

# CHALLENGES IN ENTERPRISE ARCHITECTURE MANAGEMENT: OVERVIEW AND FUTURE RESEARCH

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## Abstract

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Due to the ongoing digitalization, today's business world is changing rapidly. To stay competitive, companies need to adapt quickly to a fast changing-environment. This can be difficult, as organizations are complex systems consisting of many technical and infrastructural elements. Enterprise architecture management (EAM) is therefore increasingly important to companies when managing their infrastructure and adapting it to environmental changes. Despite its relevance, many companies struggle with challenges related to EAM tasks. Up to now, research lacks comprehensive reviews about the field of EAM and the related challenges. This article aims to close this research gap by conducting an iterative systematic literature review (SLR) to identify relevant EAM challenges in different EAM tasks. Hereto, based on Schmidt and Buxmann (2011), the tasks of EAM are divided into six dimensions — EA documentation, EA planning, EA communication and support, EA programming, EA implementation, and EA governance — which are investigated separately. This article's result is a comprehensive overview of research in the field of EAM challenges. Additionally, interdependencies between the dimensions are assumed. Furthermore, an outlook on future research opportunities from an organizational, corporate governance, project, and technical perspective is provided.

**Keywords:** Enterprise Architecture, Enterprise Architecture Management, Literature Review, EAM Challenges, EAM Tasks

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## 1. INTRODUCTION

In the current age of digitalization, the business world is changing rapidly and dramatically due to the usage of new information technologies (Urbach & Ahlemann, 2016). In order to stay competitive, it is

a decisive factor to adapt fast to the new and steadily changing environment (Ahlemann, Stettiner, Messerschmidt, & Legner, 2012). However, enterprises are complex systems consisting of interconnected social, technical, and infrastructural elements. To be successful in this age, it is important for

organizations to understand, engineer, and manage the complexity of the enterprise (Nightingale & Rhodes, 2004). A suitable approach to understand the entire organizational system, the interrelations, and to manage its complexity, is enterprise architecture management (EAM) (Lange & Mendling, 2011).

EAM is a well-investigated area in information system research. The management of enterprise architecture (EA) is a complex task due to the relationships and interactions between the elements of an EA (Jugel & Schweda, 2014). An EA represents the structure of the business its IT landscapes and their interrelations. It provides descriptions that focus on a domain-aspect (e.g., business or IT infrastructure) and time-aspect (e.g., as-is or to-be architecture) (Tamm, Seddon, Shanks, & Reynolds, 2011). Thereby, an EA can consist of thousands of different business applications (Buckl, Ernst, Matthes, & Schweda, 2009). Stakeholders have different information needs of an EA that range from only knowing the used applications, the interdependencies between objects, up to an overview of the entire EA (Rehring, Greulich, Bredenfeld, & Ahlemann, 2019b).

Despite this complexity, EA is important for business innovation, information technology success, and technology adoption (Stecher, Pohl, & Turowski, 2020). Information technology (IT) is increasingly important, and many organizations rely on IT to be able to realize their objectives and activities (Batyashe & Iyamu, 2016). In the context of digital transformation, governing IT successfully is, therefore, an important aspect. The corporate board should thus pay attention to, for example, data governance (Correia & Água, 2021; Jagals, Karger, & Ahlemann, 2021) as well as information systems governance (Água & Correia, 2021). By providing an overview and a well-founded basis for decision-making in enterprises, EA can help companies with decisions about, for instance, reduced costs and complexity, an increased business and process flexibility, or an improved business-IT alignment (Tamm et al., 2011).

This well-founded decision-making offers rational arguments about EA (van der Linden & van Zee, 2015). However, several researchers described a low usage of EAs in the context of decision-making in organizations (Hiekkanen et al., 2013; Löhe & Legner, 2014). This has its reasons, for instance, in the understanding and quality of the visualization of EA models (Buckl et al., 2009; Löhe & Legner, 2014). Regardless of its relevance, many companies are still facing numerous challenges when implementing EAM. For example, architects of an EA struggle with the rapid changes and the documentation of these tasks due to inadequate tool support (Kleehaus & Matthes, 2021). Another example is employees of organizations criticizing a supporting lack from the EA based on missing resources like time or know-how (Uludag, Kleehaus, Reiter, & Matthes, 2019).

In recent research, different literature reviews and bibliometric studies within the field of EA were published. For example, Simon, Fischbach, and Schoder (2013) provided a comprehensive overview of the literature about EA. As a more recent example, Gampfer, Jürgens, Müller, and Buchkremer (2018) conducted a holistic and systematic literature

review (SLR) and presented a historical overview of research about EA. Research has also described numerous difficulties in the implementation of EAM tasks, already. To the best of our knowledge, however, there is still no overview or literature review with a clear focus on the identified challenges related to EAM. This lack of research is surprising, as the area of EAM is an important field for practice and many challenges seem to remain unsolved. Furthermore, a lot of interdependencies exist between the different EAM tasks and challenges. Therefore, a view covering the area of EAM as a whole is necessary to successfully address existing challenges. This review wants to close this research gap and aims to structure the research field of EAM challenges, identify open research directions, and thus serve as a platform for future research (Paul & Criado, 2020). By conducting an iterative systematic literature review, the following two research questions are investigated:

*RQ1: What are the tasks of enterprise architecture and which challenges do exist?*

*RQ2: What are future research directions and opportunities in the field of EAM challenges?*

The rest of this paper is structured as follows. In the next section, the theoretical foundations of EA and EAM are described to ensure a common understanding. The third section describes the applied research method, namely an iterative SLR that was conducted to identify the tasks of EAM as well as their challenges. The results of the literature review about EAM tasks and their challenges are outlined in the findings section. In Section 5, the contributions of the research are presented, as well as an outlook on future research opportunities, based on this paper's results. This article ends with a conclusion that includes a short summary of the results.

## 2. THEORETICAL FOUNDATIONS

Enterprises struggle with the complex information technology environment and their frequent changes (Kleehaus & Matthes, 2019; Winter, Legner, & Fischbach, 2014). However, for a successful enterprise, it is important to understand, develop, and manage this complexity (Nightingale & Rhodes, 2004). EA aims to address these problems by trying to give a holistic overview and norms. The discipline of EA has been introduced in the 1980s and has since then evolved into a popular practice with the goal to manage information systems and align them with business needs (Gampfer et al., 2018). EA is said to have many different advantages and benefits. Examples include, among others, a reduction of complexity of business-IT alignment and reduced costs and risks when realizing projects (Foorthus, van Steenbergen, Brinkkemper, & Bruls, 2016).

In general terms, an EA can be considered as a framework to ensure the consistency of organizational objects, policies, IT objectives, and the decision-making process related to the information technology systems (Alonso, Verdún, & Caro, 2010). Thereby, architectural decision-making is influenced by stakeholders and their communication, organizational culture, and governance mechanism (Roos & Mentz, 2018). In research, however, many different definitions of EA exist (Rahimi, Götze, & Møller, 2017). The difference among these definitions

is based on their diverse understanding of architecture and their enterprise scope. Based on their understanding of architecture, the definitions can be grouped into different categories: 1) description of an enterprise, 2) inherent structure of an enterprise, 3) inherent structure and management approach, 4) principles for guiding enterprise design, and 5) management approach for guiding enterprise design. Because this paper focuses on the challenges of EAM tasks, we rely on the definition of Lankhorst (2017). He defines EA as “a coherent whole of principles, methods, and models that are used in the design and realization of the enterprise’s organizational structure, business processes, information systems, and infrastructure” (Lankhorst, 2017, p. 3).

According to Fischer, Aier, and Winter (2007), there are three main goals of EA: First, the current as-is architecture needs to be documented and communicated. Second, EA has to support the to-be architecture’s design. And third, projects that aim to transform the as-is into the to-be architecture have to be implemented and realized. Recent research mentioned at least part of these goals (Rehring et al., 2019b; Zhang, Chen, & Luo, 2018). These goals are supported by EA models that create transparency, measurability, and consistency. In addition, a critical success factor for EA is the effective collaboration and engagement between different EA stakeholders (Kurnia, Kotusev, & Dilnutt, 2020). EA stakeholders are employees who have an origin in a business or IT area, who are affected by EA. Examples of EA stakeholders are the top management level, project teams, and architects (Kurnia, Kotusev, Shanks, Dilnutt, & Milton, 2021).

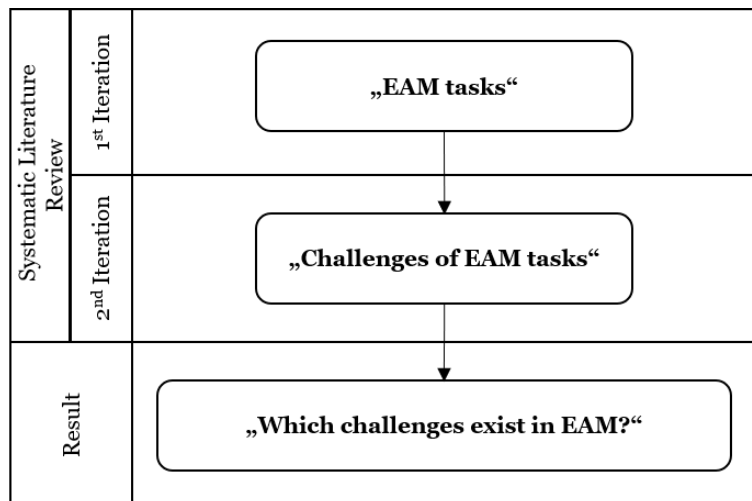
In the first years after the introduction of EA, research focused on understanding how to define different building blocks of EA and their dependencies. However, in recent years, an increasing amount of research appeared that focused on the management of EA, referred to as EAM (Gampfer et al., 2018). EAM has become an appropriate approach to manage and understand the complexity and change of an EA (Lapalme et al., 2016). An EAM supports an organization to improve its business performance by creating architectural

transparency, a documented architectural vision, and the definition of clear architectural principles and guidelines (Ahlemann et al., 2012). EAM provides different tools and methods for the establishment, maintenance, and development of an EA from an integrated and holistic view (Aier, Gleichauf, & Winter, 2011; Simon, Fischbach, & Schoder, 2014). It aims to help stakeholders in cases of analyzing the as-is architecture and planning and defining requirements for to-be architectures independently of their background (Farwick et al., 2010). In order to fulfill the goals of EA, this paper is based on the definition of Ahlemann et al. (2012) that includes four different characteristics of an EAM. These characteristics describe EAM as a management philosophy, organizational function, methodology, and culture. Ahlemann et al. (2012) define EAM as “a management practice that establishes, maintains and use a coherent set of guidelines, architecture principles and governance regimes that provide direction for and practical help with the design and the development of an enterprise’s architecture in order to achieve its vision and strategy” (p. 20). To fulfill the goals of an EA, the tasks of EAM can be grouped into the six dimensions: EA documentation, EA planning, EA programming, EA implementation, EA communication and support, and EA governance (Schmidt & Buxmann, 2011). These dimensions and their corresponding challenges that were identified in the literature are described in the findings section.

### 3. RESEARCH DESIGN

This paper is based on a SLR to identify 1) the different tasks of EAM and 2) the challenges of these tasks. A SLR may be used to evaluate and interpret “all available research to a particular research question, topic area or phenomenon of interest” (Kitchenham & Charters, 2007, p. 7). To answer the previously defined research questions, a SLR, therefore, was found to be a meaningful research method. We followed the guidelines of Kitchenham and Charters (2007) for conducting this research.

Figure 1. Illustration of the systematic literature review process



For the complete research, we conducted a two-folded iterative SLR that is visualized in Figure 1. In the first iteration, we aimed to get an overview of the different tasks of EAM. In a second iteration, we aimed to search for challenges of the different identified EAM tasks. We conducted separate literature searches for each EAM task to not miss any important publication. This second iteration is based on the results, namely the identified dimensions of EAM tasks, of the first iteration. Therefore, seven SLRs were conducted that are independent of each other. We used Scopus as our primary database. Scopus is a meta-database that covers searches in several scientific journals and references (Paul & Criado, 2020). To make sure to not miss any relevant publication, we additionally searched in the Association for Information Systems

(AIS) Electronic Library and IEEE Xplore since these are databases covering relevant research within computer science and information systems. Finally, we did a search in the Senior Scholars' Basket of Journals (<https://aisnet.org/page/SeniorScholarBasket>).

After we defined the research questions, we derived the first SLR's search string of it. Besides the term "enterprise architecture management" and "EAM", it contains the terms "task", "goal", and "objective" to identify publications that describe tasks directly, and tasks that are needed to fulfill the goals of EAM. In the second iteration, we built each search string based on a combination of the identified task dimensions and the term "challenge". The following Table 1 gives an overview of the search strings of each literature review.

**Table 1.** Overview of the used databases and search strings for each literature review

Topic	Search strings
<b>1st iteration: EAM tasks</b>	
EAM tasks	("enterprise architecture management" OR EAM) AND (task OR goal OR objective)
<b>2nd iteration: Challenges of EAM tasks</b>	
EA documentation	("EA documentation" OR "enterprise architecture documentation") AND challenge
EA planning	("EA planning" OR "enterprise architecture planning") AND challenge
EA programming	("EA programming" OR "enterprise architecture programming") AND challenge
EA implementation	("EA implementation" OR "enterprise architecture implementation") AND challenge
EA communication and support	((("EA support" OR "enterprise architecture support") AND challenge) OR ("EA communication" OR "enterprise architecture communication")) AND challenge
EA governance	("EA governance" OR "enterprise architecture governance") AND challenge

To get a final sample in each of the literature reviews, we conducted three steps of eliminations to select the identified studies. First, we removed publications based on their title, abstract, and keywords. If the publication does not fit the topic of research by reading the title, abstract, and keywords, it was eliminated from the sample. Secondly, we read the full text of each remaining publication. If a publication was relevant for the results of the respective iteration, it was added to the final

sample. For being relevant, the publication should describe at least one EAM task (first iteration) or at least one challenge of an EAM task dimension (second iteration). After this selection process, we conducted an additional backward search in each literature review. Table 2 gives an overview of the elimination criteria, the process of it, and the number of the final sample of each literature review.

**Table 2.** Overview of the elimination criteria and the resulting numbers of publications

Topic	Sample after the search in the databases	Sample after reading the title, abstract, and keyword	Sample after reading the full text	Publication identified by a backward search	Final sample
<b>1st iteration: EAM tasks</b>					
EAM tasks	104	43	12	8	20
<b>2nd iteration: Challenges of EAM tasks</b>					
EA documentation	185	126	9	3	12
EA planning	362	124	5	2	7
EA programming	47	40	0	1	1
EA implementation	326	193	7	3	10
EA communication and support	65	41	4	2	6
EA governance	137	100	7	2	9

For summarizing and getting an overview of the EAM tasks and their challenges, we used the approach of the concept matrix based on Webster and Watson (2002). It helps by structuring the results and enabling a discussion for each matrix. This research provides a basis to identify and structure the EAM tasks and their challenges.

#### 4. FINDINGS

This section is divided into two parts. In the first subsection, the identified dimensions of EAM tasks are described. In the second subsection, the challenges of each of the identified dimensions are explained.

##### 4.1. EAM tasks

According to the framework of Schmidt and Buxmann (2011), the tasks of EAM can be categorized into six general dimensions. Schmidt and Buxmann (2011) group the six dimensions into strategic and operational tasks. The strategic tasks consist of the dimensions: EA documentation, EA planning, and EA programming. The operational tasks include EA implementation, EA communication and support, and EA governance. These six dimensions are the basis of the categorization of the tasks, and they are extended by tasks that are described by other authors. As our literature analysis shows, the categorization is complete, which is why it is

used below to describe our results. Thereby, the literature review shows that tasks regarding the EA documentation dimensions are most

mentioned in the literature ( $n = 12$ ). In contrast, EA governance tasks are hardly ever considered in the literature ( $n = 4$ ).

**Table 3.** Overview of the publications describing EAM tasks

Publications		EAM task dimensions					
Author	Year	EA documentation	EA planning	EA programming	EA implementation	EA communication and support	EA governance
Abraham, Labusch, and Aier	2013			X	X	X	
Ahlemann et al.	2012	X	X	X	X	X	
Aier et al.	2011	X	X		X		
Aier	2014		X	X			
Boh and Yellin	2006			X		X	
Buckl et al.	2009	X	X	X			
Drews, Schirmer, Horlach, and Tekaas	2017	X	X	X	X	X	X
Farwick et al.	2010	X					
Hauder, Fiedler, Matthes, and Wüst	2013	X	X	X		X	
Hylving and Bygstad	2019	X				X	
Kotusev, Singh, and Storey	2015	X	X		X		
Lange, Mendling, and Recker	2016					X	X
Leppänen, Valtonen, and Pulkkinen	2007		X				
Löhe and Legner	2014	X				X	X
Pulkkinen, Naumenko, and Luostarinen	2007		X				
Richardson, Jackson, and Dickson	1990			X			
Schilling, Aier, and Winter	2019				X	X	
Schmidt and Buxmann	2011	X	X	X	X	X	X
Schneider, Schulz, and Matthes	2013	X					
Wißotzki and Koç	2013	X	X				
$\Sigma$		12	11	9	7	10	4

EA documentation is needed to manage the complexity of the current EA. It provides a basis for the management of an EA and supports decision-making (Schmidt & Buxmann, 2011). EA documentation contains activities of creating, maintaining, modifying, validating, and releasing current as-is documentation (Löhe & Legner, 2014) and helps to establish transparency around the EA (Ahlemann et al., 2012). In practice, the documentation focuses on the most important aspects of the enterprise architecture (Ahlemann et al., 2012; Schmidt & Buxmann, 2011) and models are usually complemented with management relevant information (e.g., security or risk information) (Ahlemann et al., 2012). These models are stored in repositories (Buckl et al., 2009; Schmidt & Buxmann, 2011). The models can be visualized by different traditional visualization types (e.g., tables, lists, or charts) (Roth, Zac, & Matthes, 2014) or new approaches like an augmented reality layer or city model (Rehring, Brée, Gulden, & Bredenfeld, 2019a; Rehring et al., 2019b). This dimension also includes the tasks of analyzing, evaluating, and complying these models and other EA artifacts and EA policies and analyzing the differences between the as-is situation and the planned to-be situation (Hauder et al., 2013; Löhe & Legner, 2014). Several authors mention different typical tasks like identification of the impact on the EA by new demands (Löhe & Legner, 2014) or the analysis of the current as-is architecture (Drews et al., 2017; Farwick et al., 2010).

The second identified EA task dimension is EA planning. Schmidt and Buxmann (2011) define EA planning “as a goal-oriented process of developing

descriptions of the target architecture based on global and long-term requirements” (p. 174). Mostly, different to-be architecture models are developed that cover different viewpoints, abstraction levels, scenarios, and time spans (Schmidt & Buxmann, 2011). Although these models often have a high abstraction level (Schmidt & Buxmann, 2011), they could include additional financial and strategic planning information (Abraham et al., 2013). They help the management in their decision-making by providing information about strategic initiatives’ implications and consequences from different views (Ahlemann et al., 2012). Additionally, the goal of EA planning is to improve the as-is situation by elaborating on development steps (Leppänen et al., 2007).

The last strategic task dimension is EA programming. It can be described “as the process of setting architecture rules and standards to be obeyed by change projects” (Schmidt & Buxmann, 2011, p. 174). It includes architectural principles (guidelines and rationales), as well as reference architectures and technical standards, that describe implementation rules and guidelines (Richardson et al., 1990; Schmidt & Buxmann, 2011). These standards can be documented in different ways (e.g., text, diagrams, pictures, and blueprints) (Boh & Yellin, 2006). The principles and standards are used to guide decision-making and purposeful development of an organization’s management related to IT resources (Ahlemann et al., 2012; Boh & Yellin, 2006). A successful EA programming may lead to reduced system variety and maintenance and operation costs (Boh & Yellin, 2006; Schmidt & Buxmann, 2011).

EA implementation is the first operational task dimension. Schmidt and Buxmann (2011) describe EA implementation as “the initiation and/or execution of system changes through the EAM function itself” (p. 174). It can include general system consolidation and the development of shared infrastructure components or reusable business services. Active EA implementation may result in improved IT flexibility and IT efficiency (Schmidt & Buxmann, 2011). After the implementation of a change, it is important to determine who will update the as-is architecture on time and keep the EA documentation consistent (Ahlemann et al., 2012). Therefore, the task of EA implementation is closely entangled with EA documentation.

EA communication and support is needed for an effective EA implementation as well as acceptance of EAM by the stakeholders. Communication comprises the activity to inform stakeholders about information and issues of the EA (Schmidt & Buxmann, 2011) and can be done in an oral or written way (Hylving & Bygstad, 2019). Information can be about EA artifacts and EA results (Hauder et al., 2013). EA support is needed during the planning and implementation phases of change projects that have to conform with the EA and the architectural principles (Drews et al., 2017; Hauder et al., 2013; Schmidt & Buxmann, 2011). Furthermore, EA can support strategic decision-making, strategy implementation, and operational management (Ahlemann et al., 2012; Drews et al., 2017). However, bad or non-existing communication and support can lead to misunderstandings and developments, that are not conformed with EA rules and standards (Schmidt & Buxmann, 2011).

The last operational task dimension is EA governance. It describes the degree to which organizational EA-related guidelines and decisions are binding (Schmidt & Buxmann, 2011). This can be prescribed due to formal processes. It is important to check and approve projects by ensuring conformity due to to-be architectures (EA planning) and guidelines (EA programming) (Drews et al., 2017). A sufficient degree of EA governance, which may be achieved by formal reviews and approval processes in practice, is needed for an effective EA implementation (Schmidt & Buxmann, 2011). Further governance aspects are the formal mandate of EAM, and the centralization of and the governance mechanism for EAM-related decision-making (Lange et al., 2016).

## 4.2. Challenges of EAM tasks

All the previously described task dimensions struggle with different challenges to be carried out successfully. In this section, we describe the results of the SLR about the challenges of each EAM task. The challenges have a diverse origin. While challenges could be identified for the task dimensions of EA documentation, EA planning, EA implementation, EA communication and support, and EA governance, challenges regarding EA programming were not identified in the literature.

The challenges of EA documentation are quite variable. Until today, the documentation of EA models is often a task done manually (Kleehaus & Matthes, 2021). The complete process of documentation including the manual collection of EA information and manual maintenance is error-prone, time-consuming, and costly (Bebensee & Hacks, 2019; Farwick et al., 2011b; Kirschner & Roth, 2014; Roth, Hauder, Farwick, Brey, & Matthes, 2013). During the maintenance of the documentations, organizations struggle with unclear responsibilities and missing know-how about EA and the responsible stakeholders, resulting in outdated and wrong documentations (Farwick et al., 2016; Kleehaus & Matthes, 2021). The stakeholders and teams that are responsible for the documentation of the EA, struggle with the size and complexity of the EA landscapes (Farwick et al., 2011a; Haeusler et al., 2019; Löhe & Legner, 2014). This complexity may lead to a cognitive overload of decision-makers (Rehring, Greulich, et al., 2019). Moreover, the changes of it led to difficulties with keeping pace with the as-is documentation (Farwick et al., 2013; Kleehaus & Matthes, 2019; Roth et al., 2013). In practice, there are two challenges about the usage of the documentation. On the one side, too fine-grained data of the EA are collected. This results in increased work to keep the high quality of the models (Farwick, Schweda, Brey, & Hanschke, 2016; Roth et al., 2013). On the other side, the models can be too inflexible and static to be used in the real world (Kim & Everest, 1994; Rehring et al., 2019b). Overall, a resistance towards change coming from stakeholders and insufficient quality of documentation may lead to low usage of the documentation (Löhe & Legner, 2014; Rehring et al., 2019b). Table 4 shows an overview of identified challenges within the field of EA documentation.

**Table 4.** Overview of identified challenges in the field of EA documentation

Publications		Challenges							
Author	Year	MD	WD	SC	VC	LA	FL	QA	SR
Bebensee and Hacks	2019	X							
Farwick et al.	2011a	X							
Farwick et al.	2011b	X	X						
Farwick et al.	2013	X		X	X				
Farwick et al.	2016	X	X			X			
Haeusler et al.	2019			X					
Kim and Everest	1994	X					X		
Kirschner and Roth	2014	X							
Kleehaus and Matthes	2019				X				
Kleehaus and Matthes	2021	X	X						
Löhe and Legner	2014			X				X	
Rehring et al.	2019b			X		X	X		X
Roth et al.	2013	X			X	X			
Σ		9	3	4	3	3	2	1	1

Note: MD = Manual documentation; WD = Wrong or outdated documentation; SC = Size and complexity; VC = Velocity of change; LA = Level of abstraction; FL = Flexibility; QA = Quality; SR = Stakeholder resistance.

EA planning is faced with different challenges based on the EA and the stakeholders, who are involved in it. The first issue refers to the complexity of the EA. The dependence between the EA elements and the modification of these elements and their interrelations over time results in higher complexity of the EA and the EA planning process (Nowakowski et al., 2018; Saat, Aier, & Gleichauf, 2009). Additionally, changes in the business and technology of an organization can be expected and unexpected. Thereby, unexpected changes are a costly challenge for the planning process if they have an impact on the EA (Saat et al., 2009). These changes may require the EA architects to do a replanning on the to-be documentation (Armour & Kaisler, 2001). As mentioned before, Nowakowski et al. (2017) has figured out that the documentation of the EA planning is often done manually. Another challenge is missing knowledge and attitude of relevant stakeholders of the EA. The lack of knowledge and experience may create a barrier for EA planning (Nowakowski et al., 2018; Shams Aliee et al., 2017). Also, different authors describe the issues of missing communication between EA stakeholders during the EA planning, that are discussed in the penultimate paragraph of this subsection (Dang & Pekkola, 2016; Nowakowski et al., 2018). Moreover, the stakeholder's priorities and available time are not considered often, which may result in conflicts (Dang & Pekkola, 2016; Saat et al., 2009). Overall, it is important to find the right scope and level of abstraction to avoid conflicts (Nowakowski et al., 2017; Saat et al., 2009).

The challenges of EA implementation have a diverse origin. Several authors describe challenges are based on a lack of communication and support (Ajer & Olsen, 2018; Santos, Ribeiro, Santos, de Farias Junior, & de Oliveira Rodrigues, 2020), a lack of governance structures (Ajer & Olsen, 2018; Alwadain, 2020; Isomäki & Liimatainen, 2008), and unused documentations that are obsolete (Löhe & Legner, 2014). These deficiencies can be supplemented with a lack of understanding and unknown expectations of the management and organizational unit (Bourmpoulas & Tarabanis, 2020; Isomäki & Liimatainen, 2008; Nasef & Azaliah, 2020; Olsen, 2017). Moreover, researchers describe more challenges that are not directly connected to different EAM tasks. According to Alwadain (2020), and Ylinen and Pekkola (2018), a missing acceptance of EA by users and the organization can hinder EA implementation projects. It also includes a lower willingness to use EA (Santos et al., 2020). Missing skills and resources have a negative effect on the implementation and may reduce the ability for doing it (Ajer & Olsen, 2018; Isomäki & Liimatainen, 2008). Another issue can be a missing management commitment and EAM authority in an organization (Alwadain, 2020; Olsen, 2017). In the implementation process, Bui and Levy (2017) identified difficulties of

the transition of EA in value and practice and the link of it to valid norms, values, and cultures.

Although EA communication and support are important EAM tasks, they are faced with different challenges. According to Uludag et al. (2019), due to the limited capacity of enterprise architects, stakeholders may perceive a lack of support in their work. Additionally, they identified an overload of work and missing technical know-how. Moreover, during the architecting process challenges emerge in the internal communication. It is difficult to distribute messages across all relevant stakeholders of the organization and to mediate the corresponding purpose and value of EA (Chuang & van Loggerenberg, 2010). A lack of communication in processes has an impact on the EA implementation ability and the governance of an organization (Banaeianjahromi & Hekkala, 2019). Additionally, this lack is supported by a communication gap between stakeholders in the same organization based on the usage of the same terminologies in widely different ways (Buckl et al., 2009). Also, the support of EA projects by management can be limited and hinder a successful EAM. As a result, a lack of management support can lead to a restriction on the needed resources (Banaeianjahromi & Smolander, 2019).

EA governance deals with several challenges that are mostly based on the organizational structure. A lack of the organizational structure can have its cause in a missing central responsible EA unit (Banaeianjahromi & Smolander, 2019). Moreover, organizations often struggle with a lack of clarity regarding EA governance that could lead to unclear responsibilities (Cram, Brohman, & Gallupe, 2016; Lam, 2004). Also, these companies do face problems with the enforcement of EA governance rules (Lucke & Lechner, 2011) due to insufficient resources (Seppänen, Heikkilä, & Liimatainen, 2009). Compliance with EA governance rules and principles is even more difficult due to external contract work and the usage of legacy systems because of the difficulties and costs to keep them conform with the as-is EA (Boh & Yellin, 2006; Espinosa, Armour, & Boh, 2010). In addition, also an insufficient understanding of EA can obstruct the implementation and work of EA governance (Ajer & Olsen, 2019; Bourmpoulas & Tarabanis, 2020).

Summarized, most challenges of EAM consist in tasks related to EA documentation, EA planning, and EA communication and support. Further, some challenges of EA implementation and EA governance are based on issues in other tasks. Overall, 44 different challenges of the six tasks dimensions were identified. Thereby, the most challenges are mentioned in tasks of EA implementation ( $n = 12$ ). Whereas no EA-specific challenges of EA programming could be found in the literature. Table 5 gives an overview about the number of publications and number of challenges that were found for each dimension.

**Table 5.** Overview of the number of publications and challenges of EAM tasks dimensions

<i>Dimension</i>	<i>Number of publications</i>	<i>Number of identified challenges</i>
EA documentation	13	8
EA planning	6	9
EA communication and support	5	6
EA programming	1	0
EA implementation	11	12
EA governance	9	7

### 5. DISCUSSION

As shown in the results, we identified different challenges in the dimension of EA documentation, EA planning, EA communication and support, EA implementation, and EA governance. However, challenges for EA programming could not be found and need to be addressed in future research.

Additionally, based on the identified challenges, it should be investigated in the future how these challenges can be quantified and solved in the best way. As our analysis of the literature shows, there are several opportunities for future research. Table 6 presents an overview and categorization of open research in the field of EAM and EAM challenges.

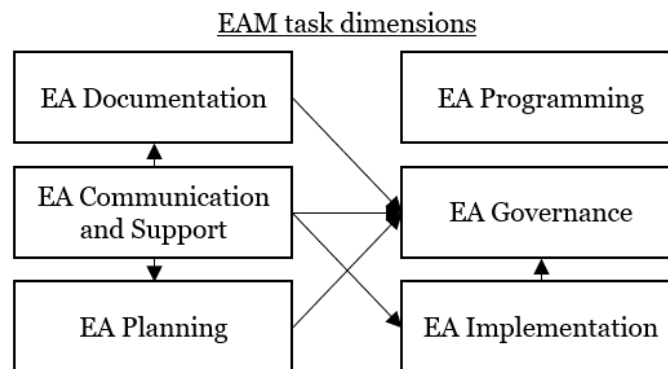
**Table 6.** Overview of future research opportunities in the field of EAM challenges

<i>Thematic area</i>	<i>Future research opportunities</i>
Challenges	What challenges do exist in the field of EA programming? How can specific challenges be solved in the best way? How can the effects of EAM challenges be quantified?
Interdependencies between EAM tasks	What kind of interdependencies do exist between the different EAM tasks and challenges? Is it possible to solve different EAM-related challenges with single countermeasures? Do trade-offs exist, for example, does solving challenges in one EAM task cause challenges or problems in other EAM tasks? <u>Can interdependencies be reduced, minimized, or increased?</u>
Organizational perspective	Do different challenges exist in different types of organizations? Is the amount and severity of EAM-related challenges dependent on the size of the company (e.g., do small companies have less problems?). What type of EAM-related challenges do companies from different industries suffer the most from? What is the management's role in solving EAM-related challenges? Which organizational unit should be responsible for solving and avoiding EAM-related challenges?
Corporate governance perspective	How can the board of directors benefit from data governance? How can EAM benefit the processes of corporate governance? How can the board of directors help to solve EAM-related problems? <u>What is the role of the directors in EAM and how are they involved in related tasks?</u>
Project perspective	How do projects with the aim to solve EAM-related challenges differ from regular projects? What competencies should project leaders and project members of EAM projects have in order to guarantee a successful outcome? How should workflows in EAM-related projects should look like? How do these workflows differ from projects dealing with different EAM challenges?
Technical perspective	How can modern technologies (e.g., Artificial Intelligence, Big Data, Blockchain, etc.) be used to help overcome EAM challenges? How can the analysis of data, for example, used in AI algorithms, help overcome EAM-related challenges? How can data be generated for data-dependent technologies used in the context of EAM? How can the data's quality be warranted?

We used the framework of Schmidt and Buxmann (2011) to categorize the different EA tasks into six dimensions. This framework does not make a direct statement about the interdependencies between the dimensions. Based on the identified tasks and challenges, several interdependencies could be assumed. Figure 2 visualizes these interdependencies on the level of the six dimensions. It can be recognized that the dimensions of EA documentation, EA planning, EA communication and support, and EA governance are faced with challenges like a lack of knowledge (Nowakowski et al., 2018), wrong or outdated information (Kleehaus & Matthes, 2021), or a lack of communication and support

(Ajer & Olsen, 2018) that have their origin in the dimension of EA communication and support. Furthermore, the challenges of EA implementation are influenced by tasks of EA documentation, EA planning, and EA governance. EA implementation struggles with the difficulties of the link between EA and norms, values, and culture, and a lack of governance (EA governance) (Alwadain, 2020; Bui & Levy, 2017), and with a lack of documentation (EA documentation and EA planning) (Löhe & Legner, 2014). Because no EA-specific challenges of EA programming could be identified, it has no interdependencies with the other dimensions.

**Figure 2.** Overview of the interdependencies between the EAM task dimensions





However, the interdependencies between different EAM tasks and challenges can be complex. Therefore, it is necessary to deepen the research of potential interdependencies. This can be done based on different foci. First, the interdependencies could be analyzed in more detail due to their emergence in theory and practice. Future research can investigate how EAM-related challenges can be solved, whether solving a challenge has an impact on other tasks. For instance, better documentation could improve the implementation tasks of EA. This also involves the question of how influential the interdependencies between EA documentation and EA implementation are.

Besides future investigations about the challenges and the interdependencies between these challenges, there is an opportunity to conduct future research from an organizational, project, and technical perspective. From an organizational perspective, this research leaves open questions about the interdependencies between the identified challenges and the type, size, and operating industry of an organization. Furthermore, the responsibilities for solving and avoiding EAM-related challenges and in particular, the role of an organization's management is an interesting further research approach because a missing central EA unit (Banaeianjahromi & Smolander, 2019) and therefore, a lack of clarity about responsibilities is a major challenge in the dimension of EA governance (Cram et al., 2016; Lam, 2004).

Another important perspective that needs to be considered is the corporate governance perspective, which especially deals with the role of top management and the board of directors. On the one hand, the board of directors can benefit from valuable information which can serve as the foundation for decisions and strategic management. Here, EAM can serve as a foundation that enables the generation of data and its provision as usable information to the board of directors. On the other hand, IT needs top-management support to successfully transform or improve the infrastructure and processes. For management to adequately support IT, some understanding of its importance, relevance, and function is required. Therefore, it is also important that the board of directors knows the tasks of EAM to a certain extent and is also involved in this.

To solve the identified challenges, organizations would probably carry out different projects. From this project perspective, in the future, the specific characteristics of projects that aim to solve EAM-related challenges should investigate what guidelines for organizations could look like. For instance, this includes the composition of the project team and the workflows. Moreover, the competencies and responsibilities that were mentioned as a challenge before, if they are not defined, should be considered.

As the last perspective, future research can be considered from a technical perspective. Nowadays, disruptive technologies, such as artificial intelligence and blockchain, become one focus of research (Salah, Rehman, Nizamuddin, & Al-Fuqaha, 2019). This leads to the open question of how these and other disruptive technologies could be used in EAM, especially for the solving of EAM challenges. Furthermore, for technologies like artificial intelligence and big data, the availability of high-

quality data is an important precondition. How this data can be generated and afterwards used are therefore two important areas to be investigated. Thereby, it should be taken into account that AI technologies can be used for supporting employees' work and replacing their work by automatizing systems and processes (Rao & Verweij, 2017). Possible EAM tasks dimensions that consider human work are EA documentation, EA planning, and EA communication and support. Furthermore, for using AI technologies, the availability of high-quality data is necessary to conduct analyses (Sturm & Peters, 2020). Hence, it is necessary to investigate how the analysis of data can help to solve the challenges and which data quality is needed for AI. Moreover, it is open if the current data quality of an EA is sufficient to use this technology, and how the needed data quality can be warranted.

## 6. CONCLUSION

Enterprises are complex systems with several social, technical, and infrastructural elements and components. Organizations need to be able to adapt to changes quickly to stay competitive in the digital age that is characterized by a fast-pacing environment. The management of the internal infrastructure is, therefore, an important factor for today's companies. Despite its relevance, however, EAM is still an area many companies are struggling with. Surprisingly, research lacks comprehensive overviews and reviews about the challenges of different EAM tasks. This article aimed to close this research gap by conducting a systematic literature review about EAM, its tasks, and the respective challenges. We wanted to answer the following two research questions: *What are the tasks of enterprise architecture and which challenges do exist? What are future research directions and opportunities in the field of EAM challenges?*

The field of EAM can be divided into six groups of tasks, namely EA documentation, EA planning, EA communication and support, EA programming, EA implementation, and EA governance. Our review of the literature identified several challenges for each of these groups except EA programming. In total, 44 challenges were identified, with the most challenges related to tasks within EA documentation, EA planning, and EA communication and support. For the field of EA programming, however, no challenges are described in the literature.

Our research is not without some limitations. First, the iterative structured literature review was conducted on a specific database. This may lead to the fact that publications were overlooked and not considered in this article. Furthermore, our research is based on six tasks dimensions. Therefore, EAM tasks that are not fit in one of the dimensions may not be included in this project. However, to the best of our knowledge, the six dimensions of the framework of Schmidt and Buxmann (2011) are still comprehensive and cover most of the EAM tasks. As a result, however, some specific EAM challenges that are not covered by the six dimensions of Schmidt and Buxmann (2011) might not be included in this article. Furthermore, we found that several interdependencies between the different EAM dimensions exist. It is likely that a closer investigation of these interdependencies

might lead to insights into new challenges that have not been covered by literature, so far. This results in several open research fields within the field of EAM and EAM challenges. First, the investigation of interdependencies between different EAM tasks might lead to interesting insights. Also, EAM tasks

and challenges can be further researched from an organizational, technical, and project perspective. Finally, also the role of the board of directors and how they can benefit, and benefit from, EAM should be addressed by future research.

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