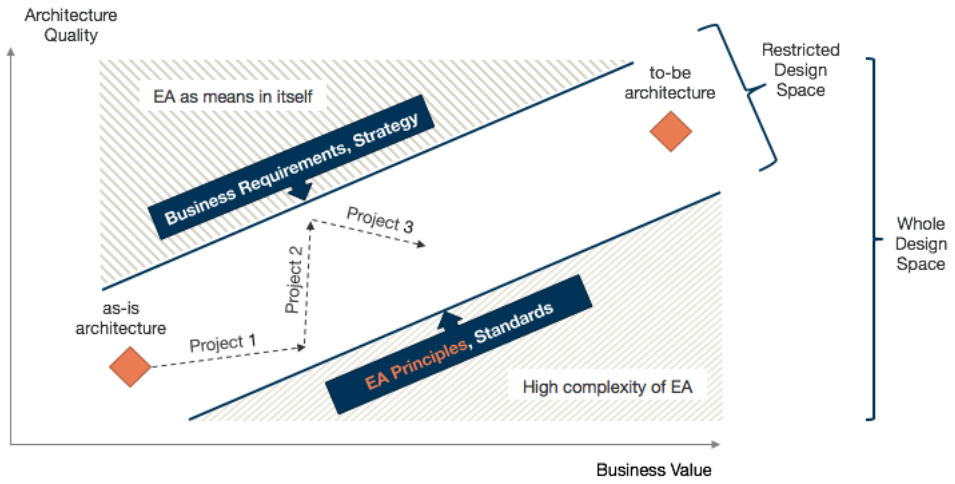


Figure D.8: Influence of EA Principles on the Design Space in the context of managed evolution [Fuh13a].

List of EAM Principles

A list of EA principles defined in the TUM Pattern Catalog created at the Chair for Software Engineering of Business Information Systems at Technische Universität München can be found in Table D.2 [Ale+15]. Another list of EA principles can be found in TOGAF [11b].

D.8 IT Standards

Standards increase the homogeneity of an IT landscape by limiting the number of allowed in-use technologies. If implemented correctly, standards lead to cost savings and improved productivity with regards to IT solutions.

IT Standards Foundations

IT standards steer the development of an enterprise architecture by limiting the number of allowed technologies and by defining minimum thresholds for the delivery of IT services [Fuh11d]. A visual example of how IT Standards restrict the design space in the context of the managed evolution approach is given in Figure D.9. The goal of standardization is to decrease complexity in an IT landscape and thereby enable better manageability and control [SGM15].

Standards can be categorized according to three different classes. The first class are legal and regulatory obligations, comprising standards mandated by law. The second class are industry standards, which are established by industry bodies and adopted by organizations on a voluntary basis. The advantage of adopting this kind of standards is that they could offer potential for

Table D.2: List of EA Principles identified in [Ale+15]

Possible EA Principles
Compliance with security regulations
Technology portfolio is based on few technologies
Reuse of functionality
Buy before make
High flexibility, efficency and modularity of architectural solutions
Loose coupling of systems or services
Consider architecture principles in future application landscape development
Service-orientation of architecture
Prevention of replication of inventory data
High availability of sales & and customer portals
Analyses are conducted by a central data warehouse system
Subsidiaries are responsible for own data; common data model for group-wide information
Process- and task-oriented architectural solutions
Provision of target group specific functionalities
Common development of common source code for group-wide information systems
Functional target image as a framework for the deployment of systems
Tool support for product development and direct change opportunities for functional areas
Systems have predefined run time, Removal of old systems is mandatory
Seperated modeling of processes, organization and IT

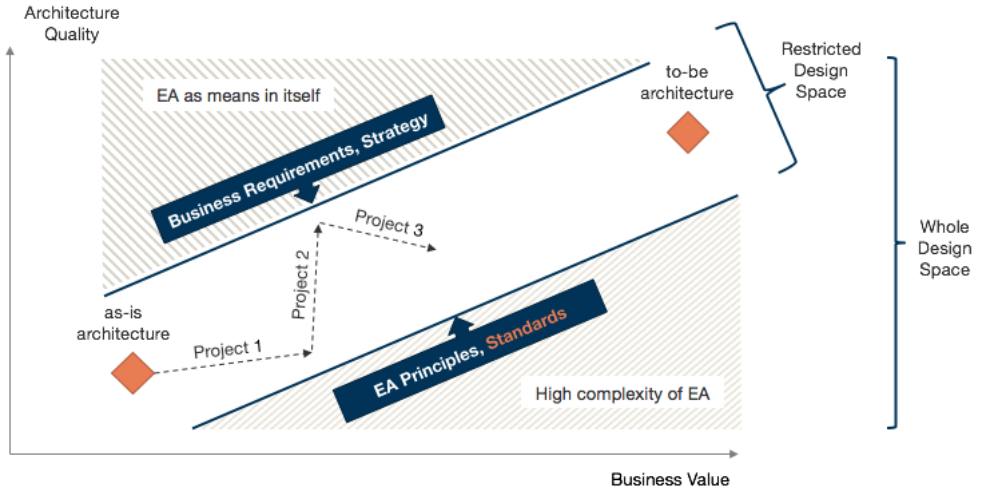


Figure D.9: Influence of IT standards on the design space of the enterprise architecture in the context of the managed evolution approach [Fuh13a].

inter-operation across enterprises of the same industry. The third and last class of standards are the organizational standards, which are set within an organization [11b]. In practice this usually means, a book of standards is developed which lists products and technologies allowed to be used in future projects [SGM15] but it could also comprise the definition of reference architectures, architecture patterns or frameworks which are to be applied in the transformation of certain parts of the enterprise architecture [Nie08; Fuh11d].

IT Standards and EA Principles

Further, IT standards operationalize the IT strategy and the EA principles [Fuh11d; Fuh13b]. This link can be illustrated using an example taken from [Buc+10b]. The basic assumption is that an organization has an EA principle in place, which obliges the IT department to concentrate development competences [Buc+10b]. This EA principle can be operationalized by establishing an IT standard stating that only a restricted set of programming languages can be used in future projects [Buc+10b].

Approaches to the Definition of IT Standards

The creation and establishment of IT standards is a difficult and costly process [SGM15]. Standards can be created in a bottom-up or a top-down manner [Nie08]. If the bottom-up approach is used, the standards are defined based on best practices, lessons learned and other experiences made during projects [Nie08]. Advantages of this approach are that standards are concrete and

pragmatic [Nie08]. Nevertheless, it can also lead to unnecessarily proprietary solutions [BBL12]. On the other hand, using the top-down approach, IT standards can be derived directly from the enterprises strategy [Nie08]. This way, the bigger picture with regards to the goals of the enterprise are maintained, but it can also easily drift into a blind enforcement of standards (ivory tower syndrome) [BBL12]. In conclusion, a good strategy is to combine both approaches.

To measure the progress of standardization efforts, KPIs can be used [SGM15].

Advantages of IT Standards

The enforcement of standards facilitates decision making by limiting the amount of solution options [BBL12; Fuh13b; Fuh11d]. The best possible case would be that standards enable project teams to just assemble a significant portion of their solution [BBL12]. This leads to a decrease in the amount of possible integration scenarios as well as to a decrease of integration costs and risks [SGM15].

Challenges of IT Standards

Choosing good standards is difficult. On the one hand, they have to foster complexity reduction by limiting possible technology solutions to be used and thereby enable manageability and control of the application landscape [BBL12]. On the other hand, they should not constrain the need for diversity and flexibility of solutions demanded by the business too much [BBL12; Fuh11d]. Excessive standardization efforts can also lead to a dependency on certain technologies or vendors [SGM15].

D.9 Managed Evolution Approach

The managed evolution approach is an iterative, controlled and continuous approach for enterprise architecture development. The approach ensures that each transformational project influences the business value and the EA quality positively.

Foundations of the Managed Evolution Approach

The basic idea of the managed evolution approach is visualized in Figure D.10 [Fuh13a]. The starting point of the approach is the knowledge of the as-is enterprise architecture as well as the to-be state of the architecture. These two states are located in a diagram where the x-axis represents the enterprise architectures contribution to the business value and the y-axis represents

its level of architecture quality. Boundaries are applied creating a corridor which connects the as-is with the to-be architecture. On the one hand, the upper boundary is supposed to restrict states where the quality of the enterprise architecture is high but it doesn't support the enterprises' strategy or fulfill the business requirements, making it a means in itself. On the other hand, the lower boundary prevents states with high business functionality, but also high complexity of the enterprise architecture, rendering the enterprise architecture inflexible and difficult to manage. This lower boundary is implemented using IT principles and IT standards [Buc+10b]. The resulting corridor constitutes the space of all allowed EA states of an enterprise architecture [MWF08].

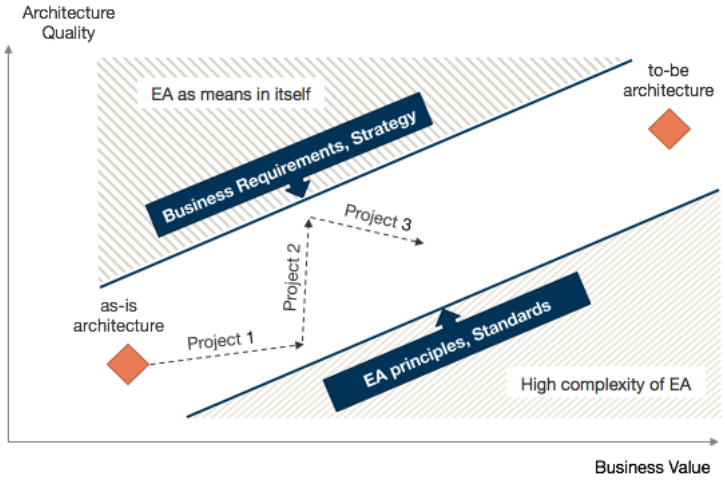


Figure D.10: The Managed Evolution Approach [Fuh13a].

Transformation projects change the business value and the quality of the architecture and therefore also its positioning within the diagram. It is now the enterprise architects' task to ensure that only those transformation projects are chosen, that move the state of the enterprise architecture towards the to-be architecture and which lay within the evolutionary corridor [Fuh13a]. This way, each project contributes to the business value and the quality of enterprises architecture. The to-be architecture is a theoretical optimum, which can never be reached and which also changes over time [Fuh13a]. This leads to a never ending, iterative transformation process of the enterprise architecture [Fuh13a].

Advantages of the Managed Evolution Approach

Advantages of the managed evolution approach are that the current architecture is seen as a valuable asset. Business value and quality of an enterprise architecture are improved continuously through transformational projects while preventing the erosion of the existing enterprise architec-

ture [Fuh13a]. This way, a controlled development of the as-is enterprise architecture towards the to-be state is enabled.

D.10 Service-Oriented Architecture (SOA)

Service-Oriented Architecture (SOA) is an architecture paradigm for designing large software systems [BBL12]. The idea is that IT functionalities are offered as services to users within and outside of the enterprise [Kel11]. This approach fosters better alignment between business and IT [Buc+09a].

SOA Foundations

The basic concept of SOA is to introduce a new layer of abstraction between the business and the IT of an organization [Buc+09a]. This new layer consists of services [Buc+09a]. According to [Men07], a service is defined as being *"[...] a self-contained and stateless business function which is accessible through a standardized, implementation neutral interface."* . A service can be of different granularity ranging from simple database calls up to aggregated services like a service for billing an order [Buc+09a]. Further, a service is a black box to its consumers [11b], since all implementation details are encapsulated and the only information about the service is provided via a service agreement [Fuh13b].

An abstract example of a SOA infrastructure is illustrated in Figure D.11. The SOA infrastructure is implemented using a process engine [PTS10]. The lowest layer of services in the process engine reuses the basic functionalities provided by the existing applications of an organization [PTS10]. Within the process engine, four different different layers of services are portrayed, where each services consists of orchestrated services of the layer below. Lastly, the only service layer that the users actually interact with, is the highest layer of the process engine [PTS10] representing cumulated services which directly enable business capabilities [SLI08].

Summarizing, SOA means that functionalities which support business processes are no longer provided directly by business applications, but instead by services [Buc+09a]. This enables application landscapes to be structured according to the business of an organization [Hes+07] and therefore to improve the understanding between business and IT [Buc+09a].

Advantages of SOA

As already mentioned, advantages of SOA are the alignment [PTS10; BBL12] and the improved communication and understanding between business and IT [Buc+09a]. Further, the reusability of

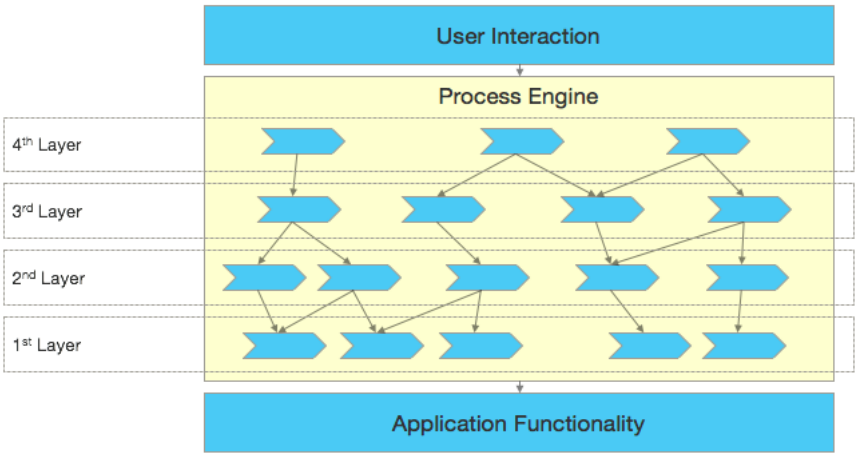


Figure D.11: Abstract illustration of a SOA infrastructure based on a process engine. Adapted from [PTS10].

services reduces costs, since duplication of functionalities is prevented [Buc+09a]. Additionally, the concept of self-contained services which can be combined flexibly enables fast reactions to business changes [Buc+09a][SLI08] and therefore agile business support [PTS10]. Finally, the concept of loose coupling stabilizes the IT landscape since outages and performance fall-offs become locally isolated [BBL12].

Challenges of SOA

Prerequisites for the successful implementation of a SOA is the availability of standardized and documented business processes to enable potential for reuse of the services [Buc+09a]. In addition, an accounting method for running and using a service is needed. This is not trivial, since several organizational units can use a certain service. Therefore measures for billing like e.g. the number of usages need to be defined [Buc+09a]. Lastly, one of the major challenges is the growing number of services and the increasing amount of service interdependencies [PTS10]. To manage such a growing service landscape, suitable concepts and tools need to be implemented [PTS10].

Summarizing, strong governance of service representation and implementation is needed for a successful implementation and operation of a SOA [11b].

Approaches for implementing a SOA

One methodology for SOA introduction and evolution is Quasar [PTS10] developed by Capgemini[47] and now available in its current version Quasar 3.0 [Eng+12]. The basic idea of the approach

[47] Initially developed by sd&m Research and sd&m IT Consulting [Hes+07].

is to define domains grouping functional-logical components [Hes+07]. These domains form the domain model of the organization [Hes+07], which can be interpreted as a high level business architecture [Buc+09a]. By assigning services to each of the identified domains, the service landscape is organized and the definition of services with overlapping functionality is avoided [Buc+09a].

To enable a SOA, the physical applications providing the services need to be integrated using an appropriate integration infrastructure [Hes+07]. One possible approach to enable this integration is the use of an enterprise service bus (ESB) [SLI08]. An ESB presents a universal mechanism to interconnect all services of an organization while ensuring security, reliability, performance and scalability [Men07]. This makes ESBs an ideal backbone for implementing a SOA [Men07].

EAM and SOA

The relationship between EAM and SOA is bilateral. On the one hand, the EAM function of an organization enables a SOA transformation by providing the information necessary to define functions the right way [Buc+09a] and by managing the transformation of the enterprise architecture to a SOA [Fuh13a]. On the other hand, EAM has to adapt to the new challenges imposed by a SOA, meaning that concepts and methodologies have to be modified to handle the upcoming complex service landscapes [PTS10].

D.11 The Open Group Architecture Framework (TOGAF®)

TOGAF® is an open, industry-neutral enterprise architecture framework developed by the Open Group Architecture Forum. The core of TOGAF® is the Architecture Development Method (ADM), an approach for creating systems or whole enterprise architectures [Kel11].

TOGAF Foundations

The TOGAF® framework is the de facto global standard for EAM. It is an open enterprise architecture framework, meaning that it is applicable across all industries [BBL12]. The Open Group Architecture Forum, comprising more than 200 enterprises, develops and maintains the TOGAF® standard and publishes successive versions at regular intervals. The latest release is TOGAF® version 9.1 published in late 2011 [11b].

The TOGAF® framework comprises a detailed method for developing architectures as well as a set of supporting tools [Kel11]. Generally, an architecture can be developed for single systems or subsystems, clusters of applications systems or for blueprints of the top level architecture of an

enterprise [Kel11]. The term enterprise architecture is defined as *"A formal description of a system, or a detailed plan of the system at component level to guide its implementation."* [11b].

TOGAF® Architecture Development Method (ADM)

The core of TOGAF® is the Architecture Development Method (ADM), a method describing the activities and artifacts necessary to transform an EA from a current state towards a target state [11b]. In order to do so, the ADM addresses a business need through a process of visioning, architecture definition, transformation planning, and architecture governance. The whole process consists of ten phases including the preliminary and the requirements management phase as depicted in Figure D.12 [11b].

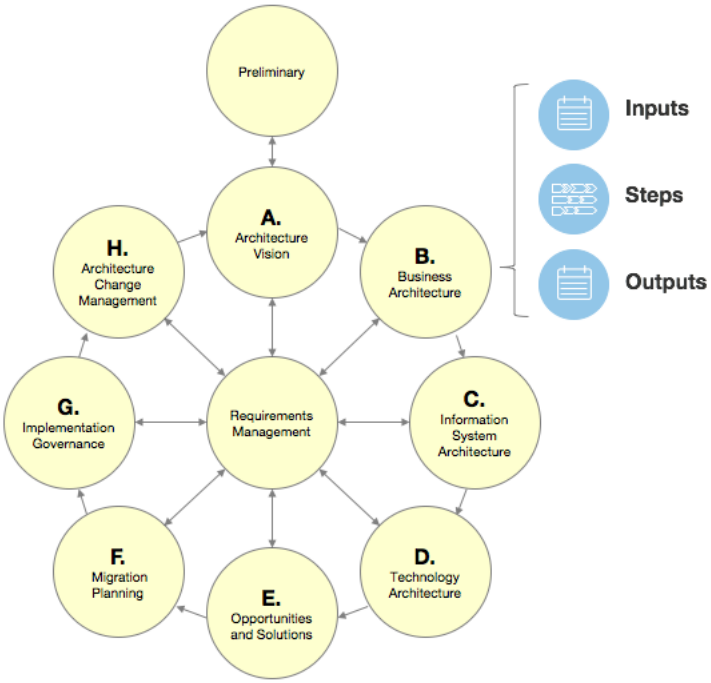


Figure D.12: TOGAF® Architecture Development Method (ADM) [16].

Each of these phases is split up into several steps necessary to achieve the goal of the respective phase [11b]. Additionally, for each phase a list of artifacts necessary as input and a list of documents that will be produced as output of the phase is given [11b]. The ADM is an iterative method, encouraging iterations over the whole process, between phases, and between steps [11b]. Further, it is a generic method, meaning that it is necessary to modify or extend the ADM to meet specific needs of certain enterprises [11b]. Summarizing, ADM can be seen as a condensed checklist guiding enterprise architects through the development of a certain architecture [Kel11].

Additional TOGAF® Tools

Additional tools supporting the ADM are the Architecture Content Framework, the Enterprise Continuum, Reference Models and the Architecture Capability Framework[11b]. The Architecture Content Framework is a meta-model which is used for structuring and storing the artifacts produced during the execution of the ADM [11b; Kel11]. The Enterprise Continuum is a view on the repository, which stores all architecture artifacts an enterprise wants to re-use [11b]. Additionally, two reference models are provided, namely the Technical Reference Model (TRM) and the Integrated Information Infrastructure Reference Model (III-RM) [11b]. The major benefit of these two reference models is the establishment of an extensive taxonomy with regards to applications, application platforms and their communication infrastructure [11b]. Finally, the Architecture Capability Framework provides support on topics relevant for establishing an EAM function in an enterprise [11b; Kel11].

Advantages and Challenges of TOGAF®

An advantage of TOGAF® is its compatibility with other recognized enterprise frameworks, meaning that the ADM can be used for developing the products associated with e.g. the Zachman, FEAF, TEAF or C4ISR/DoD framework [11b; Kel11]. Also, TOGAF® it is an internationally accepted standard and the ADM is a mature and extensive method [Kel11]. Additionally, trainings and certificates as well as TOGAF® compliant tools are available.

On the downside, TOGAF® version 9.1 has some 690 pages and is a major challenge to read, making it difficult for non-experts to get access to the topic. Further, strategic EAM tasks like IT strategy development or IT portfolio management are not addressed [Kel11]. Finally, the process description in the ADM is very generic and coarse-grained [Hau+14b].

In summary, TOGAF® is a standard with an emphasizes on the development of architectures and not so much on other EAM tasks [Kel11]. Nevertheless, it enables organizations to foster a common language between stakeholders, avoids a lock-in on proprietary solutions for EAM and allows cost reduction due to the more effective use of EAM resources.

TOGAF® Version 9.1 can be downloaded or viewed online.

D.12 Zachman Framework

The Zachman Framework is a visualization schema, which captures the whole EA using a predefined set of models [BBL12]. The models are organized in a matrix with the first dimension

describing one particular aspect of an enterprise and the second dimension associating it with a certain stakeholder view [Intb].

Zachman Framework Foundations

The Zachman Framework is one of the first approaches to EAM [BMS10b; BBL12]. Basically, it is a schema for classifying and organizing a set of models/artifacts used to describe an entire enterprise architecture [Intc]. This schema is derived from other disciplines, namely architecture and engineering, where the organization of artifacts resulting from the production of complex physical products like buildings or airplanes was already explored [Intc].

The concept of the framework is illustrated in the 6x6 matrix represented in Figure D.13.

	What? (Data)	How? (Function)	Where? (Location)	Who? (People)	When? (Time)	Why? (Motivation)
Business Concept Planner	Inventory Identification	Process Identification	Distribution Identification	Responsibility Identification	Timing Identification	Motivation Identification
Business Concept Owner	Inventory Definition	Process Definition	Distribution Definition	Responsibility Definition	Timing Definition	Motivation Definition
Business Logic Designer	Inventory Representation	Process Representation	Distribution Representation	Responsibility Representation	Timing Representation	Motivation Representation
Business Physics Builder	Inventory Specification	Process Specification	Distribution Specification	Responsibility Specification	Timing Specification	Motivation Specification
Business Component Implementer	Inventory Configuration	Process Configuration	Distribution Configuration	Responsibility Configuration	Timing Configuration	Motivation Configuration
User	Inventory Instantiations	Process Instantiations	Distribution Instantiations	Responsibility Instantiations	Timing Instantiations	Motivation Instantiations

Figure D.13: Simplified Zachman Framework [Intb].

The rows of the matrix constitute the different perspectives of the EAM stakeholders [BBL12]. These stakeholders are the planner, the owner, the designer, the builder and the implementer of an enterprise as well as the enterprise itself [Intb]. Each of those views is of different nature, not just a representation of a different levels of abstraction of the enterprise [Zac87].

The columns of the matrix each describe disparate aspects of the enterprise [Zac87]. The possible aspects are described using key questions, more specifically the questions what? (data), where? (location), how? (function), who? (people), when? (time) and why? (motivation) [Intb]. Each of those aspects can stand alone even though they describe the same object [Zac87]. Also, the columns should be considered as being equal in importance [BBL12].

In the resulting matrix, each cell contains a model of a certain aspect of the enterprise from the perspective of a certain stakeholder[BBL12]. Therefore, the matrix constitutes the total set of models needed for describing the enterprise [Intb]. The models are all related but at the same time represent unique concepts of the same enterprise [Zac87]. Combining the models in one row forms a complete view from the perspective of one type of stakeholder [BBL12].

Advantages and Challenges of the Zachman Framework

The benefit of the Zachman Framework is, that it provides a holistic perspective on the whole enterprise while at the same time allowing to focus on certain aspects of the object [Intc]. Thereby, informed decision making with regards to creating, operating, and transforming the enterprise is enabled [Intb].

A deficit of the framework is, that it doesn't provide any insight into relationships in between single models [BBL12]. Further, is does not specify how to collect, manage or interpret the information that is organized in the framework [BBL12].

Concluding, it needs to be emphasized that the Zachman Framework constitutes a structure for documenting an enterprise architecture [Intb]. This means, it is not providing an EAM process for enterprise transformation [Intb]. Hence, it is best used in combination with other frameworks [BBL12].

Appendix E

Short Survey

E.1 Simple Survey

The simple survey handed out in section 6.1 is depicted in the following.

Introduction

Evaluation of the Website eam-initiative.org

Dear Sir or Madam,

thank you for participating in this survey which aims at evaluating our website eam-initiative.org. The mission of the website is to make Enterprise Architecture Management (EAM) accessible to a wider audience and to advance the effectiveness of EA initiatives based on contributions from the EA community.

The survey is split into three parts and completing it will take about 5-10 minutes. The results of this survey will be incorporated in a Master Thesis about the website.

In case of questions regarding the survey or regarding the website eam-initiative.org, please don't hesitate to contact me at gloria.bondel@tum.de.

Thank you very much!

Gloria Bondel

Section 1: Website eam-initiative.org

Please take a couple of minutes to look at our website eam-initative.org.
Afterwards, please answer the following questions:

I understand the mission of the website eam-initiative.org.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

The website eam-initiative.org is clearly structured.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

The website eam-initiative.org is easy to navigate.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

The website eam-initiative.org is designed in an appealing way.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

I would use the website eam-initiative.org to acquire or deepen my knowledge about Enterprise Architecture Management (EAM) concepts.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

I would recommend the website eam-initiative.org to a friend who wants to acquire or deepen his knowledge about Enterprise Architecture Management (EAM) concepts

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

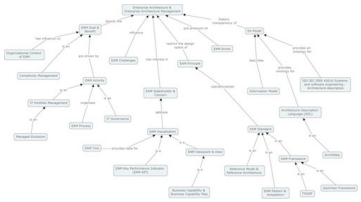
I would share my Enterprise Architecture Management (EAM) related knowledge on a website like eam-initiative.org.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

If you have further remarks with regards to the website eam-initiative.org, please indicate them here:

Section 2: Concept Map

Please take a look at the Concept Map provided at eam-initiative.org. The concept map was created using the concepts defined as foundational to the field of Enterprise Architecture Management (EAM).



With regards to this concept map, please answer the following questions:

The Concept Map provides a meaningful overview of Enterprise Architecture Management (EAM) concepts and their relationships.

○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree

The Concept Map provides important additional insights into the field of Enterprise Architecture Management (EAM).

○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree

The Concept Map provides easy access to the topic of Enterprise Architecture Management (EAM).

○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree

If you have further remarks with regards to the Concept Map, please indicate them here:

Section 3: Information about the Participant

For evaluation purposes, please fill in some basic information about your organization and your Enterprise Architecture Management (EAM) experience.

In what kind of industry is your organization operating?

Dropdown: [Agriculture, Mining; Communication, Utilities; Construction; Education, University; Finance, Insurance, Real Estate; Government; Health Care; IT, Technology, Internet; Manufacturing; Nonprofit; Retail, Wholesale; Services; Transportation; Others (Comment)]

How many people are employed within your organization?

Dropdown: [1 - 10; 11 - 50; 51 - 250; 251 - 500; 501 - 1.000; 1.001 - 2.000; 2.001 - 5.000; 5.001 - 10.000; 10.001 - 50.000; 50.001 - 100.000; > 100.000]

How much revenue did your organization generate in 2015 (US Dollars)?

Dropdown: [Non profit; 1 - 50.000; 50.001 - 100.000; 100.001 - 500.000; 500.000 - 1.000.000; 1 Mil. - 5 Mil.; 5 Mil. - 50 Mil.; 50 Mil. - 500 Mil.; 500 Mil. - 1 Bil.; 1 Bil. - 5 Bil.; > 5 Bil.]

In which country does your organization have its headquarter?

Dropdown: [Germany; Other (Comment)]

In which country do you operate for your organization?

Dropdown: [Germany; Other (Comment)]

Is your organization operating on national or international level?

Dropdown: [National; International]

How many years has your organization been engaged with Enterprise Architecture Management (EAM)?

Dropdown: [<1; 1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12; 13; 14; 15; 16; 17; 18; 19; 20; > 20]

What is your present role in the organisation?

Dropdown: [Technical Architect (Security Architect, Software Architect, Technical Architect); Enterprise Architect; Domain Architect / Solution Architect; Business Architect / Process Architect; Internal Audit / External Audit / Revision; External Partner / Consultant; Controller (Business or IT); Head of Department IT; Head of Department Business; Project Manager IT; Project Manager Business; Portfolio Manager (Business of IT); Corporate Development / Corporate Governance; Software Developer; Requirements Engineer; Business Analyst; Process Owner; Data Owner; Business Owner; Application Owner; Others (Comment)]

How many years of experience do you have with Enterprise Architecture Management (EAM)?

Dropdown: [<1; 1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12; 13; 14; 15; 16; 17; 18; 19; 20; > 20]

Thank you for your participation. Your answer has been recoded.

Appendix F

Initiator Survey

F.1 Extended Survey

The extended survey handed out in section 6.1 is depicted in the following.

Introduction

Evaluation of the Website eam-initiative.org

Dear Initiator,

thank you for participating in this survey which aims at evaluating our website eam-initiative.org. As you know, the mission of the website is to make Enterprise Architecture Management (EAM) accessible to a wider audience and to advance the effectiveness of EA initiatives based on contributions from the EA community.

The survey is split into four sections and completing it will take about 20 minutes. The second section is quite extensive and will probably need most of the time, but all other sections are a lot shorter. The results of this survey will be incorporated in my Master Thesis about the website.

In case of questions regarding the survey or regarding the website eam-initiative.org, please don't hesitate to contact me at gloria.bondel@tum.de.

Thank you very much!

Gloria Bondel

Section 1: Website eam-initiative.org

Please take a couple of minutes to look at our website eam-initative.org.
Afterwards, please answer the following questions:

I understand the mission of the website eam-initiative.org.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

The website eam-initiative.org is clearly structured.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

The website eam-initiative.org is easy to navigate.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

The website eam-initiative.org is designed in an appealing way.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

I would use the website eam-initiative.org to acquire or deepen my knowledge about Enterprise Architecture Management (EAM) concepts.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

I would recommend the website eam-initiative.org to a friend who wants to acquire or deepen his knowledge about Enterprise Architecture Management (EAM) concepts

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

I would share my Enterprise Architecture Management (EAM) related knowledge on a website like eam-initiative.org.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

If you have further remarks with regards to the website eam-initiative.org, please indicate them here:

Section 2: Enterprise Architecture Management (EAM) Foundations

On the website eam-initiative.org, I defined a couple of concepts as being foundational to the field of Enterprise Architecture Management (EAM) based on literature research. Since the website aims at being relevant mainly for practitioners, it would be great if you could indicate which concepts you categorise as being foundational in Enterprise Architecture Management (EAM).

Looking at the concepts and their short descriptions listed below, which concepts would you categorise as being foundational to the field of Enterprise Architecture Management (EAM), especially with a focus on practical application of Enterprise Architecture Management (EAM)? You can tick as many concepts as you want to. If you need more information on one of those concepts, you can look up more extensive descriptions on eam-initiative.org. If you have any remarks with regards to a certain concept or its description, you can fill it into the text field provided below each concept.

- **ArchiMate®:** ArchiMate® provides an Enterprise Architecture modeling language which defines core concepts as well as their graphical illustration. The core of ArchiMate® is the ArchiMate® framework, which allows to categorize elements along two dimension
- **Architecture Description Language (ADL):** An Architecture description language (ADL) is domain-specific modeling language for EAM.
- **Business Capability & Business Capability Map:** A Business Capability is a functional building block of the business architecture that supports the business model and the business strategy. It defines the organization's capacity to successfully perform a unique business activity. Based on Business Capabilities, Business Capability Maps can be created, which enable the assessment of capabilities and support the identification and communication of EA demands.
- **Collaborative EAM:** Collaborative EAM fosters and moderates participation of different stakeholders in the EAM process.
- **Complexity Management:** High complexity due to uncontrolled growth makes it difficult to manage application landscapes efficiently. The goal of EAM is to consolidate the IT landscape using portfolio management, standards, and a clear assignment of responsibilities.
- **EA and EAM Definition:** The Enterprise Architecture (EA) is a model of the enterprise's most important elements and their relationships. Enterprise Architecture Management (EAM) is the process of creating and using the EA.
- **EA Layer:** An organization can be conceptually divided into different architectural layers. For example, TOGAF defines four layers, namely the business architecture layer, the data architecture layer, the application architecture layer and the technology architecture layer.
- **EA Model:** EA Models capture the enterprise architecture with the purpose of making it transparent and thus enabling informed decision making and effective enterprise architecture development.
- **EA Visualization:** Visualizations enable effective communication with stakeholders.
- **EAM Activity:** EAM comprises a multitude of activities. Which activities are implemented in an enterprise depends on the goals which are chosen to be accomplished by EAM.
- **EAM Challenge:** Challenges of EAM are manifold. Often mentioned examples are unclear business goals and ad-hoc EAM demands.
- **EAM Data Collection:** To create an EA Model, data from different sources need to be collected and integrated. This is a non-trivial process.

- **EAM Driver:** Fast changing environments lead to the need for continuous business transformation. Enterprise Architecture Management is a good measure to cope with need.
- **EAM Framework:** An EAM framework comprises a predefined set of methods and tools for developing enterprise architectures and enterprise architecture practice.
- **EAM Goal:** Possible goals of EAM are manifold. Some of the most prominent goals are IT cost reduction, alignment of business and IT, and IT landscape consolidation.
- **EAM Information Model:** An Information Model is a simplified representation of the elements of an Enterprise Architecture, their attributes and their relations to each other. A good information model can reduce the complexity of an enterprise architecture and supports informed decision making.
- **EAM Key Performance Indicator (EAM KPI):** EAM Key Performance Indicators (KPIs) are used to measure EAM goal achievement.
- **EAM Organization:** EAM can be internally organized in many different ways. This comprises for example where the EAM team is located within the organigram or what roles and processes are implemented.
- **EAM Pattern & Antipattern:** Enterprise architecture patterns are general, reusable solutions to standard problems encountered in enterprise architecture management. They are extracted from real world situations.
- **EAM Principle:** Enterprise architecture principles constitute generally valid guidelines for the development of an Enterprise Architecture.
- **EAM Process:** An EAM process aims at providing a simple guideline for implementing and conducting EAM activities.
- **EAM Reference Model & Reference Architecture:** A reference model or a reference architecture is a technological solution pattern for the design of a system.
- **EAM Stakeholder & Concern:** EA stakeholders are all people who have any kind of concern with regards to a companies' Enterprise Architecture. These concerns need to be addressed by models provided through Enterprise Architecture Management.
- **EAM Standard:** Standards increase the homogeneity of an application landscape by limiting the number of allowed in-use technologies. If implemented correctly, standards lead to cost savings and improved productivity with regards to IT solutions.
- **EAM Tools:** EAM Tools support the collection and the visualization of Enterprise Architecture related information.
- **EAM View & Viewpoint:** Viewpoints define conventions on how to address the concerns of stakeholders with regards to certain systems-of-interest. Views result from the application of viewpoints to a system.
- **Enterprise Transformation:** The Enterprise Architecture of an enterprise needs to be continuously transformed to meet changing business needs. This transformation is implemented via projects.
- **ISO/IEC/IEEE 42010:2011 Systems and software engineering - Architecture description:** ISO/IEC/IEEE 42010:2011 provides an ontology defining architecture elements, architecture frameworks and architecture description languages.
- **IT Governance:** IT Governance comprises the entirety of structures, processes, roles used to ensure that IT supports the company strategy. Effective implementation of such a governance requires models provided by EAM.
- **IT Portfolio Management:** The goal of portfolio management is to decide which projects with an impact on the enterprise architecture should be implemented based on their expected benefits.

- **IT Strategy:** The IT strategy is derived from the enterprises' business strategy and is one of the major drivers of EAM, since the enterprise architecture aims at optimally supporting the IT strategy at any time.

- **Managed Evolution:** The managed evolution approach is an iterative, controlled and continuous approach for EA development. The approach ensures that each transformational project influences the business value and the EA quality positively.

- **Organizational Context of EAM:** Organizational factors like IT organization and budgeting need to be taken into account when establishing an EAM process.

- **Role of an Enterprise Architect:** An Enterprise Architect has to have many different skills like EA related skills for e.g. IT Portfolio Management or being able to use an EAM Tool, as well as operational IT skills, which are needed to accompany IT projects.

- **Service Oriented Architecture (SOA):** Service Oriented Architecture (SOA) is an integration strategy for applications within an application landscape. The idea is, that IT functionalities are offered as services to the users within at outside of the enterprise. Services can be obtained from inside and outside of the enterprise.

- **TOGAF:** TOGAF® is an open, industry-neutral enterprise architecture framework developed by the Open Group Architecture Forum. The core of TOGAF® is the Architecture Development Method (ADM), a method for developing system or enterprise architectures.

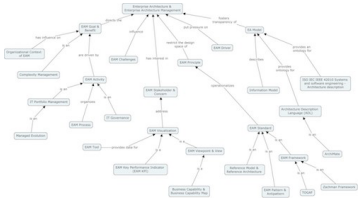
- **Zachman Framework:** The Zachman Framework is a visualization schema, which captures the whole enterprise architecture using a predefined set of models. The models are organized in a matrix with the first dimension describing one particular aspect of an enterprise and the second dimension associating it with a certain stakeholder view.

Are there any additional concepts, that you would categorize as foundational concepts of the Enterprise Architecture Management (EAM) field? If so, please indicate them here:

If you have further remarks with regards to foundation concepts of Enterprise Architecture Management (EAM), please indicate them here:

Section 3: Concept Map

Please take a look at the Concept Map provided at eam-initiative.org. The concept map was created using the concepts defined as foundational to the field of Enterprise Architecture Management (EAM).



With regards to this concept map, please answer the following questions:

The Concept Map provides a meaningful overview of Enterprise Architecture Management (EAM) concepts and their relationships.

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

The Concept Map provides important additional insights into the field of Enterprise Architecture Management (EAM).

○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree

The Concept Map provides easy access to the topic of Enterprise Architecture Management (EAM).

○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree

If you have further remarks with regards to the Concept Map, please indicate them here:

Section 4: Information about the Participant

For evaluation purposes, please fill in some basic information about your organization and your Enterprise Architecture Management (EAM) experience.

In what kind of industry is your organization operating?

Dropdown: [Agriculture, Mining; Communication, Utilities; Construction; Education, University; Finance, Insurance, Real Estate; Government; Health Care; IT, Technology, Internet; Manufacturing; Nonprofit; Retail, Wholesale; Services; Transportation; Others (Comment)]

How many people are employed within your organization?

Dropdown: [1 - 10; 11 - 50; 51 - 250; 251 - 500; 501 - 1.000; 1.001 - 2.000; 2.001 - 5.000; 5.001 - 10.000; 10.001 - 50.000; 50.001 - 100.000; > 100.000]

How much revenue did your organization generate in 2015 (US Dollars)?

Dropdown: [Non profit; 1 - 50.000; 50.001 - 100.000; 100.001 - 500.000; 500.000 - 1.000.000; 1 Mil. - 5 Mil.; 5 Mil. - 50 Mil.; 50 Mil. - 500 Mil.; 500 Mil. - 1 Bil.; 1 Bil. - 5 Bil.; > 5 Bil.]

In which country does your organization have its headquarter?

Dropdown: [Germany; Other (Comment)]

In which country do you operate for your organization?

Dropdown: [Germany; Other (Comment)]

Is your organization operating on national or international level?

Dropdown: [National; International]

How many years has your organization been engaged with Enterprise Architecture Management (EAM)?

Dropdown: [<1; 1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12; 13; 14; 15; 16; 17; 18; 19; 20; > 20]

What is your present role in the organisation?

Dropdown: [Technical Architect (Security Architect, Software Architect, Technical Architect); Enterprise Architect; Domain Architect / Solution Architect; Business Architect / Process Architect; Internal Audit / External Audit / Revision; External Partner / Consultant; Controller (Business or IT); Head of Department IT; Head of Department Business; Project Manager IT; Project Manager Business; Portfolio Manager (Business of IT); Corporate Development / Corporate Governance; Software Developer; Requirements Engineer; Business Analyst; Process Owner; Data Owner; Business Owner; Application Owner; Others (Comment)]

How many years of experience do you have with Enterprise Architecture Management (EAM)?

Dropdown: [<1; 1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12; 13; 14; 15; 16; 17; 18; 19; 20; > 20]

Thank you for your participation. Your answer has been recoded.

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