Benefits of Enterprise Architecture Management – Insights from European Experts

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Rainer Schmidt[1], Michael Möhring[2], Ralf-Christian Härting[2], Christopher Reichstein[2], Alfred Zimmermann[3], Sandro Luceri[2]

[1]Munich University of Applied Sciences
Computer Science and Mathematics
Munich Germany
Rainer.Schmidt@hm.edu
[2]Aalen University of Applied Sciences
Business Administration
Aalen, Germany
[3]Reutlingen University
Computer Science
Reutlingen, Germany

Abstract: Excellence in IT is a key enabler for the digital transformation of enterprises. To realize the vision of Digital Enterprises it is necessary to cope with changing business requirements and to align business and IT. In order to evaluate the contribution of Enterprise Architecture Management to these goals, our paper explores the impact of various factors to the perceived benefit of EAM in enterprises. Based on literature, we build an empirical research model. It is tested with empirical data of European EAM experts using a structural equation modelling approach. It is shown that changing business requirements, IT Business Alignment, the complexity of Information Technology infrastructure as well as enterprise architecture knowledge of Information Technology employees are crucial impact factors to the perceived benefit of EAM in enterprises.

Keywords— EAM, empirical research, benefit of EAM, use of EAM, enterprise architecture management, study, european experts, IT business alignment

1 Introduction

Enterprise Architecture is the organizing logic for business processes and IT infrastructure [1]. It reflects the integration and standardization necessary for delivering goods and services [1]. Enterprise Architecture Management [2] aims at aligning business and IT. Service-oriented Enterprise Architecture Management and engineering [3] target innovative enterprise architectures based on services and cloud-computing.

One of the challenges to Enterprise Architecture Management is digitization. Digitization embraces the digital representation of data, the automation of processes, and the enrichment of products by services [4]. E.g, the majority (63%) of executives

in a study from MIT Sloan Management Review said that the pace of digitization, the transformation to digital processes in their organization is too slow [5].

To overcome such challenges, a number of frameworks have been developed such as TOGAF [6], Archimate [7], SEAM [8] and ARIS [9]. They are supported by a plethora of tools [10]. Using them, different stages of maturity can be achieved. To formalize these stages, models as described in [1] and [11] have been developed.

Despite the ongoing research in academia, the benefits and the use of Enterprise Architecture Management are still a topic of lively discussions (cf. related work section). According to the current literature, there is a gap of research on different influencing factors on the perceived benefit of Enterprise Architecture Management in enterprises as well as a multivariate analysis of it. Therefore, this paper will present insights on the contribution of the perceived benefit of Enterprise Architecture Management that are collected from 126 experts via an empirical model driven research approach and multivariate data analysis based on a structural equation model.

The paper proceeds as follows. In the following section, the research model and the background are described. Then, the research methods and data collection are defined. Finally, we present and discuss the insights obtained from the data collected as well as a section for related work.

2 Research Model and Background

According to the current topic and challenge of the use and benefit of EAM [12], we explore the impact of different influencing factors regarding the perceived benefit of EAM. In general, the perceived benefit of EAM can be defined as the individual observed benefit of Enterprise Architecture Management in companies (or organizations) from the viewpoint of an EAM expert. Therefore, we develop in this section a theoretical research model with testable hypotheses according to general empirical research guidelines [13] [14] regarding the current literature [15].

2.1 Changing Business Requirements

Business requirements often change because most organizations compete in dynamic and rapidly altering environments (e.g. need for modification of strategies, business models as well as business processes, etc.) [16]. The question how to assure the ability of IT to cope with changing business requirements is a topic that received attention in research and practice [17] [8]. Therefore the question, whether Enterprise Architecture Management contributes to the ability of IT to cope with changing business requirements is a subject of high relevance. In consequence, we created hypothesis 1:

Hypothesis 1: Frequent changes of business requirements positively influence the perceived benefits of EAM.

2.2 IT Business Alignment

IT Business Alignment is the application of Information Technology in an appropriate and timely way [18] [19]. IT Business Alignment is a crucial topic for IT-management [20]. The use of Enterprise Architecture Management for the alignment of business IT has been proposed by a number of authors such as [21] [22] [23]. The alignment of business and IT is considered mature, if IT and other business functions adapt their strategies to each other [19]. The question how organizations improve and achieve a mature alignment of business and IT has been identified as a key subject in management [19]. Yet, it is not discovered how IT Business Alignment influences the perceived benefit of EAM (from the point of view of European experts). Based on this finding, we created hypothesis 2:

Hypothesis 2: The alignment of Business and IT positively influences the perceived benefits of EAM.

2.3 EAM Frameworks

Enterprise Architecture Frameworks [24] provide both means for the specification of architecture components and tools for planning and solving problems [25]. Therefore, Enterprise Architecture Frameworks [26] [25] [27] are an important concept of Enterprise Architecture Management. Their support for the concerns of CIO's has been already investigated in [28]. In [12], two questions are discussed: first how governance impacts the use of EA standards and how EA standards support the integration and sharing of IT. Nevertheless, an empirical investigation of this interesting research question did not take place so far. Therefore, we created hypothesis 3:

Hypothesis 3: The use of EAM frameworks has a positive impact on the perceived benefits of EAM.

2.4 IT Landscape Complexity

IT landscapes [29] are proposed as a mean for Enterprise Architecture Management in order to create integrated IT governance platforms [29]. Their visualization is thus an current theme of research [30] [31]. Tackling IT landscape, complexity is an important means for the reduction of IT cost [32]. According to systems science, complexity can be defined by the number of components and relations as well as the heterogeneity of relations and components [33] [34] [35] [36]. Complexity in general can be measured by different indicators (e.g. Entropy Measure, McCabe, LOC, Average Service Cyclomatic Complexity etc.) [37] [38] [39]. Depicting the IT landscape using enterprise architecture may consequently help to identify areas that are driving cost due to their high complexity [40]. To discover the influence on the perceived benefit of EAM, we created the hypothesis 4:

Hypothesis 4: The complexity of the IT landscape positively influences the perceived benefit of EAM.

2.5 EAM Knowledge of IT Employees

The role of IT employees within Enterprise Architecture Management has been addressed by [41]. The communication of enterprise architectures has been identified as an important theme of research in [42]. In general information systems knowledge is very crucial for developing competitive, successful enterprises [43]. To explore the impact of enterprise architecture knowledge of Information Technology employees to the perceived benefit of EAM, we created hypothesis 5:

Hypothesis 5: EAM Knowledge of IT employees influences the perceived benefit of EAM.

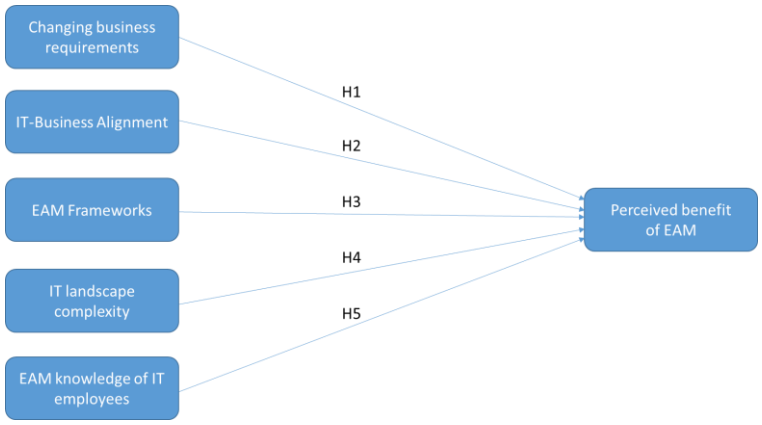

Figure 1: Research model

In order to examine the impact of the specified factors on the perceived benefit of Enterprise Architecture Management, participants had to respond to our questions related to the hypothesis in our model (see also Figure 1) within the online-based survey on a one to five Likert scale (5: very important; 4: important; 3: neither... nor; 2: unimportant; 1: very unimportant) [44]. The questions related to the hypotheses are listed in the following table:

Table 1: Applied questions according to the hypotheses

Perceived benefit of EAM *(How high is the benefit of Enterprise Architecture Management for enterprises?)*
IT Business Alignment *(How important are IT Business Alignments (balancing business and IT goals) for EAM?)*
EAM Frameworks *(How important are EAM frameworks to implement EAM in general?)*
IT landscape complexity *(How important is EAM to manage the IT landscape complexity?)*
EAM knowledge of IT employees *(How important is EAM knowledge of IT employees?)*
Changing business requirements (*How important is EAM to react to changing business requirements?)*

In addition, there are further questions related to the descriptive analysis as well as check questions to ensure a high quality of the study (cf. data collection section).

3 Research Methods

To investigate our research model, we used a quantitative research approach [45]. In general a quantitative research approach is applied to test the confirmation or disconfirmation of hypotheses [45]. Based on empirical data we want to confirm or disconfirm our hypotheses defined in the last section. A web-based survey is one method to collect quantitative empirical data [46]. According to the next section, we collect these data via the internet from leading European experts.

For analyzing a theoretical model, different approaches like correlation and variance analysis as well as structural equation modeling etc. can be used. To test our hypotheses (theoretical causal model) with the data sample of the web-based survey (empirical data), we chose a structural equation modelling approach (SEM). SEM is a further development of multivariate analyses according to get more details about the analysis of different relations [47] [48]. In general, there are two parts of an SEM [49] [48]. First, the measurement model validates the latent variables. Second, the structural model analyses the relationships between the variables and the model. To visualize the relations between different impact factors (variables), a SEM can be built via several approaches (e.g. AMOS, Lisrel, SmartPLS) [50]. Because of special requirements through EAM experts (limited data set), we chose SmartPLS. Single item sets are allowed and often used by SmartPLS [51]. Furthermore, path significances are calculated via Bootstrapping [50] [52] [53] based on our empirical sample.

4 Data Collection

To test our developed hypotheses, we conducted a quantitative research model using a web-based online survey [54]. Before implementing the online survey in the German language via the open source software LimeSurvey [55], we pretested our questionnaire to ensure a high quality of research standard by removing potential ambiguities.

The revised survey finally started in December 2014 and finished in March 2015. During the period of 4 months, we received a sample of n=263 different IT experts from Central Europe. Regarding the different participants, we only addressed IT experts with knowledge and experience in Enterprise Architecture Management by contacting them partly formal via email, phone, or letter and partly informal using personal networks. In addition, the first question in our survey proved the expertise of the respondents in EAM by asking whether the respondent has knowledge and/or experience in EAM or not. Experts that stated to have no knowledge and/or experience in EAM were selected and were no longer taken into consideration. We only asked IT experts, because a previous pre-study in 2014 showed that other experts from outside the Information Technology field cannot well answer to our specific EAM questions. Furthermore,

expert surveys are very often used in information systems research (e.g. [56] [57] [58]) and can control bias e.g. via cross-checking [59].

After data cleaning, we obtained a final sample of n=126 IT experts having a special expertise in EAM of about 7.56 years on average. Only 1 participant has a work experience with less than 1 year while most of the experts have an EAM work experience of far more than 5 years (see Figure 2):

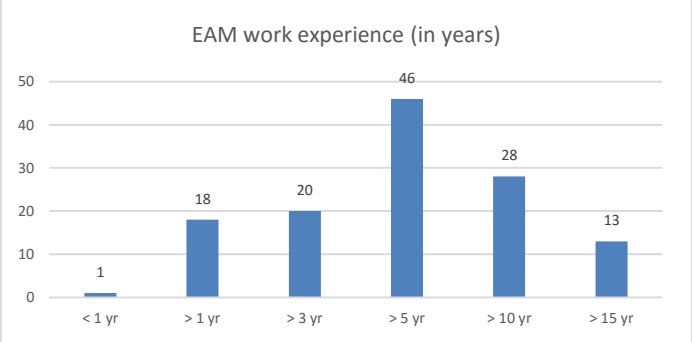

Figure 2: EAM Work Experience

Circa 84.2 % of the experts are male, only 15.8 % are female. The average age of our EAM experts is 42.54 years. The majority of the experts are from the industry (ca. 90 %). Only ca. 10% (n=13) are researchers in the field of EAM. According to the following figure, the benefit of EAM is important (> 90 %) for most of the experts asked:

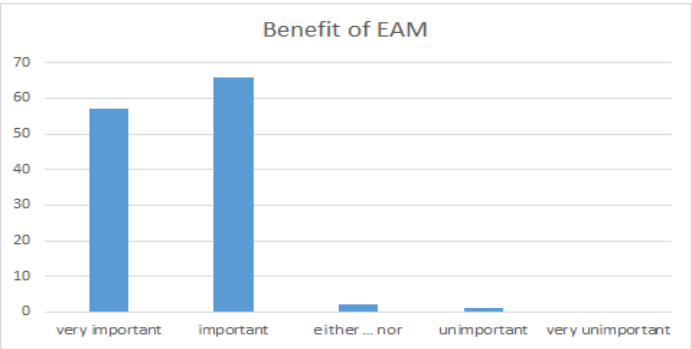

Figure 3: Benefit of EAM

Furthermore, for 44% of the experts (n=56) the size of the enterprise is not decisive for the use of EAM. In contrast to this, 56 % (n=70) define that the size of the enterprise is very important for the use and implementation of EAM.

For the majority of the experts (n=124, 98%) EAM is not only useful for a special industry sector but can be implemented in various industries.

After this descriptive analysis, our hypotheses (cf. section II.) are tested in the next section via multivariate analysis.

5 Results

We tested our empirical data with our research model via structural equation modelling (SEM). Therefore, we used SmartPLS 3.1 [52]. According to the research method section, we followed the guidelines of SEM to calculate and analyze our model. After SEM modelling and analyzing, we got the following results:

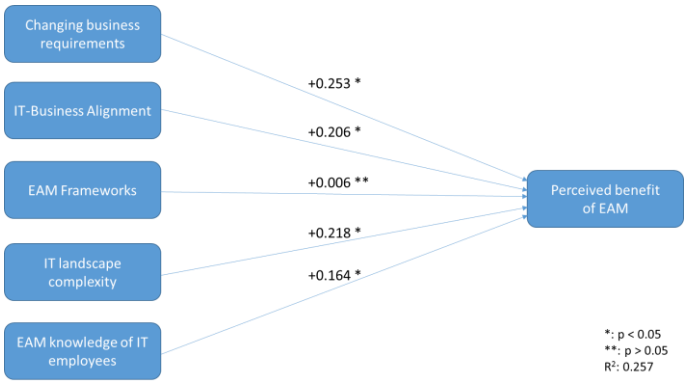

Figure 4: Results of our Research model and empirical data via SEM

According to hypothesis 1 **(*Frequent changes of business requirements positively influence the perceived benefit of EAM*)** the frequent change of business requirements has a positive impact on the perceived benefit of Enterprise Architecture Management, because of a positive path coefficient (+ 0.253) of our SEM. Therefore, hypothesis 1 can be confirmed. Based on these results, enterprises have a higher benefit of EAM if they are placed in a dynamic environment with frequent changes of business requirements. The positive impact can be explained also by the theory of transaction costs [60]. Studies based on this approach indicate, that information systems, which are aligned with the enterprise strategy, are able to raise business processes to a higher level of efficiency and to generate economies of scale [61]. In that context EAM can help to manage this complexity.

IT Business Alignment is a very important challenge in many enterprises or other organizations [20]. Our study explores the influence of IT Business Alignment to the perceived benefit of EAM via hypothesis 2. Regarding the results of our structural equation model, we can support hypothesis 2 (***The alignment of Business and IT positively influences the perceived benefit of EAM.***). The path coefficient (+ 0.206) shows a positive significant influence. Therefore, the benefit of EAM is very huge by implementing a high degree of IT Business Alignment. According to the literature, a high degree of IT Business Alignment is recommended [62]. Thus, EAM should be very important for enterprises.

The impact of enterprise architecture frameworks to the perceived benefit of EAM is discovered in hypothesis 3. Unfortunately, the results are not significant according to table 2 ($p > 0.05$). Therefore, hypothesis 3 ***(The use of EAM frameworks has a positive impact on the perceived benefit of EAM.)*** cannot be confirmed. One reason of this result could be the variance of the data generated by the disagreement of the different experts asked according to this question about EAM frameworks. Another explanation could be various foci of numerous frameworks. That causes a different understanding of EAM frameworks.

The growing Information Technology infrastructure complexity in organizations and enterprises is a very important topic to the daily business of many CIO's [63]. Our research tries to find out, if there is a positive link between the IT landscape complexity and the perceived benefit of EAM. According to our SEM analysis (path coefficient: + 0.218), we can support hypothesis 4 ***(The complexity of the IT landscape positively influences the perceived benefit of EAM.)***. In relation to our analysis, we recommend enterprises to use EAM if they have a high complex IT landscape. Therefore, enterprises can better manage complexity from the point of view of the experts asked. This point can also help by acquiring (e.g. Merger & Acquisition transactions) new companies (and their IT landscape) [64].

Finally, hypothesis 5 explores the impact of enterprise architecture knowledge of Information Technology employees to the perceived benefit of EAM. Based on our data we can confirm hypothesis 5 ***(EAM Knowledge of IT employees influences the perceived benefit of EAM.)***, because of a positive path coefficient (+ 0.164) of the SEM. According to these results, enterprises should train their IT staff with EAM basics and fundamental skills to get a higher benefit of EAM. This could be a sustainable way to ensure a good EAM implementation.

All values of our structural equation modelling analysis are described in the following table:

Table 2: SEM Coefficients, Significance

SEM Path	Path Coefficient	T Statistics	P Values (Significance)
EAM-Frameworks → perceived benefit of EAM	0.006	0.080	0.936
Enterprise architecture knowledge of Information Technology employees → perceived benefit of EAM	0.164	2.017	0.044
IT Business Alignment → perceived benefit of EAM	0.206	2.157	0.032
Information Technology landscape complexity → perceived benefit of EAM	0.218	2.719	0.007
changing business requirements → perceived benefit of EAM	0.253	3.170	0.002

Furthermore the coefficient of the determination (R^2) is in a good range (0.257 > 0.19) according to literature [53]. The path coefficients of hypotheses 1,2,4,5 are significant ($p < 0.05$ according to table 2). Only the path coefficient of hypothesis 3 is not significant (0.936 > 0.05). Furthermore, single item sets are allowed by using the SmartPLS SEM approach as well as often used in research [51]. For single item sets there is no need to calculate metrics like Cronbachs Alpha [51].

6 Related Work

Enterprise Architecture Management has been the theme research in a number of areas. A very broad view on the state of the art in Enterprise Architecture Management can be found in [65]. A broad and thorough overview on enterprise architecture concepts and principles presented in [66] [67]. To provide a formal foundation for Enterprise Architecture Management, a meta-model is used in [68]. In [69] the context of Enterprise Architecture Management is described and challenges for it are identified.

Directly related to our work are the following papers. A literature review is conducted in [70] to identify the benefits of Enterprise Architecture. It is supplemented by interviews with seven practitioners from five organizations. Factors for the success of Enterprise Architecture Management in the financial industry are investigated in the empirical analysis in [71]. The impact of Enterprise Architecture standards on the sharing and the integration of IT resources is investigated in [12].

Digitization and enterprise architecture is the theme of the following papers. In [72] the impact of digitization on enterprise IT is analyzed and shifts from efficiency to speed in implementing change is identified as central requirement. In [5] three areas of transformative effects of digitization are identified: improvement of customer experience, operational improvements and business model change. In [73] the phases of transformation by digitization are analyzed and drivers for digitization are identified.

Beneath these approaches, a number of other researches exist in relation to the investigation presented here. An empirical analysis on the design of Enterprise Architecture Management is presented in [74]. The relationship of changes in enterprise architecture and business models is investigated in [75]. A relation between Archimate [7] and the business model canvas [76] is established. Kluge, Dietsch and Rosemann, design a value realization model for Enterprise Architecture in [77]. They identify service quality and actual use as factors for Enterprise Architecture success. The question whether enterprise architecture frameworks give support on managing IT, is discussed in [28]. The use of an scorecard to depict the strengths and weaknesses in the EA realization is developed in [78]. A comparative study of methods to measure the effectiveness of enterprise architecture is given in [79]. An examination of the organizational factors influencing EAM Challenges is described in [57]. A catalog of capabilities in Enterprise Architecture Management is developed in [24].

Challenges of Enterprise Architecture Management are identified in [80]. A framework for the support of Enterprise Architecture Management with Advanced Analytics is introduced. In [10] a number of tools for the support of Enterprise Architecture

Management are compared. The visualization of Enterprise Architecture Management models is discussed in [81].

7 Conclusion and Discussion

Enterprise Architecture Management is a widely discussed topic and a challenge for practice and research. It plays a crucial role in implementing the vision of digital enterprises. Our paper explores the impact of different important impact factors regarding the perceived benefit of EAM in enterprises. Therefore, we build an empirical research model based on the literature and test it with empirical data of European EAM experts via a structural equation modelling approach.

According to our research, we got interesting insights of different impact factors to the perceived benefit of EAM in enterprises. Changing business requirements, IT Business Alignment, Information Technology infrastructure complexity, as well as enterprise architecture knowledge of Information Technology employees are very important impact factors to the perceived benefit of EAM in enterprises. Nevertheless, one impact factor (EAM Frameworks) could not be significantly explored.

There are different implications according to our research results. First, we contribute to the current information systems research by constructing and testing a new model of the perceived benefit of Enterprise Architecture Management. Our model can help researchers to get a deeper understanding in the benefit of Enterprise Architecture Management in enterprises. Therefore, current approaches of the benefit of information systems can be adapted based on our results. Second, important impact factors, how the perceived benefit of EAM can be explained and influenced, are defined and validated.

Practical users and managers are able to work with our model to prepare EAM decisions by checking their individual instance of the different impact factors to get a recommendation of the perceived benefit of EAM according to their individual enterprise. Employee EAM trainings, good IT Business Alignment etc. can be a good chance for well implementing EAM in enterprises. Therefore, enterprises can go a sustainable as well as very competitive way.

There are some limitations according to our research. First, we only asked experts from Central Europe. There could be other results according to other countries with a different Information Technology use and structure (e.g. BRIC states). Furthermore, there might be some more influencing factors which were not taken into consideration within our quantitative approach. In addition, there are general limitations of a quantitative research method via a web-based survey, according to the literature [45] [82]. A qualitative research approach might probably investigate more influencing factors. Finally, one of our paths is not significant (refer to EAM Frameworks – hypothesis 3).

Therefore, future research should enlarge the sample according to the experts asked and involved countries. Furthermore, more domain-specific factors (e.g. in highly complained environments) should be discovered. Current models of the use of

information systems can be adopted and qualitative research approaches can be implemented to get a deeper insight. Future research should use our model to improve and communicate the current understanding of the use of EAM in organizations.

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