

Determinants to Benefit from Enterprise Architecture Management – A Research Model

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Abstract. A successful digital transformation in enterprises requires surpassing infrastructural flexibility within firms and high IT competency to accomplish changing business requirements. Digital Enterprises are challenged to combine business and IT to gain from existing technological achievements. Previous studies showed that there are certain factors influencing the benefit of Enterprise Architecture Management. However, there are some more influencing factors due to the digital transformation that were not taken into consideration yet. An alternative research approach investigates more factors and helps to get a deeper insight of impact factors. This paper draws on a first approach to investigate additional factors and their impact on EAM. The approach is based on a profound literature research in order to build a new empirical research model. In addition, the indicators were examined in a case of industrial digital transformation. It is shown that factors aggregated to the determinants IT Landscapes, internal as well as external Business Environments and the level of EAM Establishment have substantially impact on the benefit of EAM in enterprises.

Keywords: EAM, enterprise architecture, impact factors, benefit of EAM, use of EAM, qualitative study, IT business alignment

1 Introduction

Enterprise Architecture Management (EAM) is a crucial task for enterprises and their IT infrastructure [1][13]. Therefore, it is an often discussed topic for management and research [2]. It also plays an important role in implementing new digital strategies [3]. The different developments of digitization embrace new technologies (Hadoop, RFID et al.), services (cloud services et al.) and applications with new business models [4]. To include such challenges specific frameworks like SEAM [4], ESARC [3] 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 [1][6][7][8][12], but did not focus on the tremendous impact of the digital transformation. Digitization is a driver

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 (2010)	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		
BITKOM (2011)	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 & 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			
Luftmann (2004)	Approach for assessing the maturity of the business-IT alignment.				X			
Luftmann & Brier (1999)	This article develops a methodology that leverages the most important enablers and inhibitors to business-IT alignment.	C			X			
Hanschke (2011)	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 & Ba (2015)	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 & 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 & 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. (2015)	Empirically and theoretically grounded insights into EA evolution, in particular in relation to the introduction of SOA.	C		X				

3 Determinants to Benefit from EAM: A Research Model

To prove how to benefit from EAM, the authors build a research model based on literature review guidelines by Cooper et al. [9]. The model (see Fig. 1) consists of six determinants including 22 indicators and two moderating effects (firm size and industry).

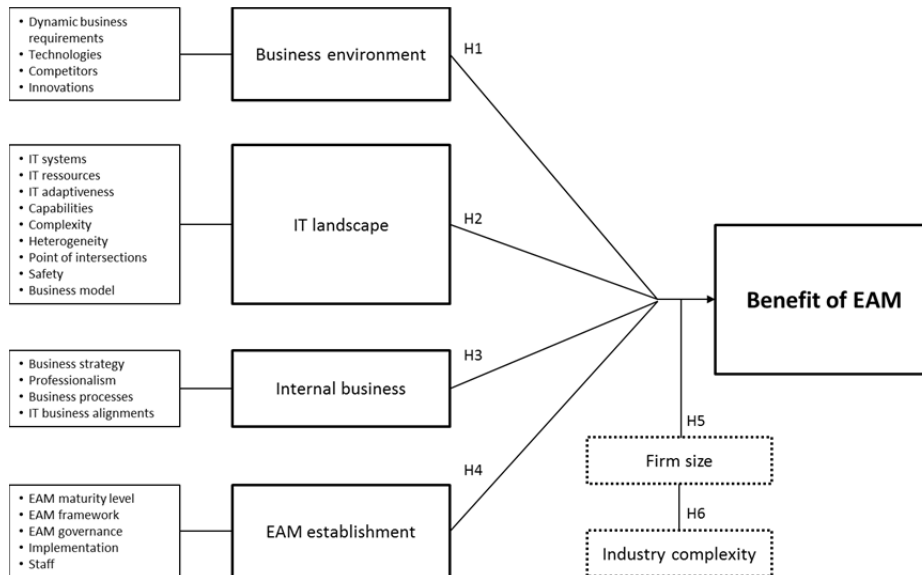


Fig. 1. Research model

Recent research studies have shown that there are potential drivers to benefit from EAM [1][12]. 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 [12]. 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 [16][29]. Requirements for a useful EAM are a customized, efficient and flexible IT solution and an effective information 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 [17]. The improvement of transparency and control capability of the organization results in a value contribution of EAM [18][29].

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 [12]. For a better handling of IT Landscapes they should be well-structured, that means the reduction of the complexity [36]. 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 [17][28]. Therefore, 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 [30][33]. 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 [19][35].

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 [16]. 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 [20]. Business processes and specific functions are both part of the business architecture, which is crucial for the business of the enterprise [17]. IT Business Alignment is the application of Information Technology in an appropriate and timely way [21][22] and a crucial topic for IT Management [4][30]. The benefit of EAM can be very extensive by implementing a high level of IT Business Alignment [12][31]. A distinctive degree

of IT Business Alignment is recommended and is very important for the majority of enterprises [23][12].

Hypothesis 3: A well-structured Internal Business positively influences the benefits of EAM.

An established and sustainable EAM requires the arrangement of a EAM governance [18]. 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 [24]. The assessment of the EAM maturity level is important to get implementable expectations [17]. 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 [17]. An adjusted EAM governance is needed for all levels of implementation [19]. EAM benefits also from EA knowledge by training IT staff with EAM basics as well as fundamental skills [12].

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

In addition to these four 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) [25]. 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 [25]. 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 [25] 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 [27][33]. 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 [33]. As a result, the control variable “Industry Complexity” positively affects the influences regarding the benefit of EAM.

4 Industrial Case of 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 as 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 sub-systems, the case study company designed and implemented reusable services and components for either products or back-office infrastructure. From an enterprise architecture management 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 [38].

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 is in the case study company 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 exist.

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 issue could be a candidate for another determinant. This, however, is not grounded by the available literature. Table 2 summarizes the validation results.

Table 2. Summary of Indicator Validation

	<i>Feasible to operationalize the indicators?</i>	<i>Feasible to capture values in use case?</i>	<i>Fitness of indicators to determinants?</i>
Business environment	Yes – by rating explicit documentation and level of detail	Yes – from frequent reports on market and technology 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

5 Conclusion and Outlook

Enterprise Architecture 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 [1]. 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 [37]. Based on the determinants *Business Environment* (external), *IT Landscape*, *Internal Business* as well as *EAM Establishment*, the authors found four main factors with 22 indicators positively influencing the benefit of EAM. Moreover, there are two moderating effects found, Firm Size and Industry Complexity, which positively affect the influences with respect to the benefit of EAM.

This paper is based on a first approach to investigate additional factors and neglected impact factors with respect to the benefit of EAM in relation to digital transformation. An extensive and structured literature research shows a new conceptual research model with clear influencing factors and related indicators. Applied to an industrial digital transformation case study most of the proposed indicators could be operationalized and values could be captured. Also the indicators have been proved suitable for the determinants with exception of “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 more detailed factors or indicators. Second, the empirical research model should be proved by a quantitative approach. 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 not possible for us to find relevant papers from A-Journals within literature research. Furthermore, it was not our intention to test the hypotheses in the industrial case, as this would require the possibility of comparison or benchmarking with other companies. The validation of the indicators was purely textual/argumentative, which is why future investigations can start here by operationalizing the presented constructs in the presented study model.

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 endeavours. 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 whereupon industry sector specific adoptions of the classification can be considered [38].

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