How companies can benefit from Enterprise Architecture Management – An Extended Research Model

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Abstract. *A successful digital transformation in enterprises requires surpassing infrastructural flexibility within firms and a high level of IT competence in order to meet changing business requirements. Digital enterprises face the challenge of combining business and IT to benefit from existing technological achievements in the digital age. Previous studies have shown that there are critical factors that influence the benefits of Enterprise Architecture Management (EAM). However, factors influencing the digital transformation have not been considered yet. An alternative and iterative research approach develops new success factors for enterprises that benefit from EAM. In this context, this paper builds on a qualitative research approach to examine additional factors and their impact on EAM. The approach is based on an extended structured literature review to build a new empirical research model. In addition, the indicators were validated by three different industrial case studies reflecting the benefit from EAM within the digital transformation process. The results of the extended research models and case study validation show that factors aggregated to the determinants IT Landscapes, Internal Business and EAM Establishment have substantially impact on the benefit of EAM in enterprises. Moreover, the authors found two factors (firm size and external business) in the model moderating & the effects on the benefit from EAM.*

Keywords. EAM • enterprise architecture • impact factors • benefit of EAM • digital transformation • IT business alignment • qualitative study

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1 Introduction

Enterprise Architecture Management (EAM) is a crucial task for enterprises and their IT infrastructure (Lange et al. 2016; Ross et al. 2006). Therefore, it is an often discussed topic for management and research (Möhring et al. 2014). It also plays an important role in implementing new digital strategies (Zimmermann et al. 2016). The different developments of digitization embrace new technologies (IoT, Industry 4.0, etc.), services (cloud services, data mining services, etc.) and applications (Hadoop, RFID, etc.) with new business models (Wegmann 2003). To include such challenges specific frameworks like SEAM (Wegmann 2003), ESARC (Zimmermann et al. 2016) or "Internet of Things reference architecture" have been developed.

Previous studies have explored the effects of various important impact factors regarding the perceived benefit of EAM in enterprises (Cooper 1998; Lange et al. 2016; Niemi et al. 2008; Schmidt and Buxmann 2011; Schmidt et al. 2015), but did not focus on the tremendous impact of the digital transformation. Digitization has a variety

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of definitions depending on the levels of intensity. A common interpretation of digitization describes intelligent business processes and the usage of efficient and new technology concepts like Big Data, Cloud and Mobile Computing, Internet of Things or Social Software. Companies have to adapt to these digital approaches in order to use the full potential of the digital transformation (Reichstein et al. 2018). In that context, digitization is the creation of new business processes and models, i. e. the creation of new products, and the creation of new supply chains. Approaches to digital transformation can be found across sectors, including traditional sectors such as services and manufacturing (Härting et al. 2017). This results in additional impact factors that were not taken into account within existing quantitative approaches.

An additional (e. g. qualitative) research approach might be useful to investigate more factors in relation to the digital transformation to get a deeper insight, which finally can help to classify these factors into relevant determinants. Therefore, this paper will explore determinants of the perceived benefit of EAM and impact factors based on a structured literature research.

The paper proceeds as follows. In the following section (Sect. 2), the research methods are described. Then, in Sect. 3, the initial research model and the determinants to benefit from EAM are defined. Sect. 4 initially investigates the use of the impact factors in a first industrial digital transformation case. Afterwards, Sect. 5 presents the revised research model regarding the determinants of a EAM benefits proved by two further industrial cases in Sect. 6. Finally, the paper concludes in Sect. 7 with a summary and an outlook for future work.

2 Research Method

The work presented in this paper started from the following research question (RQ) which is based on the motivation discussed in the introduction and builds on a previous study from Härting et al. (2018): *What determinants of the perceived benefits of EAM and indicators specifying these determinants have to be considered to qualify the benefit of EAM for an organization?*

The research method used towards this RQ is a combination of literature study, design of the research model and descriptive case study. More concrete, we identify relevant theories and findings about determinants and indicators for perceived EAM benefits in the literature (step 1), derive a research model conceptualizing and qualifying determinants and their inter-relations in an argumentative-deductive process (step 2) and evaluate the research model's hypotheses, applicability and external validity in real-world settings (step 3). This three-step research process was performed in two iterations to reach an adequate level of maturity of the results. The first iteration resulted in an initial research model on determinants for EAM benefits (Sect. 3), validated in an industrial case (Sect. 4). Based on improvement potential detected in the case study and in discussing the initial model with other researchers at a conference, we decided to perform a second iteration. The literature study in the second iteration focused on additional papers from areas of the scientific body of knowledge which were not sufficiently covered in the first iteration (Sect. 5.1). The resulting second version of the research model for determinants of EAM benefits (Sect. 5) was applied for validation purposes in a two more case studies (Sect. 6). This paper covers the core results of the first iteration in Sect. 3 and 4; the second iteration and conclusion are presented from Sect. 5 onward.

The methodical purpose of the literature study in both iterations was on identifying relevant theories, conceptual approaches and existing work on determinants that would be starting points or candidates for developing a research model on determinants of EAM benefits. The underlying approaches for the literature studies are introduced in Sect. 3 and 5. Since the literature study returned only "aspects" for determinants of EAM benefits rather than proven theories (see Sect. 3), we decided to validate the resulting research models in case studies – which also had the option of a practice perspective on the model developed.

Qualitative case study is a research approach that facilitates exploration of a phenomenon within its context using a variety of data sources. This ensures that the subject under consideration is not explored from only one perspective, but rather from a variety of perspectives, which allows for multiple facets of the phenomenon to be revealed and understood. Yin (2018) identifies different kinds of case studies: explanatory, exploratory and descriptive. All case studies (Sect. 4 and 6) have to be considered as exploratory, as they explore the existence of the phenomenon of EAM benefits using the research model in the real-life context in which it occurs. By so doing, the authors cooperated within the framework of this research by sharing their expertise with regard to both the methodological and the content part of the work.

From a methodological perspective, the research model should also be subject to a quantitative study for additional testing of the hypotheses and relationships between determinants. This will be part of future work (cf. Sect. 7). However, the three case studies were essential elements of the research process as the determinants are meant to reflect perceived benefits. Whether there is a shared understanding of the researchers (developing the research model) and practitioners (in the case studies) regarding the concepts and determinants can be verified much more easily in face-to-face meetings during qualitative case studies than in surveys in quantitative studies.

3 Determinants to benefit from EAM: Initial Research Model

3.1 Literature Analysis

To prove whether there are some more important impact factors as found in the first research experience about benefits of EAM (Schmidt et al. 2015), the examination was enhanced with current literature starting from the year 2016. By searching for additional factors influencing the benefit of EAM, a common approach based on an extensive and structured literature review and intensive reading has been followed (Cooper 1998; Hennig-Thurau et al. 2004; Rouhani et al. 2015). The authors searched for the keywords "EAM", "Enterprise Architecture" and "Enterprise Architecture Management" within the databases SpringerLink, AISel, Web of Knowledge, EbscoHost, IEEexplore and Science Direct. To limit the results, often used search items "Business Environment", "IT Landscape", "Internal Business", "EAM Establishment", "Benefit" and "Impact Factor" were added to the above-mentioned keywords. 21 articles from different well-known journals were selected and checked according to quality by using the internationally accepted journal ranking relevant to business research (Hennig-Thurau et al. 2004), the SCImago Journal and Country Rank as well as Core Conference Rank (**cre**). Tab. 1 gives an overview of the selected articles and its impact factors as well as a summary and the ranking.

3.2 Research Model

To prove how to benefit from EAM, the authors build a research model based on literature review guidelines by Cooper (1998). The model (see Fig. 1) consists of six determinants including 22 indicators and two moderating effects (firm size and industry). Recent research studies have shown that there are potential drivers to benefit from EAM (Lange et al. 2016; Schmidt et al. 2015). In the following, the impact factors showing how to benefit from EAM are represented and hypotheses are constructed.

The frequent change of business requirements has a positive impact on the perceived benefits of EAM (Schmidt et al. 2015). Beneath adapting the corporate strategy, continuous process improvement, new laws and regulations and technical innovations, a competitive business environment is one of the major challenges for enterprises, as well in the industrial as in the service sector. EAM is an approved tool to overcome the challenges of a competitive business environment (Plataniotis et al. 2015; Sandkuhl et al. 2013). Requirements for a useful EAM are customized, efficient and flexible IT solutions and an effective information

Table 1: Summary of Literature Review

Author	Summary	Ranking	Competitive Environment	IT Landscape	Internal Business	EAM Establishment	Firm Size	Industry Complexity
Wegmann (2003)	Definition of systemic paradigm to provide a theoretical foundation for alleviating practical problems.		C			X		
Schmidt et al. (2015)	Exploration of the impact of the perceived benefit of EAM in enterprises with a literature-based research model.		X	X	X	X		
Sandkuhl et al. (2013)	Basic concepts and purposes as well as quality and possibilities for the analysis of company models are shown.		X		X			
Hanschke (2013)	The relevant core tasks are the management of the Enterprise Architecture (EA), the IT development management, the technology management as well as EAM governance.		X	X	X	X		
Auer et al. (2013)	EA describes the interplay between business processes and IT in the company and thus provides a strategic, conceptual and organizational framework for the design of IT landscape.		X			X		
Aier et al. (2008)	Literature overview of the current state of EA comparing a number of publications from recent years.	B		X		X		
Wigand et al. (1997)	Competitive strategies must re-evaluate the business-management goals of flexibility, time, quality and cost to ensure business success in the global marketplace.				X			
Pereira and Sousa (2005)	The alignment between Business and IT can be aggregated into four different dimensions. The paper presents some heuristics to ensure such alignment.				X			
Luftman (2004)	Approach for assessing the maturity of the business-IT alignment.				X			

supply. All can contribute significantly to differentiation. Information supply consists of knowledge about customer needs, competitors, competitive products and the costs and benefits of the products (Hanschke 2013). The improvement of transparency and control capability of the organization

Luftman and Brier (1999)	This article develops a methodology that leverages the most important enablers and inhibitors to business-IT alignment.	C			X			
Hanschke (2016)	Overview of the objectives and benefits of EAM. Practical examples show how to implement EAM successfully.					X		
Timm et al. (2015)	This work reveals a need for a reference EA that tailors utility enterprises demands towards EAM and derives implications for the development of such a reference EA.	C					X	X
Hanschke et al. (2015)	Based on expert interviews an integration of the TOGAF ADM and Scrum has been developed and evaluated following the Design Science research process.	C						X
Lakhrouit and Baina (2015a)	A method to evaluate the EA complexity and facilitating decisions between different architecture scenarios.	C		X				
Plataniotis et al. (2015)	This paper extends the approach with concepts from the problem space domain of the EA, such as goals, principles, and requirements.		X					
Banaeianjahromi and Smolander (2016)	Analysis of the available literature on determining the role of EA to identify gaps and state-of-the-art in research.	C		X	X			
Hinkelmann et al. (2016)	The paper deals with Next Generation Enterprise Information Systems in the context of Enterprise Engineering.	D			X			
Geerts and O'Leary (2015)	Architecture for integrating cloud computing and enterprise systems based on the Resource-Event-Agent (REA) model.	C		X				X
Azevedo et al. (2015)	Ontological analysis of concepts focusing in particular on the resource, capability and competence.	C		X				
Alwadain et al. (2016)	Empirically and theoretically grounded insights into EA evolution, in particular in relation to theintroduction of SOA.	C		X				

results in a value contribution of EAM (Auer et al. 2013; Plataniotis et al. 2015).

From this, the first hypothesis can be derived:

Hypothesis 1: A competitive business environment positively influences the benefits of EAM.

The use of EAM is recommended for enterprises with a high complex IT Landscape because of the positive link between the IT landscape complexity and the perceived benefit of EAM (Schmidt et al. 2015). For a better handling of IT landscapes, they should be well structured, i. e. reduce complexity (Alwadain et al. 2016).

This means making the IT Landscape comprehensible and manageable by simplification on all levels with standardization and homogenization, elimination of redundancies and dependencies, as well as organizational measures (Hanschke 2013; Lakhrouit and Baina 2015b). Therefore,

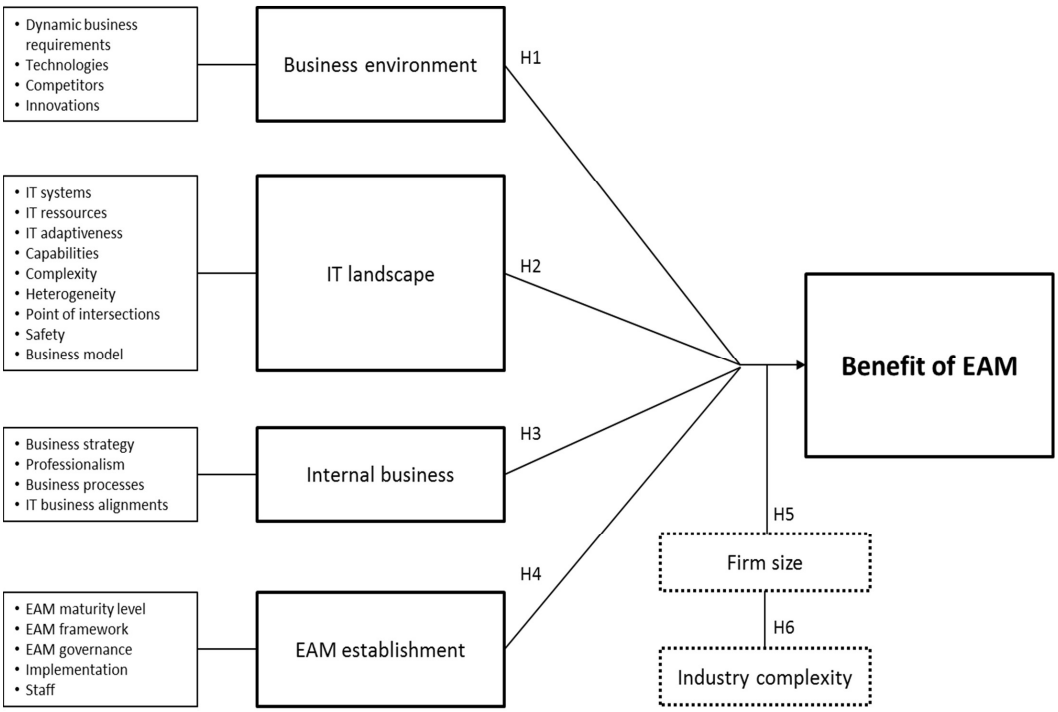

Figure 1: Research Model

several analyses are needed: the cover analyses over several levels leads to the detection of gaps and redundancies in the IT support of business processes. Interface, complexity and heterogeneity analyses lead to the improvement of the level of integration (Banaeianjahromi and Smolander 2016; Geerts and O'Leary 2015). The resulting transparency leads to a more efficient way to improve the planning of the IT strategy, the IT / business alignment and the optimization of business processes (Aier et al. 2008; Azevedo et al. 2015) leading to the formulation of the second hypothesis:

Hypothesis 2: A well-organized IT landscape positively influences the benefits of EAM.

In this context, internal business consists of enterprise strategy, specific corporate functions, business processes and IT business alignment. The enterprise strategy is needed for the definition of the IT strategy and essential for long-term success (Sandkuhl et al. 2013). Information systems, which are aligned with the enterprise strategy, are able to raise business processes to a higher level of efficiency and create economies of scale (Wigand et al. 1997). Business processes and specific functions are both part of the business architecture, which is crucial for the business of the enterprise (Hanschke 2013). IT business alignment is the application of information technology in an appropriate and timely way (Luftman 2004; Pereira and Sousa 2005) and a crucial topic for IT Management (Banaeianjahromi and Smolander 2016; Wegmann 2003). The benefit

of EAM can be very extensive by implementing a high level of IT business alignment (Hinkelmann et al. 2016; Schmidt et al. 2015). A distinctive degree of IT business alignment is recommended and very important for the majority of enterprises (Luftman and Brier 1999; Schmidt et al. 2015). This results in the third hypothesis:

Hypothesis 3: A well-structured internal business positively influences the benefits of EAM.

An established and sustainable EAM requires the arrangement of an EAM governance (Auer et al. 2013). The EAM governance has to be adjusted to the EAM maturity level, the enterprise and its general architecture, as well as its processes and guidelines of modelling to ensure the quality of the EAM database (Hanschke 2016). The assessment of the EAM maturity level is important to get implementable expectations (Hanschke 2013). The EAM framework should be developed in participation with affected stakeholders. Results of the EAM framework are the general aim and the first implementation level of EAM (Hanschke 2013). An adjusted EAM governance is needed for all levels of implementation (Aier et al. 2008).
EAM benefits also from EA knowledge by training IT staff with EAM basics as well as fundamental skills (Schmidt et al. 2015). Therefore, the authors formulated the fourth hypothesis:

Hypothesis 4: A high level of EAM establishment positively influences the benefits of EAM.

In addition to these four hypotheses/determinants, there are firm and industry specific control variables to consider. Established frameworks like TOGAF and COBIT or actual approaches regarding IoT aspects like ESARC are often too complex and expensive for small and medium sized enterprises (SMEs) (Timm et al. 2015). For them, EAM is not able to reduce complexity of IT infrastructure, although there are many frameworks of EAM available. As a result, firm size might positively affect the influences regarding the benefit of EAM (Timm et al. 2015). It can be assumed that the bigger the firm, the more it might benefit from these factors. Sectors with complex technologies or processes like the electronic, utility or plant engineering industries are expected to benefit from EAM (Timm et al. 2015) as they do have more complex requirements towards their information systems. In some sectors like utility or telecommunication industry, trade liberalization also leads to more competitiveness (Geerts and O'Leary 2015; Hanschke et al. 2015). Thus, an effective and efficient management of EA helps to create competitive advantages. The more complex the product or service of a firm, the higher the benefit of EAM (Geerts and O'Leary 2015). As a result, the control variable "Industry Complexity" positively affects the influences regarding the benefit of EAM.

4 Case Study 1: Digital Transformation

Although the determinants and indicators presented in the previous section are anchored in literature and grounded in a thorough conceptual analysis, we consider a validation of the research model to be important before conducting further qualitative studies. As a first validation step, we decided to apply the research model in an industrial case. The primary aims of this validation step are to validate first the feasibility of operationalizing the indicators, second the feasibility of capturing indicator values in practice, and third fitness of the indicators for the determinants.

4.1 Case Study Company

The industrial case is a producer of outdoor power products including, e. g., chainsaws, trimmers, robotic lawn mowers and garden tractors. The company offers products and services for both the private and industrial market. The company is in a transformation process where many of the products are enhanced and redefined by equipping them with sensors and actuators and by defining and transforming the accompanying services. Many of the products for professional customers do not only have built-in embedded systems but also networking abilities. The built-in embedded systems

are used for controlling the different mechatronic sub-systems of the product and for collecting information when the product is in use. Example: for a fleet of trimmers and garden tractors used by a housing company, sensors can collect vibration information of the individual devices to predict maintenance needs; for the overall fleet, statistics of the device use and runtimes can be applied for economic calculations and to detect the need for additional devices.
Since many of the products offer similar functionality regarding networking and built-in subsystems, the case study company designed and implemented reusable services and components for either products or back-office infrastructure. From an EAM perspective, the challenge is to integrate these product-related components and services into the general enterprise architecture of the company, which so far was focused on administrative and resource planning issues. Without integration, there would be a danger of developing services for the products again which already exist for the enterprise (e. g., license management, customer identification, security services). On the other hand, the lifecycle of product-related components is much shorter than the lifecycle of enterprise applications, which leads to conflicts in architecture management (Sandkuhl et al. 2017). The case study company has a defined enterprise architecture and the management of the architecture (roles, processes, policies) is implemented. The company currently undergoes a digital transformation process, which is also visible in company strategies and resource allocations. This makes the case a good basis for the intended validation of the research model.

4.2 Validation of Indicators

In a first validation step, we checked if the proposed indicators (shown in Fig. 1 on the left) could be operationalized and captured in the case study company:

• Future business requirements are frequently analyzed in the case study company, including competing enterprises, new technologies or related innovations. The results of this analysis are captured in internal documents or in reports provided by consultancies. The indicators for the business environment can be captured by analyzing the reports and documents and possibly be rated according to their level of detail or up-to-date-ness.

• The IT landscape is captured within the enterprise architecture model and the related information systems, like the configuration management database (CMDB). Most of the indicators listed in the research model are readily available and are already evaluated by the case study company for roadmap planning. However, the indicator "business model" is not visible and from the perspective of the research model, it should be considered to move this indicator to another determinant or to split it into several indicators.

• The internal business in the case study company is divided into production, development, operation and administration. Business processes are defined; business strategy is broken down to business line level and documented. The level of professionalism and business/IT alignment can be interpreted in different ways and would – from the perspective of the case study company – call for further refinement.

• The indicators related to "EAM establishment" can be directly linked to the extent and way roles, structures, processes, landscape and implementation are established, defined, documented and in operation. In the case study company, a collection of general policy documents, process and mandate descriptions and the system support for "IT landscape" management exists.

The above analysis of the indicators also gives some hints regarding the fitness of the indicators for the determinants. The business model might have to be moved to another determinant. Professionalism and business/IT alignment probably need a refinement. Furthermore, it was observed

that staff-related issues could be a candidate for another determinant. This, however, is not grounded by the available literature. Tab. 2 summarizes the validation results.

5 Revised Research Model on Determinants of EAM Benefit

5.1 Extended Literature Analysis

Based on our literature research in chapter 3.1, we have conducted an extended structured literature analysis with the latest literature up to the year 2019. Therefore, we eliminated irrelevant literature based on the following criteria:

- Duplicate articles
- Articles that are neither English nor German
- Articles from non-academic and/or non-peer-reviewed journals and conference proceedings
- Articles that do not seem relevant due to the title and/or abstract
- Articles that do not seem relevant after reading the whole paper

As a result, we found 26 new articles from well-known journals (e. g. European Journal of Information Systems, Journal of Enterprise Information Management, Journal of Information Systems, Computers in Industry) as well as conference proceedings (e. g. Working Conference on The Practice of Enterprise Modeling, International Conference on System Sciences, International Conference on Business Information Systems, Zeitschrift für betriebswirtschaftliche Forschung). All publications have been checked again according to quality by using the internationally accepted journal ranking relevant to business research (**cre**; Hennig-Thurau et al. 2004). It should be noted that these rankings also include proceedings, i. e. publications at conferences. Thereby, 13 publications have been ranked D or higher according to the VHB-ranking (Hennig-Thurau et al. 2004). Tab. 3 shows the taken articles in alphabetical order, a short summary, the ranking of the journals / conference proceedings (as listed above) in which they are published (if existing), and its impact factor. In the course of the extended literature research, it has become clear that the previously developed determinant "competitive environment" (Bhattacharya 2017; Lapalme et al. 2016) and "industry complexity" (Köhler et al. 2018; Lapalme et al. 2016; Nagy et al. 2017) together with the external factors "technological development" (Lapalme et al. 2016; Riku and Setyohadi 2017; Schneider et al. 2018; Teece 2018) and "market complexity" (Lapalme et al. 2016; Masuda and Viswanathan 2019; Nagy et al. 2017) indirectly affect the benefits of EAM.

5.2 Revised Research Model

To investigate how to benefit from EAM, the authors build a revised research model based on an extended literature review and a 2-step study case validation. The revised model (see Fig. 2) consists of five determinants (see hypotheses) and 22 indicators including two moderating effects (firm size and external business).
Based on the results of the first study, our extended literature review (Tab. 3) underlines that the determinant IT landscape, internal business and EAM establishment listed above do have an influence on the benefit of EAM. Findings of recent studies by Hanschke (2017) Hazen et al. (2017) and Danesh and Yu (2018), among others, provided evidence that mastering IT complexity is a critical factor for a successful digital transformation and that IT initiatives are ultimately linked to firm performance by way of EA-based capabilities. Teece (2018) also shows in this context that strong dynamic capabilities within the framework of IT landscapes enable the creation as well as implementation of effective business models and processes. All these studies confirm the assumption that a well-organized IT landscape positively influences the benefits of EAM (Hypothesis 1). With respect to the determinant internal business, further sources, e. g. Hinkelmann et al. (2016) and Köhler et al. (2018), from the latest research could be found supporting the hypothesis that a well-structured

Table 2: Summary of Indicator Validation

	Feasible to operationalize the indicators?	Feasible to values in use case?	Fitness of indicators to determinants?
Business environment	Yes – by rating explicit documentation and level of detail	Yes – from frequent reports on market and technologycapture developments	Yes
IT landscape	Yes – by using the operationalization implement in EAM systems, like planning IT	Yes – EAM system is available	Yes – with exception of "business model"
Internal business	Yes – with focus on refinement levels of processes and details of strategies and with exception of "professionalism" and "IT business alignments"	Yes – business processes and business strategy are defined and documented	Yes
EAM establishment	Yes – with focus on documentation and implementation of EAM structures and processes	Yes – partly using the same sources as for "IT landscape"	Yes

internal business positively influences the benefits of EAM (Hypothesis 2). While Bhattacharya (2017) represents the strategic alignment between business and IT to gain from EAM, Riku and Setyohadi (2017) found out how to produce an enterprise planning for increasing the information technology strategy. Besides, there are new finding amongst others by Ansyori et al. (2018), Kudryavtsev et al. (2018), Gampfer et al. (2018) and Masuda and Viswanathan (2019) showing critical success factors to implement EAM and several current EA trend topics – also with regard to current digitization processes (Urbach and Ahlemann 2017). These studies underline the hypothesis that a high level of EAM establishment positively influences the benefits of EAM (Hypothesis 3).

A major difference from the first study model to the revised model is that the original determinant "business environment" has no direct influence on the use of EAM. Instead, the construct external business was formed on the basis of the extended literature review and the validation test by the first case study. Like the construct "firm size", the construct "external business" is listed as a moderator in the model. Lapalme et al. (2016) argue that companies are confronted with ever-increasing complexity and uncertainty due to external factors such as dynamic business requirements, technological developments and market/ industry complexity. Since companies can only react to these external influences with an innovative EAM, it can be assumed that they have an indirect influence. Thus, the authors assume that

Table 3: Summary of Extended Literature Review

Author	Summary	Ranking	IT Landscape	Internal Business	EAM Establishment	Firm Size	External Business
Ansyori et al. (2018)	This paper deals with critical success factors to implement EAM.	-			X		
Bhattacharya (2017)	This paper presents a new model based on two leading modelling techniques to depict strategic alignment between business and IT through the lens of an Enterprise Architecture framework.	-		X			
Danesh and Yu (2018)	Description of the required IT skills for implementing IT Landscapes.	-	X				
Gampfer et al. (2018)	The authors identify and investigate several current EA trend topics: Cloud Computing and Internet of Things	C			X		
Hacks and Lichter (2018)	How can an optimization be determined with representation of the enterprise architecture? Consideration of the current state of the enterprise architecture under consideration of the necessary transition costs.	D		X			
Hacks and Lichter (2018)	Mastering IT complexity as a critical factor for a successful digital transformation.	-	X				
Hazen et al. (2017)	As the first study assesses the value of EA from a non-IT-centric perspective, this work serves as a pivot point for examining the reach and range of EA based capabilities, particularly in operations management. The findings provide operations and IT managers with evidence of how enterprise IT initiatives are ultimately linked to firm performance by way of EA-based capabilities.	B	X				
Kurjakovic and Hinkelmann (2018)	Documentation of the business processes to describe the requirements. Interfaces for increasing efficiency and accessibility. Safety plays an important role in non-functional requirements.	-	X	X			
Lakhrouit and Baina (2015b)	The aim of this paper is to provide a method quantifying the heterogeneity of enterprise architecture components and facilitating deciding between different TO-BE architecture scenarios.	-	X				
Hoffmann and Heimes (2018)	Classification of existing concepts of EAM and subsequent design options for the implementation of EAM.	D	X	X	X		

Kazantsev et al. (2018)	The diversity of IT systems complicates the integration of supply chain companies. This also allows conclusions to be drawn about an EAM system.	-	X				
Koç et al. (2018)	This paper presents a systematic approach to implementing a DSGVO project based on the concepts of enterprise architecture management.	D			X		
Köhler et al. (2018)	Using DHL as an example, the significance of an Enterprise Architect is illustrated. A professional process in a cross-functional team is important here. Regular monitoring and adjustments if there are changes in the business model. The customer requirements are to be met and at the same time unneeded systems are to be removed in order to reduce complexity.	-	X	X			
Kudryavtsev et al. (2018)	When using EAM models the resources (also IT) must be considered. It must be possible to quickly adapt and expand the IT landscape. Implementation is an important factor. There should be an accurate planning of the introduction and transition phase.	C	X		X		
Laasch (2018)	This paper unlocks potentials by conceptualizing homogeneous and heterogeneous organizational value logics shaped by a variety of institutional logics.	B	X				X
Lapalme et al. (2016)	This paper presents the "Grand Challenges" organizations are confronted with and need to be addressed by enterprise architecture in the future.	C					X
Malyzhenkov et al. (2018)	The coordination of business areas and IT areas is very important. The Zachman framework is a good example of this. A documentation framework is very important, as the relationships, rules and conditions are clear.	C		X	X		
Masuda and Viswanathan (2019)	It is necessary to emphasize the alignment with the management strategy/corporate strategy for new digitization projects. Promoting IT management in enterprise architecture is a very important factor. Enterprise architects must coordinate with the stakeholders, system architects and those responsible for the architectures. Which enterprise architecture strategy should be pursued? Selection of a widely used and very well rated EAM framework (requirements, ...)	-		X	X		
Mayer et al. (2019)	This paper derives current deficits of architecture management structures.	-	X		X		
Nagy et al. (2017)	This study responds to the view that the crucial problem in strategic management (research) is firm heterogeneity. The present study applies complexity theory tenets and a "neo-configurational perspective" in proposing firms' complex antecedent conditions affecting firms' complex outcome conditions.	B	X		X		

Riku and Setyohadi (2017)	The purpose of this research is to find out the recent condition of information technology in order to produce an enterprise planning for increasing the information technology strategy.	-		X			
Schneider et al. (2018)	The authors conduct a longitudinal, exploratory single-case study of the life cycle of cloud-based ES in a medium-sized organization. We develop a process theory that explains how requirements evolve beyond ES implementation and throughout its life cycle. The authors isolate nine mechanisms that explain how contextual factors and experiences are intertwined and shape the evolution of requirements.	A			X		
Suri et al. (2018)	Description of the IT business architecture/systems.	-	X				
Teece (2018)	This paper has highlighted certain important interactions between a firm's business models and its dynamic capabilities. A key theme is that strong dynamic capabilities enable the creation and implementation of effective business models.	B	X				
Urbach and Ahlemann (2017)	This article examines the implications of digitisation for the IT organisation and how the necessary changes can be actively addressed.	D			X		
Van Gils and Proper (2018)	The EAM models are involved in day-to-day business. This also includes workflows and business rules. The models must be understandable to the persons concerned. Decisions must be made regarding the design or the specific level for implementation.	-			X		

both constructs "firm size" (Hypothesis 4: *Firm size affects the influences regarding the benefit of EAM*) and "external business" (Hypothesis 5: *External business affects the influences regarding the benefit of EAM*) do have an impact on the direct influencing variables "IT landscape", "internal business" and "EAM establishment".

6 Case Study Validation of the Extended Research Model

Similar to the first case study discussed in Sect. 4, the second and third case studies also apply the research model in industrial practice for validation purposes. However, when validating the second model version the focus is not only on the fitness of indicators for determinants and on feasibility of operationalizing or using the indicators, but also on the hypotheses. This wider focus is possible because one of the information sources in the case studies are experienced enterprise architects willing to contribute their views on the hypotheses.

6.1 Case Study Company No.2

The industrial case is a small enterprise established some years ago in the area of electronic business. The company has an innovative business model combining media content and electronic commerce. First, movies or TV-programs are analyzed of their content. In a further step, the tagged video content can be used to offer commercial products visible in the video in a certain scene (i. e. in a defined period) to the audience. In addition, the tags can be applied to determine which commercials or advertisements would fit to the video content. This functionality meets the demand of marketing industries for dynamic,

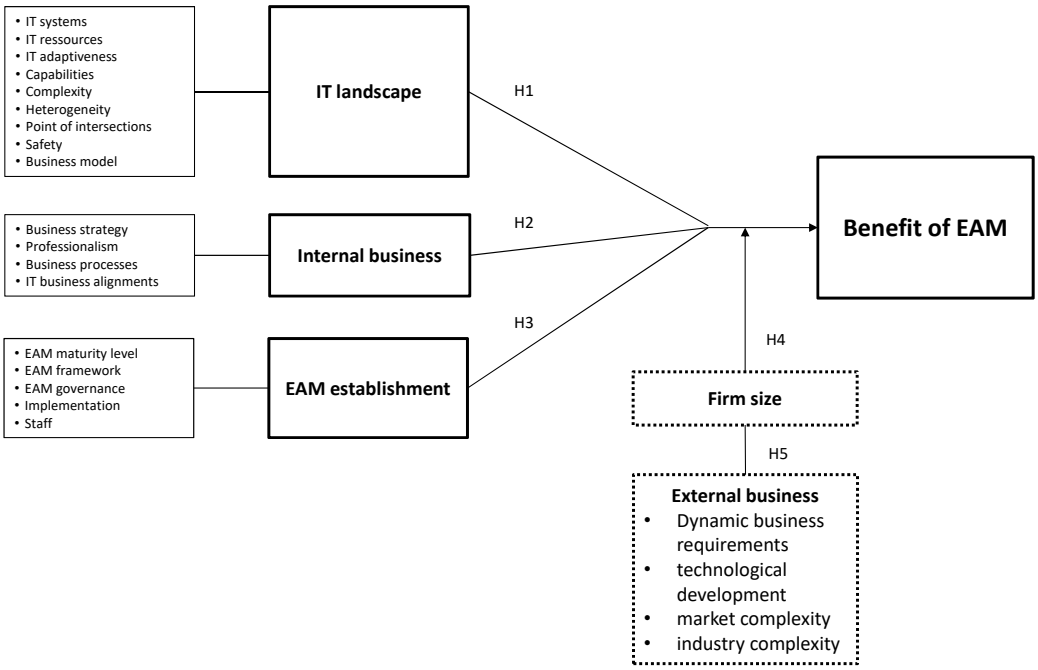

Figure 2: Revised Research Model

target-oriented marketing campaigns.

The enterprise architecture of the case study company was developed in an initial version quite early in the process of establishing the company. When the business model was defined and the required suppliers and partners were determined, the architecture served as a blueprint for a coordinated development of organizational processes and IT-solutions. The case study company still has a defined enterprise architecture and the Chief Technology Officer (CTO) accepts the responsibility of maintaining the architecture documentation. This serves as basis for decision making on changes in the IT and for roadmap planning. In comparison to the first case, there is no need to transform the company through a new business model – as the company was newly established.

6.2 Validation of the Research Model of Case Study 2

The validation of the second research model version in the case study started with a check, if the indicators (shown in Fig. 2) could be captured and applied in the case study company:

• The external business environment is under continuous analysis and investigation by the management team of the company, as the company has to defend the own market share against start-ups and intruders from neighbouring industries. This includes new technologies, changed requirements of key customers or indicators for changes in the overall market structure and partner relationships. The analysis results are documented using mind-maps and networked structures (OneNote).

• The IT landscape is captured within the enterprise architecture documentation that consists of a model-like drawing and notes regarding products and versions. Most of the indicators listed in the research model are available "on demand" from the responsible staff members.

• The internal business in the case study company is divided into production, development and marketing. Most of the administration has been outsourced. Business processes are defined; the business strategy is described as roadmaps and known to the acting persons.

• The indicators related to "EAM establishment" can be directly linked to the extent and way roles, structures, processes, landscape and implementation are established, defined, documented and in operation. In the case study company, no formal EAM structures, policies or processes were defined. So far, the number of employees in the company is small enough to position the EAM responsibility and processes solely on the CTO and the manager of the company.

The conclusions from this analysis step are (1) that it is possible to operationalize the indicators and to capture the determinants in the company and (2) that the indicators fit the determinants. It should be noted that "operationalizing" and "capturing" for many indicators – in contrast to the first case study – is not based on existing data in information systems but on interviewing the responsible persons or available documentation. The second validation step addressed the hypothesis related to the second version of the research model. We performed an interview with the CTO about his view on the hypotheses. The conducting researcher documented the statements of the CTO as hand-written notes. Although the CTO would qualify as an expert in EAM due to his academic qualification and experience, the interview has to be seen as information source in the context of the case study rather than an expert interview. The CTO agrees to hypothesis 1 (*A well-organized IT landscape positively influences the benefits of EAM*) and hypothesis 3 (*A high level of EAM establishment positively influences the benefits of EAM*). The CTO argues that established structures in the IT landscape and a "working IT" in an organization offers more options for EAM to constructively develop the IT and the enterprise that only can be implemented if the EAM is sufficiently mature in an enterprise. For hypothesis 2 (*A well-structured internal business positively influences the benefits of EAM*), the CTO argues that the relation between internal business and EAM runs in both directions, i. e. a well-structured internal business not only influences EAM benefits positively, but also the internal business positively influences EAM. This statement does not really question the hypothesis. For hypothesis 4, the CTO does not completely agree that the firm size positively influences the impact of EAM benefits. His opinion is that small firms can have equally high benefits (in relation to their size) as larger firms. However, small firms often are not aware of EAM, i. e. the share of small firms gaining benefits from EAM is much smaller as for large enterprises. For hypothesis 5, the CTO agrees that dynamics and complexity in external businesses increase the need for an established EAM, and thus, will show clear benefits.

6.3 Case Study Company No.3

The selected company is a medium-sized enterprise based in Baden-Wuerttemberg (Germany) and has approximately 200 employees. The annual turnover is between 200 and 300 million EUR. Furthermore, the company site was established in 1888 and always has new business activities. The company belongs to a German public limited company and this public limited company belongs to larger Belgian chemical group. The group is listed on a stock exchange. The company is in the chemical industry, in electroplating business. Electroplating is a cross-sectional technology and for this reason the company supplies many different industries worldwide. The focus is on the development, production and sales of electroplating solutions and electrolytes. The company has an integrated management system and the business processes are documented in a traceable manner.

The company is currently in no digital transformation process. Currently there are no market requirements that would force the company to do so. Due to the product range (chemicals and salts) there are no possibilities for connecting the products with each other or in a network. It is also not possible to carry out online maintenance or to analyze the electrolytes, as the analysis and measuring instruments are not available at the customer site. However, the company is very anxious to further develop the IT systems "around the products" and to offer customers benefit. The company is exclusively active in the B2B sector and is not allowed to sell to private individuals or consumers.
The company is already using technologies which could be part of digitization approaches such as social software and mobile computing. Big Data, Internet of Things, artificial intelligence or sensors are currently not used. The applications include the conversion and supplementation of services into digitally provided services. Furthermore, attempts are being made to supplement physical products with digitally provided services. Partly it is tried that the business processes are completely digitalized. The experts generally see potential benefits of EAM in the establishment of new digitization approaches. The new approaches are to be implemented sustainably in the IT enterprise architecture, thereby reducing complexity and costs. Software administration is partly carried out directly from the group headquarters.

6.4 Validation of the Research Model of Case Study 3

In the first step of the validation, it was checked whether the influencing factors could be operationalized and recorded in the case study company. The result of this step is as follows:

• The entire IT Landscape is documented by the company in a mind map. In addition, further databases for documentation purposes (e. g. in Access), are maintained. The "EDGE" software is used as configuration management database. The group IT management specifies this. Based on these databases, all determinants can be represented with exception of the business model.

• The company is divided into five main areas: Research and development, production, sales, technical sales and administration. All business processes are defined and documented. These are also documented as Event-driven Process Chains (EPC), so that the processes can be correctly implemented on the IT side. The corporate strategy is mapped to the divisions and departments. The professionalism and the business/IT alignment are difficult to grasp. The improvement of business processes is important in the company, this is handled with a very good CIP management (continuous improvement process). The IT department does not manage some IT systems. Several employees take these functions. This indicator is not mentioned in the study.

• Before new systems are implemented, it is first checked whether they can be included in the network. There are guidelines from the group that must be adhered to. A complete description of the EAM tool is not available, this only exists at group level. There is no role separation in the IT department. The IT manager assumes responsibility for the EAM at the site. The specialist knowledge should be retained in the company through documentation in the knowledge database.

• The firm size with 200 employees is rather small. However, the firm belongs to a group and the IT systems must be integrated into the IT architecture with a structured implementation. The size of the firm has no influence here on an EAM establishment.

• The requirements for future business activities are examined. However, no regular check of the IT requirements is carried out, as this is not required due to the product range. The dynamic requirements and the increasing market complexity are not suitable indicators. This moderating effect is very industry-specific. This is not a priority in the case study company.

The conclusion is that the influencing factors can be operationalized and the indicators recorded. For further processing, the indicator "business model" should be removed from the influencing factor IT Landscape. The indicators "professionalism" and "business IT alignment" cannot be confirmed; a closer look should be taken here. The fact that the company size and the external business environment are presented as moderating effects was confirmed by the case study. A further indicator could also be mentioned in the case of EAM establishment, because some IT systems are managed by non-IT employees. This could be improved by a complete EAM. In the second step of the validation, the five hypotheses are tested. These were also queried in the expert interviews. Regarding the first hypothesis (*A well-organized IT landscape positively influences the benefits of EAM*), the experts have given their unanimous consent to this. Structure means that standards exist in the company. An uncontrolled growth of the IT Landscape lowers the benefits of EAM and is not maintainable or assessable. A good structure is the basis for a sustainable EAM. According to the experts, acceptance of the EAM also increases. The second hypothesis (*A well-structured internal business positively influences the benefits of EAM*) is also fully supported by the experts. The advantage of standards is mentioned as an important component. Transparent or well-structured processes and business processes can be better integrated into the IT system environment. A subsequent adaptation (system requirements, release changes, upgrades, etc.) can thus be carried out faster and easier. With respect to Hypothesis 3 (*A high level of EAM establishment positively influences the benefits of EAM*), all three experts agree with this statement. There is a better acceptance and benefit, if the EAM is introduced intensively and thoughtfully. From the experts' point of view, a sustainable introduction of an EAM is essential for further processing. An awareness should be created in the IT department and in the company, which shows the benefits of an EAM. A high level of EAM can counteract uncontrolled growth and incalculable costs for further development.

Considering Hypothesis 4 (*Firm size affects the influences regarding the benefit of EAM*), an approval by all three experts is given. For bigger firms a sustainable EAM is very important. A separation of the roles is given at larger enterprises, which represents a positive effect according to the opinion of an expert. Transparency is important, because an EAM provides employees with a quicker overview of the software and hardware. In a small-sized enterprise, the processing is still clear and a fully comprehensive EAM would be associated with higher costs or expenses for maintenance. Depending on the industry, it is also very important whether an EAM is used or not. In our industry, many different hardware and software products are required that deal with analyses and measurements in the microgram range. It is very difficult to get these into an EAM and to create the corresponding interfaces. Regarding Hypothesis 5 (*A competitive business environment positively influences the benefits of EAM*), the interviewees do not have a clear opinion on this. The hypothesis is very sector-dependent and therefore cannot be answered generally. In order to be able to react quickly to changes caused by competition, a high degree of flexibility is required; this is not always the case from the experts' point of view. Flexibility may be limited by EAM standards, guidelines or limits. However, lean structures are helpful for the introduction of new systems or entire business areas. Nonetheless, all companies should manage the IT architecture with a cost-optimized software and hardware concept.

7 Conclusion and Outlook

EA reflects the IT infrastructure and business processes. It shows how to align business and IT components in conjunction with the objectives and strategies of enterprises (Lapalme et al. 2016). Aligning business processes and IT is an important task of general management. In addition, EAM plays a crucial role in implementing the vision of digital enterprises (Lapalme et al. 2016). Based on the determinants IT landscape, internal business as well as EAM establishment, the authors found

three main factors with 18 indicators positively influencing the benefit of EAM. Moreover, there are two moderating effects, firm size and external business, which positively affect the influences with respect to the benefit of EAM.

This paper is based on a qualitative research approach to investigate additional factors that demonstrate the benefits of EAM for enterprises within the digital transformation. An extensive and structured literature review shows a modified conceptual research model with clear influencing factors and related indicators. Applied to three industrial digital transformation case studies, most of the proposed indicators could be already operationalized and values could be captured. In addition, the indicators have been proved suitable for the determinants with exception of the "business model". In this context, the authors claim that some influencing factors and indicators were incorrectly represented or even missing within past researches.

Still, there are some limitations within this research. First, a further qualitative research approach might investigate factors that are more detailed or indicators as researchers will continue to deal with the topics surrounding the use of EAM in future. For example, the human side was not explicitly addressed in the research model because it was not mentioned in the inherent literature and would go beyond the scope of the paper. Nevertheless, a consideration of this aspect would be desirable. Second, the conceptual research model must be checked empirically by a quantitative approach in order to statistically confirm the hypotheses and in order to be able to address companies that do not match the pattern found so far. In addition, there are general limitations regarding our qualitative research design as there might be even more databases and valuable work (e. g. paper in supposedly "poorer" journals) to consider when reviewing literature. Additionally, it was only possible to find one relevant paper from an A-Journal within literature research. It must also be noted that the concept of digital transformation in the work was not part of the existing literature search terms, but only the model was examined based on three different companies, all of which are in the digital transformation. Furthermore, it was not our intention to test the hypotheses in the industrial cases, as this would require the possibility of comparison or benchmarking with other companies. Moreover, the validation of the indicators was purely textual, i. e. argumentative. For example, it would be conceivable that, despite great efforts in the EAM area, companies would not fit in with the patterns found in the investigation model. Future investigations can therefore begin here with the operationalization of the presented constructs in the research model, in order to test hypotheses and to test the overall model with regard to validity and representativeness.

Academics can learn from a new classification of influencing factors and related indicators regarding the benefit of EAM and can improve previous study designs. The theoretical research model with testable hypotheses can be optimized and more domain-specific correlations can be explored. The paper makes a valuable contribution to practice as they can use the proposed factors of each hypothesis to initiate own EAM endeavors. Thus, practitioners can use the classification to evaluate and improve current EAM implementations. Future research might be able to develop new models on the benefit of EAM in relation to digital transformation processes whereupon industry-/ sector-specific adoptions of the classification can be considered (Romero and Vernadat 2016).

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