



# Digitalization and enterprise architecture management: a perspective on benefits and challenges

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## Abstract

Many companies digitally transform their business models, processes, and services. They have also been using Enterprise Architecture Management approaches for a long time to synchronize corporate strategy and information technology. Such digitalization projects bring different challenges for Enterprise Architecture Management. Without understanding and addressing them, Enterprise Architecture Management projects will fail or not deliver the expected value. Since existing research has not yet addressed these challenges, they were investigated based on a qualitative expert study with leading industry experts from Europe. Furthermore, potential benefits of digitalization projects for Enterprise Architecture Management were researched. Our results provide a theoretical framework consisting of five identified challenges, triggers and a number of benefits. Furthermore, we discuss in what ways digitalization and EAM is a promising topic for future research.

**Keywords** Digitalization · Enterprise architecture management · Enterprise management · IT management

## Introduction

Digitalization projects are usually associated with a disruptive process that profoundly changes the way companies compete, interact, and create value (Ross et al. 2019; Bonnet and Westerman 2021). Digitalization deeply disrupts existing companies and economies (Ross et al. 2019; Bonnet and Westerman 2021). Incumbents as well as new competitors have to deal with increased competitive pressure (McAfee and Brynjolfsson 2017). Companies need to optimize their processes to redesign their products and services as well as to develop new business models. However, digitalization projects also create new opportunities for value

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creation and enable the development of intelligent digital systems and services (Rogers 2016).

Most enterprises are confronted with the challenge of digitalization and are searching for methodical support. Enterprise Architecture Management is an existing approach for companies to align IT resources and corporate strategy; it also helps them to gain more transparency with regard to the use of their resources (Winter et al. 2010; Schmidt et al. 2015a). Enterprise Architecture Management (EAM) is supposed to be a suitable tool for supporting the management of enterprise transformations; it also helps with fundamental changes in businesses (Simon et al. 2014). Therefore, it does not come as a surprise that different authors have already investigated different aspects of EAM in various contexts in their research (Kotusev et al. 2015). For instance, some authors have examined the topic of EAM in the context of digitalization; in the following text we will refer to their research. Bossert (2016) discussed the implications of digitalization for enterprise architecture. The question of whether EAM enables digitalization has been raised by Hafsi and Assar (2019). The role enterprise architecture plays in the digitalization of manufacturing enterprises was investigated by Goerzig and Bauernhansl (2018). They state that enterprise architecture responds to the challenges encountered in digitalization projects. Furthermore, Gampfer (2018) suggested that EAM is an adequate tool for dealing with the complexity of digitalization projects. Other authors, such as Törmer (2018), described research approaches for using EAM to support digitalization. However, there are also different case studies that highlight its shortcomings (Aier et al. 2016; Kaidalova et al. 2018). Research lacks empirical insights into current digitalization projects as well as insights into challenges related to them.

However, these challenges must be overcome to successfully implement EAM in digitalization projects. Otherwise, an EAM project may fail, be delayed or run out of budget. Unfortunately, the challenges EAM faces with regard to digitalization projects are still unclear. Empirical insights into the challenges associated with digitalization projects in general (Legner et al. 2017; Urbach et al. 2019) as well as knowledge about challenges associated with implementing EAM are important for research and practical use (Hauder et al. 2013; Löhe and Legner 2014). Therefore, there is a need for a systematic investigation of the use of EAM for digitalization projects and, in particular, for an investigation of the resulting challenges that must be covered to successfully run a digitalization project. Thus, we pose the following research question as part of our research project:

RQ1: “*What are the challenges of digitalization projects for Enterprise Architecture Management?*”

Digitalization projects can run more successfully if someone identifies and addresses the challenges mentioned in RQ1. In relation to previous research on the benefits of EAM (e.g., Ahlemann et al. 2021; Saleem and Fakhieh 2020), it is interesting to see what additional benefits it brings for EAM if the challenges of digitalization projects we discuss are solved. Therefore, we also address the following second research question:

RQ2: “*What are the benefits of digitalization projects for Enterprise Architecture Management if challenges are overcome?*”

Another aim of the present research paper is to investigate in what ways and to what extent EAM can facilitate digitalization processes. Therefore, a brief summary of the theoretical background is provided at the beginning. After a description of the research methods, we outline the way we collected our data. Since the study follows a two-step research approach, (1.) we conduct a structured literature review and (2.) a qualitative expert study. Then, the results of our research are presented. Again, we will first describe the findings of our literature review before we will present and discuss the results of the qualitative study in detail. We were able to identify five digitalization challenges for EAM. Then, the benefits of EAM are pointed out. Finally, we discuss our results and consider further steps for research in this area. Our research contributes to the current body of knowledge by investigating different challenges of digitalization for EAM (e.g., definition and documentation, flexibility) and by suggesting further research directions. Furthermore, we discuss how to overcome these challenges; we also list a number of benefits that arise from solving the challenges we identified.

## Theoretical background

### From digitization to digitalization

At first, research focused on digitization as a transformation from analog to digital assets (Markovitch and Willmott 2014). However, because of the availability of digital technologies the focus shifted more and more to organizational transformation (Schmidt et al. 2015b) and the term digitalization was used (Legner et al. 2017; Ross et al. 2019). Digitalization (Brynjolfsson and McAfee 2014; Hamilton et al. 2016) describes the more abstract transformation from analog to digital to fully digital. Digitalization is, therefore, more about changing processes through the automation of tasks and decisions than it is about the digitization of data.

Digital technologies are the crucial drivers of digitalization, as digital technologies are changing the way business is done and can potentially disrupt an existing business. Information is digitized, processes are digitalized and enterprises are digitally transformed using a digital strategy, customer-centric digital business models and architecture-driven digitalization (Zimmermann et al. 2015). Digital technologies often cause disruptive effects on business models, however, digital transformation is currently the dominant type of business transformation (Brynjolfsson and McAfee 2014; Rogers 2016), with IT acting as both a technological enabler and a strategic driver. Digital technologies provide three core features for businesses that are changing fundamentally at the moment (Ross et al. 2019): ubiquitous data availability, unlimited connectivity, and massive computing power. Digital services and related products are software intensive (Rao and Verweij 2017), malleable and usually service-oriented (Nurcan and Schmidt 2009; Newman 2015; El-Sheikh et al. 2016). A number of technologies are often associated with digitalization: cloud computing, big data combined with advanced analytics, social software and the Internet of Things (McAfee and Brynjolfsson 2017). Today, it is necessary to expand this technological set and include different related concepts, such as artificial

intelligence and cognition or robotics. New technologies, such as deep learning (Goodfellow et al. 2016), enable the use of computers for activities previously considered exclusively human and are therefore strategic enablers and strongly linked to the progress of digitalization.

## Enterprise architecture management

In general, an enterprise architecture (EA) (Jonkers et al. 2006; Aier et al. 2009) captures and structures all relevant components for describing an enterprise, including the processes used for development of the EA as such (Ahlemann et al. 2012). In this context, Enterprise Architecture Management (EAM) is defined (Ahlemann et al. 2012) as a management practice that establishes, maintains and uses a coherent set of guidelines, architecture principles and governance styles to realize a company's vision and strategy. EAM is used to guide IT implementations, alignment and several other aspects (Lange et al. 2016).

EAM frameworks identify recurring structures in EA and propose general organizational structures, processes and support for EAM. TOGAF (Josey 2016) is an EAM framework that is considered by many researchers as industry standard. TOGAF defines three different architectural levels, which can also be found in other frameworks: The Business Architecture defines the business strategy, governance, organization and key business processes. The Information Architecture often is divided into two sub-layers: Data Architecture and Application Architecture. The Data Architecture describes the structure of an organization's logical and physical data assets and data management resources. The Application Architecture provides a blueprint for the individual application systems to be deployed, for their interactions and their relationships to the core business processes of an organization. The Technology Architecture describes the physical realization of an architectural solution. In addition to EAM frameworks, there are also different modeling languages to support different EAM activities.

Lange et al. (2016) identified EAM success factors and measures. The authors used literature reviews and exploratory interviews. Based on their findings, a theoretical model is suggested that explains key factors and measures of successful EAM. Al-Kharusi et al. (2017) investigated the methodologies and theories used in EAM research. They found that case studies and interviews play a crucial role. On the other hand, EAM research is rarely based on theories. Beese et al. (2022) revealed the moderating effect of EAM on the relation between organizational and technical complexity. Organizations that use EAM are able to avoid an increase in technological complexity due to increased organizational complexity. Kanin et al. (2022) investigated challenges of and requirements for EAM in Digital Transformation Projects. The authors found that IT infrastructure, data automation, the acceleration of IT processes and the proper use of cloud services are central challenges to EAM in Digital Transformation Projects. A Review of essential dimensions of EAM is presented by Trishan et al. (2022). They present a concept map that depicts the essential EAM dimensions and their relationships. Furthermore, the authors found that the focus of EAM shifts toward people, skills, communication and governance.

In a multiple-case study, Cammin et al. (2021) assess the requirements for agile EAM. They identified a number of requirements that are necessary to enable agile EAM in organizations. Practical Recommendations for digitalization and EAM are presented by Warnecke (2020). They suggest the use of capability-based planning, the inclusion of product IT in EAM and to give EAM practices the necessary power in the organization.

EAM also has many proven benefits that make it theoretically applicable in the context of digitalization (van Gils and Proper 2018a, b). To generate these benefits, there are always risks one has to accept and challenges one has to overcome. For this reason, it is of the utmost importance to know the most fundamental challenges in advance to be adequately prepared. Therefore, a systematic investigation is of great importance to gain further theoretical and practical insights. Furthermore, knowledge of the benefits that arise when these challenges are overcome gives businesses additional reason to engage in digitalization projects.

## Methods, data collection and data analysis

### Literature review description

*Method:* Based on the above-mentioned research questions, we conducted a systematic literature search following the common recommendations of various authors (e.g., Cooper 1998; Webster and Watson 2002; Kitchenham et al. 2009). The literature review itself was conducted in sequential interlocking phases. First, a literature search was performed using Google Scholar with keywords and phrases such as “enterprise architecture digital transformation” or “EAM digitalization”. Then, we used a snow-balling (Wohlin 2014) approach to identify further (basic) research and literature that might not have been covered by the initial search terms. The publication period was narrowed down to emphasize the timeliness of the research results in this dynamic context.

*Data Collection:* We selected research papers starting from 2017 and capture the most prominent research. Finally, we analyzed the 50 most prominent hits. We started by selecting papers based on their abstracts and narrowed down the selection by extending the scope of our analysis to the introductions and discussion sections. Starting from this list of relevant papers, a graph-based approach in two directions was run to use a snow-balling approach (Wohlin 2014). First, a search for related papers in the citations of the papers was conducted. Then, the relevant papers were filtered by analyzing the abstracts. Second, the inverse citation search of Google Scholar was used to search for papers that cited the relevant papers.

*Data Analysis:* We identified six papers for full-text analysis. The results are described in the results section.

## Expert study description

*Method:* A qualitative expert study was conducted to answer the research question and to generate new scientific insights as recommended in literature (e.g., Myers 1997; Recker 2012). In general, qualitative research approaches (e.g., Myers 1997; Recker 2012) are well-suited to gain insights into less explored fields, particularly with regard to questions like “Why?” and “How?” Additionally, a qualitative approach helps understanding phenomena within their real-world settings and is particularly useful when theoretical constructs are still missing (Recker 2013). In an on-going scientific discourse, the findings of the qualitative study can be used for a further, detailed exploration of the topic and the related aspects.

*Data Collection:* The present study was conducted as an online survey using an open-ended questionnaire realized via the data collection tool Limesurvey (Team TL project 2011). The participants for the expert sample were recruited between the end of 2018 and the mid of 2019.

*Sample:* In total,  $n = 18$  experts participated in the study and completed the survey. The survey consisted of 19 questions. The responses to 16 open questions were analyzed (e.g., Based on your experiences: “What challenges exist for EAM in digitization projects?”). Furthermore, three questions concerned with background information about the expert were included (e.g., “Are you experienced in the area of digitization or the digital transformation of processes?”). The experts had a working experience of approx. 19.8 years on average. They work for companies with more than 58,000 employees on average from different industry sectors like Healthcare, IT, Energy, Consulting; all of them are headquartered in Europe. An overview of the sample and the survey’s questions is provided in Table 1. The questionnaire as well as the queried statements can be provided on request.

*Data Analysis:* For analyzing the data, qualitative content analysis was used, as described, by different authors in literature (Mayring 2014). Additionally, the procedure was enriched and complemented by coding techniques (Strauss and Corbin 1994). The approach includes 6 steps. All steps were followed; they are described in the following sections:

*Step 1* helps to decide what material should be analyzed. Here, the analysis is based on the experts’ responses provided in the survey. However, not all questions were used with regard to the research questions. The background information provided by the experts was not used for the data analyses; it served as a structural variable that helped with the interpretation; it was also used to validate the results.

*Step 2* explicitly states how the data collection (i.e., the online survey) should be arranged and prepared. This step helps making all factors transparent that could be relevant for an interpretation of the data. It is extremely important to choose experts with a high level of experience in EAM and digitalization. Therefore, only well-known experts that are also working for renowned organizations were contacted via email, phone calls and business networks. Furthermore, check-up questions about their working experience and knowledge were used to ensure a high level of expertise among the participants.

*Step 3* clarifies how the material should be transcribed. The material was analyzed step by step; it was then devised into content analytical units. The rules included

**Table 1** Expert overview

#	Working experience (in years)		Current position	Gender	Industry sector
	IT experience	EAM projects			
1	18	12	Lead IT architect	Male	Health Care
2	15	15	EA experte	Male	Economic Services
3	20	15	SVP IT & processes	Male	Trade and Commerce
4	25	11	Head of research group	Male	Information and Communication
5	25	12	Head of EAM	Male	Traffic and Warehousing
6	7	5	Digitalization specialist	Male	Agriculture, forestry and fishing
7	29	18	CEO	Male	Economic Services
8	40	15	Consultant	Male	Energy Sector
9	20	1	Head of EAM and IT-strategy	Male	Finance and Insurance
10	5	5	Consultant/EAM specialist	Male	Information and Communication
11	28	6	CTO	Male	Information and Communication
12	20	15	Solution head of custom solution development	Male	Information and Communication
13	20	10	CIO	Male	Art, entertainment and recreation
14	33	24	Head of data economy	Male	Information and Communication
15	10	6	Director enterprise architecture	Male	Information and Communication
16	15	10	Programm lead enterprise architect	Male	Information and Communication
17	20	15	Chief enterprise architect	Male	Information and Communication
18	8	7	EAM specialist	Male	Economic Services

what IDs to use for the units of different completed surveys when extracting them from the tool, how to tag content related to the experts, how to mark comments etc.

*Step 4* concerns the subject reference of the analysis. That means, for instance, that one has to make sure that there is a connection to the concrete subject of the analysis. To follow step 3, we (1) defined the expected contribution of each survey question to our research questions; we also (2) checked that all responses to the survey questions were related to the subject (which was the case).

*Step 5* recommends theory-guided analysis of the data, which is supposed to balance the fuzziness of qualitative analysis with theoretical stringency. We followed that step with regard to the formulation of our survey questions and our analysis of the material.

*Step 6* defines the analysis technique that should be used; in this case, we used different coding techniques (Strauss and Corbin 1994). First, open coding was used to analyze our data. As a first result, 52 different codes within the qualitative data were identified and used in further analysis. Then, an axial coding procedure was conducted and categories upon the different codes were created. After that, the

selective coding procedure was conducted. Here, categories were aggregated and evaluated based on their importance and informative value. Hence, categories that were selected only once or very rarely were sorted out. Finally, all useful categories were integrated in an overall framework. To improve the quality of our data analysis, a number of steps and checkpoints for the human coder have been implemented. For instance, the coder reflected on each step and performed checks to avoid, for example, biases (Baran and Jones 2016) with regard to past experiences or blind spots.

## **Enterprise architecture management and digitalization: a literature review**

Our literature review on EAM and digitalization yielded papers that used different methodological approaches. First, we investigated literature reviews that are concerned with EAM in general. We then discussed papers that identify benefits of EAM and usually also develop models to explain them. After that, we investigated case studies that give deeper insights into practical applications of EAM. Our literature review also embraces more abstract papers. We covered papers that discuss architectural considerations and papers that try to further develop EAM on a conceptual level.

A literature-based investigation of how enterprise architecture adds value to organizations is presented by Tamm et al. (2011). A more specific view that considers the sociological context as well as the economic and technical aspects of EAM is offered by Zimmermann et al. (2014). In their research, the authors investigated the use of Enterprise Architecture in SmartLife ecosystems. Their findings provide insights into how EAM should be changed to support a more flexible decision-making process in organizations, particularly in the context of fast changing customer needs.

### **Benefits**

Saleem and Fakieh (2020) identified organizational benefits of EAM. The authors performed a literature review and developed a benefits model with enterprise architecture experts. Lange et al. (2012) investigated the theoretical benefits of EAM. Later, Foorthuis et al. (2016) found that many benefits of enterprise architecture are indirect benefits that lie in compliance and architectural insights. Wetering (2021) investigated how enterprise architecture-driven dynamic capabilities enable agility. Enterprise architecture benefits are also the subject of a research paper by Wan et al. (2013). The perceived benefits of enterprise architecture are also investigated in a study by Plessius et al. (2014).



## Case studies

In their case study, Kaidalova et al. (2018) investigated how EAM is affected by the concept of digitalization. They described and highlighted the fundamental necessity of a strong conceptual approach in this context. Also using a case study approach, Törmer (2018) additionally stressed the importance of creating digital platforms in enterprise architecture projects. In the example the author selected and described, enterprise architecture was used to guide the transformation process. In his explanations, the author showed how a company can move its legacy systems onto a digital platform. In a multi-case study, Gerber et al. (2020) focus on small- and medium-sized enterprises. They tried to find patterns for the growth of small and medium enterprises. They found that enterprise architecture can explain the start-up, growth and transformation of small and medium-sized businesses.

## Architecture

There are few papers on architecture. In their research, Kar and Thakurta (2018) investigated the architectural implications of digitalization. Therefore, they focused on two things: the objectives of the organization and organizational readiness. Based on their discussions, they developed a framework that uses Enterprise Architecture Management to support digitalization processes. Furthermore, there is a study of Zimmermann et al. (2018) that proposed a decision-oriented composition architecture for digitalization processes. It is particularly interesting that the framework is based on a multi-perspective management approach and supports micro-granular architecture.

## Conceptual and methodological aspects

In an exploratory analysis, Assar et al. (2019) investigated the extent to which EAM can support digitalization. The authors raised the question what activities are necessary for digitalization. They also determined what information is required for this purpose. Afterward, the question in what ways EAM fulfills the requirements was answered. Szabo and Ori (2017) identified EAM as a major facilitator; it makes planning easier. Although, it has not fulfilled this role in the context of digitalization yet, it could contribute more to planning and strategic alignment. Furthermore, the authors provided suggestions on how Enterprise Architecture Management can support strategical information system planning. Ross et al. (2019) investigated the topic from a different point of view. The authors discuss opportunities for digitalization initiatives using EAM to assess strategic alignment problems in their research. They present a framework for identifying areas for digitalization initiatives and show how the synchronization of business and IT can be facilitated. A domain-oriented approach is presented by Schmidt et al. (2017). In their research, the authors provide a comprehensive overview of the current situation and of the future direction of digital EAM in tourism.

Therefore, it is necessary to focus on the conceptual and methodological aspects of digitalization. However, at the moment, our research question about the challenges of digitalization projects for EAM cannot be answered by previous research. Therefore, a qualitative expert study was conducted to gain insights with regard to this gap in research.

### Results expert study

As a result, the data analysis revealed several challenges for EAM that occur within management triggered digitalization projects. However, the possible benefits that can be realized when addressing the challenges properly were highlighted, too. Next, the findings of the expert study are presented. Based on the initial triggers, the up-coming challenges are described firstly. Then, the focus is shifted to the benefits of EAM in digitalization projects with regard to these challenges.

Figure 1 shows a framework that summarizes the challenges and benefits of digitalization for EAM. The different aspects are described more precisely in the following sections where you will also find statements and opinions of selected experts.

### Triggers

Organizations generally run digitalization projects (Brynjolfsson and McAfee 2014; Hamilton et al. 2016) to replace manual approaches with digitized business processes. This goal is clearly stated by one of our experts, who also stresses the importance of seeing digitalization in a wider context:

“For us, digitalization is no longer IT-support for employees, but the shift from complete processes, including necessary decisions, to fully automated processes.”

Usually, the managerial decision to run a digitalization project can be seen as a primary trigger for EAM as it is an important part of digitalization projects according to experts’ opinion. Hence, whenever management decides to run digitalization, project activities for EAM are triggered, too.

Moreover, EAM itself can be seen as an enabler for digitalization projects, as the following expert statement underlines:

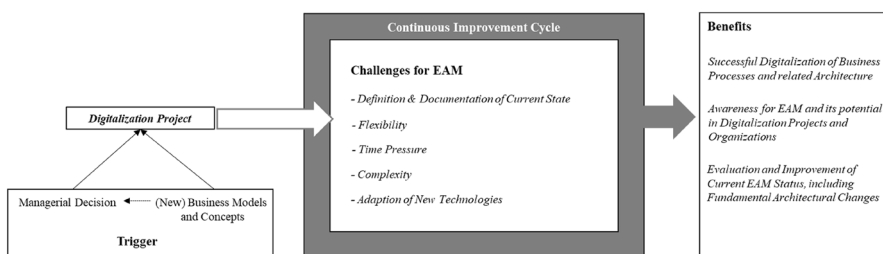


Fig. 1 Framework of digitalization challenges and benefits for EAM

"[...] a clearly structured architecture is to be seen as an enabler [...]."

Apart from the managerial decision to launch digitalization projects, other interesting triggers are mentioned, too. Another expert lists the possibilities of digitalization for new business models and the introduction of new concepts such as digital twins (Tao et al. 2019) as further triggers for digitalization projects and EAM:

"[...] Enables creation of new offerings/business models and faster market entry [...] and lifecycle, e.g., digital twins."

Although managerial decisions that trigger digitalization projects are usually seen as beneficial, there are a number of requirements that must be met first. Therefore, it is not particularly surprising that experts see EAM confronted with several challenges in the context of digitalization. The most important challenges for EAM are described in the following text.

### Digitalization challenges for EAM

Before initiating a digitalization project, it is crucial to **define and document the current state of the architecture**; it is also important to have an idea of how an effective future EAM might look like. According to experts, this is a very challenging task, particularly when applying a holistic approach to EAM:

„In general, the biggest challenge is to create a complete model of the EAM. Once it is in place, tracking every change is also a challenge.“

A holistic approach is also needed in other important domains such as IT risk management (Barateiro et al. 2012). However, most experts argue that such a definition of a holistic architecture is simply not available. Because of that, decisions are extremely hard to make — a fundamental requirement for launching new digitalization projects is missing. Furthermore, as the expert stated, it is hard to track every architectural change. Thus, the significance of this challenge in EAM and its importance for the majority of decisions in digitalization can be exemplarily highlighted as follows:

"To map the status quo of different digitalization initiatives to provide a good baseline for decision-making."

Furthermore, our experts see additional challenges in running a proper EAM documentation if the organizations are confronted with an immature IT–business alignment. In general, IT–business alignment enables IT and business to react better to environmental requirements and to achieve organizational goals more effectively (Luftman and Kempaiah 2007; El-Masri et al. 2015). It is important that all processes and collaborations are well-defined. If this is not the case, documentation becomes even more difficult and the overall challenge grows.

"The challenge in all projects is always to ‘catch’ unmanaged and unplanned (or not coordinated with IT) activities in the business.”

**Flexibility** is another important challenge for EAM in current digitalization projects. This is in line with the previous literature (e.g., Jonkers et al. 2006; Kumar and Stylianou 2014) and it was also stated by the interviewed experts. In modern organizations, requirements—particularly in the context of digitalization—change very frequently. The challenge for EAM is to meet these ever-changing requirements.

Therefore, possible solutions should not be monolithic but easy to implement and to remove based on your current needs; the following quote underlines this fact:

"Aligning the systems, applications so that quickly adding services and applications never disrupts the overall construct."

To meet this challenge, and to fulfill these requirements, experts have experienced that micro-service-based (Bogner and Zimmermann 2016) and container-based (Bernstein 2014) architectures can be useful. This can be illustrated by the following statement:

"On the one hand, it is an opportunity, as digitalization very often goes hand in hand with a micro-service architecture, and thus the idea of flexibility in the architecture is supported."

The **time pressure** associated with digitalization projects is an important challenge for EAM as well. The nature of digitization demands that more and more digitized functions are available for services and goods as quickly as possible (McAfee and Brynjolfsson 2017). Furthermore, business value is increasingly created by the use of information technologies (Hess et al. 2020). As a result, more and more digitalization projects are being launched. This creates pressure to develop a solution as soon as possible. One expert points out that EAM is fundamentally important for the success of digitalization projects:

"Develop foundational solutions and not be ad-hoc driven."

Another expert states:

"Support multi-speed IT approaches."

According to leading experts, new technologies and a high level of **complexity** are serious challenges that EAM has to face with regard to digitalization projects.

In general, complexity (Benbya and McKelvey 2006) in Information Systems development domain can come from the system and its IT environment itself, from the application or from the organizational environment using it. The following statement highlights how important EAM is for dealing with complexity:

"For large and complex IT systems, it is important to define the basic information technology and organizational strategies in the form of an overarching IT architecture or a holistic enterprise architecture, as well as to take into account the challenges of digital transformation (with a special focus on mobile and cloud-based systems and architecture platforms)."

Another expert elaborates on the aspect of complexity and focuses on the challenge posed by different architectures as well as on ideas for solutions:

"The main challenge with the digitalization hype is getting a grip on the proliferation of all kinds of ideas. Therefore, to allow the desired dynamics and still be able to guide and direct."

In addition to technical factors, human factors may increase technological complexity, too. Different people coming from different divisions have diverse knowledge and various ideas about how to solve an issue. Therefore, we often see a wide variety of opinions on how to implement digitized solutions; also, technical possibilities vary widely. Furthermore, thanks to new agile project settings like in SAFe (Conboy and Carroll 2019), different stakeholders will be integrated within the architectural design and development process. This may increase complexity, too.

Additionally, in line with this, more and more **new technologies** are constantly coming onto the market and can be adopted (Panetta 2021). For example, new containerized deployment and operation possibilities (e.g., through Kubernetes) arise; and, today, organizations can use new databases for their digital solutions compared to the past (e.g., document-based, graph-based). Another expert highlights the challenges EAM faces to support the management of the technology portfolio:

"There are many different products and ideas. The trick is to have an overarching strategy so that everything goes in the same direction. Furthermore, the rapid technological development is a challenge for the management of the technology portfolio."

Other experts stress the fact that there is a lack of knowledge about technologies in digitalization projects:

"There exists a lack of expertise in new technologies."

According to the recommendations given in published literature, this could be, for example, a field of operation for a data-driven architecture in terms of Machine Learning/Artificial Intelligence knowledge, or, in general, for new CI/CD pipelines (Nogueira et al. 2018). However, the findings obtained from the analysis of the expert survey show a different picture. For instance, one expert remarks that many projects are still stuck in old paper-based and manual processes, which means that they are not future-oriented (they, for example, do not use a data-driven architecture):

"Many companies are still in the process of converting business processes from paper to IT or are collecting data without defining the benefits. This preparatory work prevents the benefits from being derived from the data."

## Proposed measure

To realize the benefits of EAM in digitalization projects, it is first necessary to address the challenges outlined. According to the experts, the definition of a continuous improvement cycle is a suitable solution for this purpose.

The experts recommend defining a continuous improvement cycle. In general, continuous improvement cycles are implemented to make sure that systems can be used over a longer period of time (McGinnis and Huang 2007); they also renew the organization and prevent it from ossification (Cole 2001). First, this is an argument against a static architecture that does not show current progress and possibilities. Second, by implementing new technologies and processes, it is now possible to meet important business requirements. One expert clearly underlines this:

"Continuous development of the EAM to meet new IT needs."

Furthermore, EAM continuously discovers and evaluates new technologies as well as architectural developments in the market. Experts strongly recommend this, as is exemplified by the following statement:

"Simultaneously follow developments in the market and assess them in sufficient depth."

## Potential benefits

All experts agree that organizations can realize significant benefits if EAM confronts the aforementioned challenges. It is safe to say that more and more digitized processes will be available within organizations. Hence, there is potential for fundamental changes and improvements of business processes and related architectures; this is confirmed by the following statement:

"Digitalization projects are allowed to question 'old habits', overturn accustomed processes and open up a power of transformation that rarely exists in a company. This can be used in the sense of a flexible and future-oriented architecture."

Many experts stress the importance of digitalization projects for recognizing the clear benefits of EAM; here is an example:

"Through digitalization projects, the benefits and advantages of an EAM become transparent, known and recognized within the company."

In addition to the benefits that EAM brings to digitalization projects, experts also see advantages for EAM itself. Additionally, we must not forget the enormous pressure on businesses that digitalization projects entail. However, herein lies an opportunity to expand, realign and restructure the existing EAM.

This creates a positive impact for all adjacent projects, now and in future. The following statement emphasizes this advantage:

"Opportunity to reposition EAM within digitalization projects."

If EAM overcomes the identified challenges posed by digitalization, not only its reputation but also its importance for businesses will improve significantly; in other words, EAM will influence a company's market position in a positive way through the successful implementation of digitization projects.

## Discussion

*General summary:* The presented research findings offer perspectives and answers within the context of the challenges posed by digitalization projects for Enterprise Architecture Management (see RQ1); our paper also discusses possible benefits that arise when these challenges are adequately taken into account (see RQ2). The analysis of the experts' opinions provided within the study revealed the following key challenges that still need to be solved: definition and a documentation of EAM, flexibility, time pressure, complexity and some new challenges. If we can come up with solutions, various benefits can be realized downstream. Advantages that digitalization projects hold for EAM were also discussed.

For example, a successful digitalization of business processes and their related architecture is seen as a benefit by researchers and businesses (Kerpedzhiev et al. 2021); additional advantages are a growing awareness of EAM among organizations and the potential EAM holds for digitalization projects. It is also used to gradually improve current enterprise architecture, which experts mention as another benefit. All in all, experts agree that we can and should address the above-mentioned challenges by implementing a continuous improvement cycle; in that way, businesses can profit from the numerous benefits EAM provides.

*Scientific contribution:* Our findings are in line with previous research about EAM and digitalization by Kaidalova et al. (2018), Kar and Thakurta (2018); furthermore, our study helps to gain a better insight into EAM: First, new challenges associated with EAM have been identified and described in detail. For this purpose, we developed a framework that uses a number of categories for describing the different challenges. The way we categorized the challenges for EAM facilitates understanding and can be helpful for scientists and businesses in the context of digitalization. Our findings are particularly useful for scientists who investigate why digitization initiatives or IT digitization projects fail.

Second, this paper extends previous findings about organizational challenges of EAM in practice provided by authors like Hauder et al. (2013) or Löhe and Legner (2014). In particular, our results add a more recent perspective to previous literature on challenges for today's digitalization projects. So, the challenges for EAM identified in this study are usually remarkably different from the ones found in previous research papers. Only Löhe and Legner (2014) name one challenge that is similar: "obsolete and inadequate documentation". At least to some extent, this aspect is represented here by the definition and documentation challenge we identified. However, our findings also point out triggers to initiate digitalization projects for EAM; furthermore, our paper stresses that it will be highly beneficial for businesses if we overcome the previously mentioned challenges. Third, our research extends the findings of previous work on the benefits of the use of Enterprise Architecture Management (e.g., Schmidt et al. 2015a; Gampfer 2018) by pointing out critical limitations. In a nutshell, this means that if the key challenges are not adequately addressed, the benefits that can be achieved through EAM in this context are very limited.

*Practical contribution:* Apart from the aspects particularly interesting for research, the study also offers valuable practical implications. Companies can benefit from our findings as they clearly show the challenges and how they can be dealt with. This can provide insights into how a digitization project can be successfully implemented in an existing enterprise architecture framework; it also creates a secure foundation on which businesses can build in future. However, it is plain to see that this also suggests that managers need to invest in IT projects that define and document the IT architecture landscape.

If digitization is neglected in this context, EAM projects will be in danger because there is no reasonable and solid foundation for decision-making. Furthermore, because of frequent changes and adaptations, companies need more flexible structures, for example, using micro-service architecture. Additionally, to overcome the above-mentioned challenges and to successfully deal with today's level of complexity, our findings suggest that companies need to focus more on agile approaches and new continuous integration processes.

*Research limitations:* Apart from the usual limitations that apply to study results, at this stage, our findings are also subject to the following limitations: The findings of the study provide comparatively abstract results. This means that both the challenges and the measures to address them could not be identified in detail. To be more precise, the findings provide indications, but no concrete instructions on how to proceed in detail. Hence, we suggest a follow-up study that examines the individual aspects more deeply to be able to derive concrete instructions. Furthermore, our

results are based on an initial qualitative analysis. Therefore, further qualitative studies are to be conducted to check our results with regard to their validity and, if necessary, to adapt and extend them. For this purpose, further qualitative studies could be conducted involving additional experts from other industries and with different cultural backgrounds (e.g., BRIC states). Another limitation of our results is the lack of quantification, which to some extent can be attributed to the exploratory nature of the study. For this reason, quantitative approaches should also be used in further studies in a next step, building on the findings of this paper. Also, future quantitative studies are needed to evaluate the challenges associated with EAM and to identify possible ways of tackling them. Case studies also appear to be a suitable method for gaining further information and generating new knowledge in the context of the present research question due to their high practical relevance. This method seems particularly useful for finding out how to deal with real-world challenges best. Furthermore, we suggest that future studies compare our findings to previous research in the field of digitalization (e.g., Warner and Wäger 2019; Björkdahl 2020) to confirm and extend our findings (e.g., by identifying and investigating triggers such as competition or customer demand).

## Conclusions

Enterprise Architecture Management is an important part of successfully running digitalization projects (Bossert 2016). It is hard to carry out an IT project without being supported by EAM. That is because, from an IT point of view, knowledge about the architectural structure is important to manage an organization (Jonkers et al. 2006; Aier et al. 2009; Ahlemann et al. 2012). EAM faces several challenges arising within the context of digitalization projects.

Although this topic is important and relevant in research as well as in practice, not many studies have addressed it so far. Our paper addresses this gap in research and answers two important research questions about the challenges and benefits of digitalization projects for EAM. With the help of a qualitative expert survey, it provides answers to our research questions. To be more precise, using qualitative analysis and building on expertise and experience of leading experts, we were able to shed light on key challenges EAM faces today. By answering our second research question, it was also possible to obtain information on the benefits of EAM.

It is safe to say that without addressing the identified challenges in the context of digitalization projects and EAM, it will not be possible to experience the benefits EAM offers. Furthermore, the future role of EAM in businesses and organizations has not yet been determined, though it seems dangerous to neglect its potential. Future digitalization projects may fundamentally change the current architecture of EAM and its overall significance. As our study has shown, digitalization and EAM is a promising topic for future research that provides qualitative and quantitative insights to extend the existing body of knowledge.

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**Author contributions** The authors have done the research in a team mode together. All parts of the paper are developed and reviewed by all of the authors. However, based on the different efforts the order of the authors was derived. Sect. "Methods, data collection and data analysis", "Results expert study" most parts developed by Michael and Barbara, Sect. "Introduction" and "Discussion", "Conclusions" all authors (Michael, Barbara, Rainer, Kurt, Alfred) and, Sect. "Theoretical background", "Enterprise architecture management & digitalization: a literature review" by Rainer and Kurt.

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**Data availability** Qualitative Data are available upon reasonable request (examples are also included in the paper results section).

## Declarations

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical approval** (a) Full name of the committee that approved the research: Not applicable. (b) Confirmation that all research was performed in accordance with relevant guidelines/regulations applicable when human participants are involved (e.g., Declaration of Helsinki, or similar): We confirm. (c) If a study was granted exemption from requiring ethics approval, the reason for this should be explained in sufficient detail: Not applicable.

**Informed consent** All experts/participants of our study agreed to be part of the study by a textual email invitation from us and through clicking on our study link.

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