

Use It or Lose It? The Role of Pressure for Use and Utility of Enterprise Architecture Artifacts

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Abstract—In this paper we explore the role of pressure for the use of enterprise architecture (EA) artifact. Based on a quantitative dataset on EA artifacts and enterprise architecture management (EAM) benefits, we specifically explore the relationships between the use intensity of EA artifacts, pressure to use these artifacts, and EAM benefit realization. Focusing on the role of pressure to use EA artifacts, we conceptualize four different classes of artifacts based on (1) how intensively they are used in practice and (2) to what degree pressure increases the use intensity. Our results suggest that each class (EA shelf-warmers, EA superstars, EA annoyances, EA pressure beneficiaries) requires different approaches to foster its use intensity. We derive pressure-based and pressure-free approaches for each class aiming at increasing the use intensity of EA artifacts. Additionally we identify the EA artifacts that have the highest impact on EAM utility (e.g., map of company goals, target process map, target application landscape, and the principle ease of use). We discuss management implications accordingly.

Keywords—enterprise architecture, use, utility, pressure, EA management

I. INTRODUCTION

Information systems (IS) research is concerned with people, task, and technology ([1] based on [2, 3]). Brenner et al. [4] postulate the particular importance of the people dimension. They propose a new research paradigm “user, use, and utility in business information systems and engineering research (U3 BISE).” Use of IS represents an important construct for the impact creation of IS [5], i.e., IS only realize benefits if they are used. Therefore use and users’ behavior of specific kinds of IS need to be understood in research and practice in order to design IS appropriately.

Especially internal IS landscapes of organizations and related support functions were mainly researched from a deployment perspective without intensive focus on user, use, and utility. Extensive literature reviews highlight lacking use, user, and utility (benefit creation) focus in the area of enterprise architecture (EA) and enterprise architecture management (EAM) [6-9].

Existing EA research focuses on creating a common understanding of the research stream itself [6-8], the use scenarios and focus of EA (e.g., which layers between infrastructure and strategy [10] are addressed by EA), EA’s anchoring within the organization [7], and details regarding EA artifacts (i.e., representations of the “as is”, and “to be” architecture in the form of models as well as method fragments, and principles for transferring an “as is” into a “to be” architecture [6]). Additional research discusses EA application scenarios. Examples are the support of enterprise transformation [11], support of compliance, program management, governance, and business/IT alignment [12].

Enterprise architects struggle with justifying the value of EA within the organization [13, 14]. In order to materialize the value of EA, they aim at increasing the use intensity of EA artifacts [14]. Additionally they strive for supporting the organization to the best of their abilities in different application scenarios. This causes the need for convincing potential users to use existing EA artifacts as a support for their task fulfillment. For example, “as is” models of the current architecture can be seen as the information basis regarding an organization’s fundamental structures from a business/strategy, process, integration (alignment), software, and technology perspective [10]. Based on the nature of EA, use of EA artifacts is voluntary. Existing EA models may provide additional information, e.g., on the context of a specific project. However, this information might not be deemed immediately relevant for reaching local project goals (as opposed to global goals of the organization). Thus EA managers need to apply measures that ensure the use of existing EA artifacts (i.e., as-is models, to-be models, methods, and principles) and design the artifacts accordingly. Among others, two mutually exclusive approaches exist for fostering EA artifact use: (1) motivating potential users to voluntarily use an artifact and (2) exerting pressure on potential users to use an artifact.

In our research we follow this distinction and strive for understanding the implications for management aiming at fostering EA artifact use intensity. We distinguish different kinds of EA artifacts and answer the following research

question: *What is the impact of pressure on use-intensity and utility of EA artifacts?*

We proceed as follows: In section two, we provide details on the nature of EA, EAM, and on the concept of pressure. In section three, we introduce our proposition of different EA artifacts and the influence of pressure on the use intensity of these artifacts. In section four, we describe the results of an explorative empirical analysis that aims at understanding the relationship between use of EA artifacts and applied pressure in practice. Additionally we discuss the results and elaborate on implications for management aiming at fostering EA artifact use intensity. We conclude in section five with a short summary, limitations of our work, and opportunities for future research.

II. CONCEPTUAL FOUNDATIONS

A. Enterprise architecture (management)

According to the ISO/IEC/IEEE Standard 42010 architecture is defined as “the fundamental organization of a system, embodied in its components, their relationships to each other and the environment, and the principles governing its design and evolution” [15]. This definition involves two aspects: The first part (“the fundamental organization of a system, embodied in its components, their relationships to each other and the environment [...]” [15]) represents the descriptive aspect, concerning the structure of the system’s building blocks and the relationships between them. The second part (“[...] the principles governing its design and evolution” [15]) represents the prescriptive aspect, effectively restricting the design and evolution space of the system under consideration.

Following this definition of architecture, we adopt The Open Group’s definition of EA as (1) the fundamental structure of a public or private organization, i.e., a governmental agency or a company, and (2) the principles that guide its design and evolution [16]. Based on the principles, EA is considered to be restriction of design freedom because it allows organizational change only within predefined boundaries [17, 18].

EAM is concerned with establishing, maintaining and purposefully developing an organization’s EA [19, 20]. EAM is a continuous management process that addresses EA as its management object [19].

Based on this definition, two kinds of artifacts exist, which document an organization’s EA: descriptive and prescriptive artifacts (subsequently subsumed as EA artifacts). Descriptive artifacts describe the organization’s “as is” structure on the level of business/strategy, process, integration (alignment), software, and technology landscape [10] in the form of “as is” models. Prescriptive artifacts prescribe the desired “to be” state of an organization’s structure in the form of “to be” models. Additionally prescriptive artifacts include methods and principles containing specific procedures and guidelines that describe how the EA should be changed and which steps are necessary to transform the “as is” architecture into the planned

“to be” architecture. EA artifacts are used for different application scenarios. Application scenarios range from informing employees, supporting individual projects (either with technical focus like the implementation of a customer relationship management (CRM) system, or with business focus like the change of the customer interaction process) to supporting large programs that fundamentally change the organization (i.e., enterprise transformations) [11, 12, 21, 22].

EA artifacts are used in different ways. *Descriptive EA artifacts* are used as information objects in order to plan projects and to make sure that all relevant and related architectural components are addressed and taken into account. To be specific, in case a new warehouse management system (WMS) is implemented, while the software and technology layers are directly affected, such a project also affects the business, process and integration layer. Descriptive EA artifacts provide information regarding these interdependencies of the old WMS and therefore should be used as information sources during project planning and execution. *Prescriptive EA artifacts* (i.e., “to be” models, methods, and principles) prescribe the target state of the architecture and the planned steps that need to be performed in order to transform the current into the desired architecture. Additionally they provide overall advice for the EA’s design and structure. Without additional measures, project managers are free to obey (or not) the prescriptive artifacts and/or consult the descriptive ones.

In order to make the concept of EA more tangible, we follow Smolander et al.’s [23] concept of using metaphors to explain the use scenarios of EA artifacts. They subsume artifacts describing the current (“as is”) state as literature (i.e., “as is” models), artifacts prescribing the planned (“to be”) state as blueprints (i.e., “to be” models), artifacts prescribing choices and rationales as decisions (i.e., methods and principles).

B. The concept of pressure

From a social science perspective, pressure describes the concept of applied measures or inherent social norms that influence the behavior of people (in our case towards using EA artifacts). In other words pressure makes someone do something or keeps someone from doing something no matter whether he or she personally wants to do it or not [24, 25]. Pressure therefore leads to involuntary behavior.

In the area of IS research, the impact of pressure has been discussed in different forms and in relation to different kinds of IS. We distinguish sources of pressure that are internal or external to the organization. Whereas internal pressure can occur in the form of management pressure [26] (e.g., top level executives, team leads, project managers, based on organizational policy, etc.), peer pressure [24, 25] (e.g., members of the same working group or colleagues), or artificial scarcity of information (e.g., specific information that is only available by using special systems). External pressure can occur in the form of laws and regulatory requirements [27, 28]. A special form of pressure are social norms [26] which

can be internal or external, depending on whether or not the trigger is part of the organization.

In relation to the use of EA artifacts, internal as well as external pressure can exist. External pressure can be applied by customers of the organization based on an required implementation of quality assurance measures (e.g., the ISO 9000 norm group [29, 30]) or regulations in the area of governmental organizations (e.g., The Department of Defense Architecture Framework which is mandatory for specific ministries of the U.S. government [28]). Additionally management decisions on different levels and governance regulations can generate pressure to use EA artifacts within an organization.

In the remainder of this study we focus on internal pressure which can be influenced by the management of the organization and results in direct management orders, internal regulations, and/or governance rules.

C. Use of EA artifacts and pressure to use EA artifacts

The understanding of *use* in the study at hand follows Bhattacharjee's view who takes the perspective of continuous (i.e., ongoing) use of an artifact [31]. EA artifacts can either be used as information sources or action guidelines. EA literature is continuously used by project managers to meet information demands for planning their projects and allow them to estimate the impact their project has on the application or hardware landscape of the organization, for example. Concerning EA blueprints and EA decisions use refers to the continued compliance with these rules (like standardization or reusability) and the target-oriented planning and execution of projects that help to implement EA blueprints.

Pressure to use an EA artifact varies based on its type (i.e., literature, blueprints, and decisions). Pressure to use EA literature can appear in the form of project management guidelines that require project managers to elaborate on the impact their project has on defined EA components (e.g., hardware landscape, process map). Pressure to use EA blueprints and EA decisions can be applied through action directives, e.g., standard technology platforms must be used and new servers must be installed in order to comply with the hardware landscape blueprint.

III. RESEARCH DESIGN

Our overall research design consists of five steps. First, we introduce our proposition regarding the relationship between pressure and use of EA artifacts as well as the benefits that are created by the use of EA artifacts in practice. Second, we identify EA artifacts and EAM benefits from literature. Third, we design a questionnaire and collect data from practitioners in order to explore our proposition. Fourth, we analyze the collected data. Fifth, we discuss implications for management aiming at fostering EA artifact use intensity for the different classes of EA artifacts.

A. The impact of pressure on the use of EA artifacts

"EA does not solve the urgent problems of the project manager [...]" [14, p.1954]. Therefore there is a high likelihood that EA artifacts are not used and finally end "[...] up as shelfware." [14, p.1954] Thus measures need to be applied by top level managers in order to influence EA artifact use behavior. As stated above, pressure-based and pressure-free approaches are suitable. Pressure-free approaches influence the use behavior on a voluntary basis, e.g., by making EA artifacts more useful or easier to use. Pressure-based approaches could be applied by management decisions and instantiated rules and regulations that make the use of EA artifacts mandatory in the organization and within projects. Even when pressure-based approaches are applied, potential users can still find reasons and loopholes in order to not use the EA artifacts. Without pressure, however, the use of EA artifacts remains a recommendation which may or may not be obeyed without causing any consequence for the potential user.

We consider the impact of pressure on use intensity an inherent characteristic of EA artifacts. That means it cannot be altered. The use intensity of some EA artifacts is largely influenced by pressure, contrary the use intensity of other EA artifacts is influenced by pressure to a minor degree. What can be influenced is use intensity—depending on the EA artifact either by pressure-based or pressure-free approaches. We therefore hypothesize that the effect of pressure on use intensity is contingent on the EA artifact. In other words, use intensity for some EA artifacts may be increased by applying pressure, whereas for other EA artifacts, the application of pressure may have no (or even an adverse) effect on use intensity.

EA artifacts aim at providing different kinds of information or change aspects on different organizational layers, thus they realize different benefits. In order to propose appropriate means for fostering EA artifact use intensity based on their impact on EAM benefit realization we analyze this relationship in an additional step of analysis.

B. Identification of relevant EA artifacts and EAM benefits

Based on The Open Group Architecture Framework (TOGAF) 9.1 [16] we identify a number of relevant artifacts in order to cover each of the following categories: EA literature, EA blueprints, and EA decisions. In addition all organizational layers (business/strategy, process, integration (alignment), software, and technology [10]) should be covered and equally represented in the final list of EA artifacts. In total we select 26 artifacts for further examination. The selected artifacts are listed in Fig. 2.

In order to understand the realized benefits through the use of EA artifacts, we also identify a list of EAM benefits which we analyze in the fourth step of our research. The EAM benefits are listed in TABLE I. (based on Aier et al. [20] consolidated from [32-35]).

C. Collection of quantitative data

In order to collect empirical data we design a questionnaire that consists of four sections. In the first section we ask for descriptive demographic and background information regarding the respondent's work scenario and experience in the area of EA. The second part is comprised of questions regarding the use intensity and level of pressure to use for each of the selected EA artifacts. Section three is related to the benefits that are realized through the use of EA artifacts. Section four contains questions regarding the use intensity of the EA artifacts for specific use cases.

The respondents are asked to express their agreement to each statement in sections two, three, and four on a five point Likert-scale: (1) not at all; (2) hardly; (3) partially/neutral; (4) mostly; (5) completely. The following questions are asked: Section two: How intensive are the following EA artifacts used in your company and how much pressure exists to use the EA artifacts (one question per EA artifact)? Section three: How much benefit is created in your company based on the use of the mentioned EA artifacts (one question per benefit)? Section four: How intensive are the EA artifacts in your company used for the following use cases (one question per use case)?

We designed two versions of the questionnaire: One paper-based version and one electronic version that can be completed online. We distributed the paper-based version at one practitioner event with users of EA artifacts and enterprise architects from various industries. The event took place in Switzerland in November 2013. The participants were from German-speaking countries (i.e., Austria, Germany, Liechtenstein, and Switzerland) and the survey was conducted in German language only. Based on 47 distributed questionnaires, we collected 33 completed paper-based questionnaires, resulting in a return rate of 70.21%.

In addition we designed an online bilingual (English and German) version of the questionnaire and followed two strategies for spreading it to EA experts and users of EA artifacts between January and February 2014. First, we emailed the questionnaire to personal contacts (users of EA artifacts and enterprise architects). Second, we identified groups of EA experts and users within two professional online communities (Xing.com and LinkedIn.com) and contacted the group members asking for their support by means of posts in the groups' forums. These strategies of data collection lead to an additional 27 completed questionnaires. Thus our total sample consists of 60 datasets. The data collection process is summarized in TABLE II. Our overall sample size, therefore exceeds the recommended minimum sample size for the intended regression analyses of 53, assuming at least medium effect sizes [36].

TABLE I. EAM BENEFITS [20] CONSOLIDATED FROM [32-35]

B.1	Business/IT alignment
B.2	Consistent implementation of business strategy
B.3	Improved complexity management
B.4	Higher flexibility in reaction to external changes

B.5	Higher efficiency in reaction to customer and market needs, and pressure to be innovative by proactive action
B.6	Lower risk by preparing for unplanned changes
B.7	Fewer inconsistencies and redundancies through transparent IT functionalities
B.8	Adoption of modern technologies
B.9	Integration of business activities across business units
B.10	Dissolution of information silos (e.g. CRM information)
B.11	Lower heterogeneity of technologies in use
B.12	Lower support costs
B.13	Improved reusability of technologies, information, and functions
B.14	Lower development costs

TABLE II. DATA COLLECTION

Channel	Time	Number of responses	Language
Paper-based: EA practitioner event in Switzerland	November 2013	33	German
Online: Personal contacts and professional EA community on Xing.com and LinkedIn.com	January and February 2014	27	English or German

IV. RESULTS

A. The impact of pressure on the use intensity of EA artifacts

In order to understand the impact of pressure on the use intensity of EA artifacts we evaluate the collected questionnaires based on both dimensions: *Use intensity (I)* and *pressure to use (P)*. Based on the indicated use intensity and the existing pressure to use a specific artifact, we perform regression analyses for all 26 artifacts (A) in order to identify artifacts for which the existence of pressure has a significant impact on the use behavior. We execute linear regression analyses,¹ with pairwise exclusion of missing values, for each artifact where P represents the independent variable and I represents the dependent variable (see Fig. 1). For all 26 artifacts the regressions between P and I are found to be statistically significant, with all p-values below 0.001. The resulting regression coefficients (β) and the mean of use intensity for each artifact are listed in TABLE III.

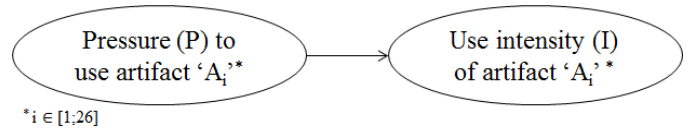


Fig. 1. Regression model ($P \rightarrow I$)

TABLE III. MEAN OF USE INTENSITY PER EA ARTIFACT AND REGRESSION COEFFICIENTS FOR EACH REGRESSION ANALYSIS ($P \rightarrow I$) PER EA ARTIFACT

Artifact	Mean ($I_{A,i}$)	$\beta (P_{A,i} \rightarrow I_{A,i})$	Artifact	Mean ($I_{A,i}$)	$\beta (P_{A,i} \rightarrow I_{A,i})$
A.1	3.236	0.868	A.14	3.036	0.698
A.2	3.246	0.817	A.15	3.250	0.680
A.3	3.196	0.567	A.16	2.911	0.730
A.4	3.772	0.501	A.17	3.193	0.726
A.5	3.211	0.550	A.18	3.179	0.826

¹ We used SPSS 21.0.0.0 for our analyses.

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A.6	3.298	0.610	A.19	3.589	0.709
A.7	2.914	0.636	A.20	2.927	0.684
A.8	3.431	0.639	A.21	3.121	0.568
A.9	3.296	0.514	A.22	2.860	0.594
A.10	2.200	0.807	A.23	2.772	0.673
A.11	2.439	0.736	A.24	3.241	0.562
A.12	2.724	0.724	A.25	3.140	0.614
A.13	2.724	0.739	A.26	3.439	0.641

Based on the regression coefficient (impact of pressure on use behavior), we split the artifacts into two groups. The first group consists of artifacts where pressure has a below median ($\beta < 0.677$) impact on use intensity and the second group consists of artifacts where pressure has an above median impact on use intensity.

In order to interpret the dimension use intensity for each artifact, we first rank the EA artifacts in descending order based on their average use intensity and identify two groups correspondingly (above and below median (3.186) use intensity).

Combining both dimensions leads to four distinct classes of EA artifacts (see Fig. 2). We argue that each class (i.e., quadrant in Fig. 2) motivates different approaches that should be followed in order to influence the users' behavior for corresponding EA artifacts. Subsequently we present details on the four classes and propose approaches for influencing the use intensity of the EA artifacts that are associated with each class. The horizontal axis of our four quadrant model represents a property of an artifact and cannot be influenced by management strategies. The target dimension of the derived approaches is displayed on the vertical axis (use intensity).

	I – EA superstars	EA pressure beneficiaries – IV
High use intensity	A.3 Process map (literature) A.4 Model of organizational structure (lit.) A.5 Role catalog (literature) A.6 Map of applications (literature) A.8 Platform model (literature) A.9 Hardware landscape (literature) A.24 Ease of use (decision) A.26 Standardization (decision)	A.1 Product catalog (literature) A.2 Map of company goals (literature) A.15 Target application landscape (blueprint) A.17 Roadmap for EA development (blueprint) A.19 Business Continuity (decision)
Low use intensity	A.7 Data model (lit.) A.21 Shared use of data (decision) A.22 Consistent definitions (decision) A.23 Being independent of technologies (decision) A.25 Reusability (decision)	A.10 Business interaction matrix (literature) A.11 Application / data matrix (literature) A.12 Application / organization matrix (lit.) A.13 Application / technology matrix (lit.) A.14 Target process map (blueprint) A.16 Target hardware landscape (blueprint) A.18 Programs (blueprint) A.20 TCO analysis (decision)
	II – EA shelf-warmers	EA annoyances – III
	Low impact of pressure on use intensity	High impact of pressure on use intensity

Fig. 2. EA artifact classes based on use intensity and impact of pressure on use intensity

1) High use intensity and low impact of pressure on use intensity (EA superstars)

Class I comprises EA artifacts that show an above median use intensity and a below median impact of pressure on use intensity. Such artifacts are used even in the absence of pressure. Thus we call artifacts in class I “EA superstars.”

Strategies aiming at influencing the use behaviors should be pressure-free. Suitable reasons and arguments might include (1) high benefits for the users; (2) artifact use is institutionalized [37], (3) enjoyment in using the artifact (intrinsic motivation) [38], (4) the EA artifact being the exclusive source for task-critical information (e.g., process map, model of organizational structure, role catalog, hardware landscape). Contrary, initiatives that apply pressure to use artifacts will not show impact and should be avoided here.

2) Low use intensity and low impact of pressure on use intensity (EA shelf-warmers)

The second class (II) comprises EA artifacts with below median use intensity and below median impact of pressure on use intensity. Artifacts of this class are mainly EA decisions, e.g., “shared use of data”, “consistent definitions”, and “reusability”. These EA decisions represent noble goals, but appear to have little practical implications in everyday work. Based on their low use intensity and low impact of pressure we call artifacts associated with this class “EA shelf-warmers”.

The manifestation of below median values in both dimensions leads to the conclusion that artifacts associated with this group are of minor importance for the EA user organization and the artifacts' benefits are not perceived by the potential users. Additionally pressure will only have minor effect on the actual use behavior. This induces specific management strategies. We need to differentiate two scenarios that managers might face. They might consider the EA artifact as not valuable for the organization in general. In this case managers should discontinue maintaining and updating the artifact. In the opposite case, if responsible managers see benefits in the use of the artifact they need to apply strategies other than pressure to get business users to use the artifact. Learnings can be derived from the management of EA superstars where pressure also has low impact on use but the use intensity is high. It would be suitable to focus on content-related reasons to motivate potential users to use EA artifacts and highlight the benefits and advantages that using the artifact has for the individual user and the organization in general. Especially highlighting the benefits on individual level (e.g., “using the artifact will make your tasks easier” or “using the artifact will allow you to increase your efficiency”) might be a promising communication strategy to foster artifact use.

3) Low use intensity and high impact of pressure on use intensity (EA annoyances)

Class III summarizes artifacts that indicate a below median use intensity and an above median impact of pressure on use intensity. Based on the data, we can see that pressure is not applied towards using these artifacts. We call this cluster “EA annoyances” because even if pressure has an above median impact on use, managers still do not apply pressure. A reason for this might be that managers do not see the value of these artifacts, or they plan to abolish these from the EA artifact portfolio.

“EA annoyances” are suitable for pressure-based management. Managers are advised to follow pressure-based

approaches in order to influence the use of corresponding EA artifacts if their aim is to increase use intensity. Organization- or business unit-wide governance regulations make artifacts mandatory parts of development projects and enforce the maintenance of interaction matrices (e.g., business interaction matrix, application/data matrix, application/organization matrix, application/technology matrix). In addition managers have the power to directly assign the task to create and communicate the EA blueprints (e.g., target process map, target hardware landscape). Use of EA artifacts can also be part of employees' personal goals. To be specific, use of EA blueprints can be included as the personal goal of project managers. They should only receive their bonus, if their projects help to develop the "as is" architecture towards the planned "to be" architecture.

4) High use intensity and high impact of pressure on use intensity (EA pressure beneficiaries)

The fourth class (IV) is comprised of artifacts that show an above median level of use intensity and an above median impact of pressure on use intensity. This implies that artifacts in this quadrant are characterized either by a high level of applied pressure and use is based on pressure (like artifacts in quadrant III with existing pressure) or use is voluntary, e.g., motivated by reasons stated for class I.

In contrast to quadrants I, II and, III, we cannot suggest any approaches without analyzing the level of actual applied pressure. Based on the regression analysis we can only conclude that existing pressure leads to increased use intensity but not the opposite direction. From a theoretical point of view, EA artifacts in this class can be positioned there because of an above median level of existing pressure that leads to an above median use intensity or because of not pressure-based reasons (see class II). A close look at the actual level of applied pressure points out that all five artifacts associated with this quadrant show an above median level of applied pressure. Therefore we name this quadrant "*EA pressure beneficiaries*". Consequently one recognizes that for these artifacts pressure shows a positive effect on use intensity. Defining approaches to influence the use of EA pressure beneficiaries, is not as straight forward as for classes I, II, and III. Two general approaches need to be distinguished. First, based on the high impact of pressure the easier approach implies to just increase the level of pressure until the desired use intensity is reached or maintain the level of pressure in order to keep the use intensity on a steady level (pressure-based management). Second, in order to balance the effort that is required to apply pressure and the desired use intensity, managers should follow a more complex approach. In order to optimize the use intensity and reduce the effort for applying pressure, managers should try to reduce the actual level of pressure but also make sure that they apply pressure-free management that requires less effort, e.g., by focusing on highlighting the overall benefits of using the EA artifacts. Based on such a balanced approach managers' make sure that the artifact does not move towards quadrant III (lower use intensity).

B. Use intensity, pressure, and benefit realization

After we have identified different EA classes that are characterized by use intensity and influence of pressure on use intensity, it still remains unclear how EA artifacts in each class contribute to EA benefit creation. Therefore we also analyze section three of the questionnaire which is comprised of 14 EA benefits. Respondents were asked to indicate the level of benefit realization for their specific case. In order to be able to derive more general approaches for managing the use intensity of EA artifacts, we first aim at discovering latent groups of benefits that are likely to be achieved jointly. Thus we have conducted a factor analysis² using principal component analysis based on a covariance matrix with Varimax rotation and Kaiser normalization. Missing values have been excluded pairwise.

The analysis leads to three different EA benefit factors. The recommended threshold of Cronbach's Alpha (0.6 to 0.7) is exceeded for every factor [41] (see TABLE IV).

Factor 1 comprises benefits related to flexibility increase and consistency in regard to organizational changes (B.2, B.4, B.5). Factor 2 comprises benefits that address future readiness by aligning business and IT, addressing unplanned changes, creating transparency, and adopting modern technologies (B.1, B.3, B.6, B.7, B.8). Factor 3 comprises benefits related to cost reduction and simplification (B.9, B.10, B.11, B.12, B.13, B.14).

In order to identify which benefits are achieved by the use of which EA artifacts, we used a regression analysis. A total permutation of 26 EA artifacts and 14 benefits leads to a total number of 364 calculated regression analyses (see Fig. 3). 202 (55%) turned out to be statistically significant. For each benefit a varying number of artifacts show a significant effect on the level of benefit realization. Because the level of benefit realization is affected by the use of various EA artifacts and also other reasons, the explained variance per artifact and benefit is rather small. More than 78% of the R² values of the significant regressions are less than 0.2.

TABLE IV. FACTOR LOADINGS AND RELIABILITY

		Factor 1 Flexi- bility & Consi- stency	Factor 2 Future readiness	Factor 3 Cost reduction & Simpli- fication
B.5	Higher efficiency in reaction to customer and market needs, and pressure to be innovative by proactive action	0.870	0.295	0.170
B.4	Higher flexibility in reaction to external changes	0.797	0.229	0.106

² Our dataset fulfills the quality criteria that are required for factor analysis. The percentage of non-diagonal non-zero values (> 0.09) of the anti-image covariance matrix is less than 25% [39]. The Kaiser-Meyer-Olkin measure of sampling adequacy is 0.757 which can be classified as "middling" and is sufficiently high [40]. We used SPSS 21.0.0.0 for our analyses.

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B.2	Consistent implementation of business strategy	0.639	0.474	0.201
B.6	Lower risk by preparing for unplanned changes	0.332	0.807	0.128
B.7	Fewer inconsistencies and redundancies through transparent IT functionalities	0.040	0.768	0.399
B.3	Improved complexity management	0.481	0.726	0.069
B.1	Business/IT alignment	0.363	0.595	0.363
B.8	Adoption of modern technologies	0.384	0.512	0.298
B.11	Lower heterogeneity of technologies in use	0.008	0.109	0.852
B.13	Improved reusability of technologies, information, and functions	0.437	0.348	0.693
B.12	Lower support costs	0.528	0.135	0.687
B.10	Dissolution of information silos (e.g. CRM information)	0.050	0.408	0.647
B.14	Lower development costs	0.614	0.172	0.642
B.9	Integration of business activities across business units	0.455	0.445	0.547
Cronbachs' Alpha		0.851	0.859	0.899

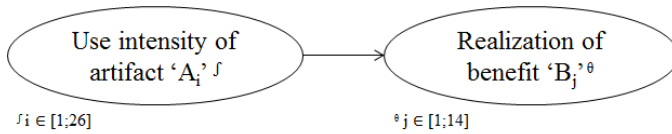


Fig. 3. Regression model ($I(A_i) \rightarrow B_j$)

Towards deriving specific management advice for EA artifacts that positively influence EA benefit creation, we identify the EA artifacts that show the highest average impact (based on the significant regression coefficients) on the three benefit categories. Based on the 78 calculated values (26 artifacts in relation to three benefit categories), we identified the top 25% average regression coefficients between artifact and benefit category. This analysis leads to the conclusion that the highest impact on creation of “Flexibility & Consistency” is caused by intensive use of A.2, A.11, A.12, A.14, A.15, A.17, A.20, A.21, A.22, A.24, and A.26. “Future readiness” is strongly influenced by use of A.12, A.14, A.17, and A.24. “Cost reduction & Simplification” is strongly influenced by use of A.2, A.14, A.15, A.17, and A.18 (see Fig. 2).

As a consequence managers are advised to foster the use of the mentioned artifacts according to the approaches presented in the previous section. Fig. 4 displays the EA artifacts that have the most impact on benefit realization.

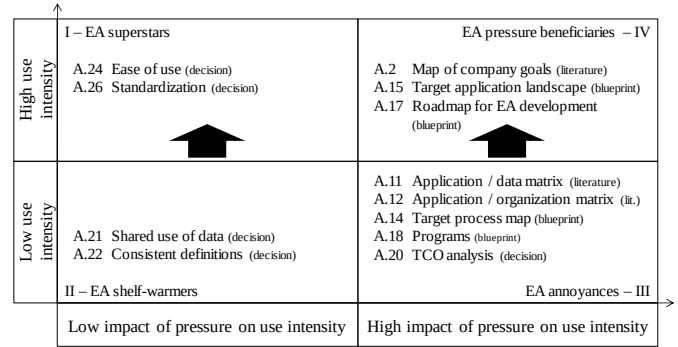


Fig. 4. EA artifact classes filtered for artifacts with most impact on benefit realization

Recall that the impact of pressure on use cannot be influenced by managers because it is an inherent characteristic of each EA artifact. What managers can influence is the choice of an appropriate approach (i.e., pressure-based or pressure-free) for influencing the use intensity of individual EA artifacts. By choosing the appropriate approach, use intensity of EA artifacts can be increased. Therefore, we expect shifts of EA artifacts between the quadrants only on the vertical axis (where up is desirable), but not on the horizontal axis.

Primarily, managers should focus on “moving” artifacts from the lower half (quadrants I and III) of the matrix to the upper half. EA shelf-warmers should be transformed into EA superstars by following pressure-free approaches. The benefits of obeying the EA decision “shared use of data” (A.21) for example should be highlighted for individual users. Those are lower complexity of programs, data accesses and interdependencies in case of IS changes which directly affect the programmers that implement new systems by making their job easier. An equal strategy should be followed for the EA decision “consistent definitions” (A.22). Managers should focus on highlighting the benefits that this decision causes for its users. A challenge might be to motivate the use of this EA decision based on the benefits that are created in future. Following consistent definitions leads to lower system and program complexity and makes the life for IS engineers and programmers easier in future. It also increases the level of consistency which improves the communication.

The following pressure-based approaches for managing the use intensity of EA artifacts help to transform EA annoyances into EA pressure beneficiaries (III $\rightarrow$ IV). Project management guidelines should include the requirement that all newly planned initiatives need to consider the “application/data matrix” (A.11) as well as the “application/organization matrix” (A.12) and state in the project proposal how the planned project impacts both matrices. This requirement forces the use of both EA artifacts. Use of the “target process map” (A.14) and “programs” (A.18) can also be enforced within the planning phase of the project. A statement of conformity to the overall program and an elaboration on how a given project contributes to the target process landscape should be required, stating if and how the project helps to implement the target

process landscape. Project budgets should only be approved if a sophisticated "TCO analysis" (A.20) is presented.

V. CONCLUSION AND FUTURE RESEARCH

In our research we identify four distinct classes of EA artifacts based on their current use intensity and the influence pressure has on use intensity. We propose approaches for influencing the use intensity of EA artifacts categorized into each of the four classes (i.e., EA shelf-warmers, EA superstars, EA annoyances, EA pressure beneficiaries). In a second step of analysis, we add the perspective of achieved benefits through the use of EA artifacts in practice and suggest specific approaches that aim at improving the benefit creation through EA artifact use. From a practical perspective we contribute approaches for EA artifact management that EA managers should follow to improve use and utility [4] of "their" artifacts. The four generic approaches are: EA shelf-warmers—decommission artifacts or follow pressure-free approaches, EA superstars—satisfactory state; intensify use based on pressure-free approaches, EA annoyances—apply pressure, EA pressure beneficiaries—keep pressure high, but also apply pressure-free approaches to highlight benefits.

Our results are limited to the explorative collection of EA artifacts and EA benefits that are covered in the analysis and within the questionnaire. Due to the extensive amount of different artifacts such a study can hardly be comprehensive. Our conceptual framework nevertheless can be used in order to classify additional artifacts which have not been included yet. According to the two dimensions, use intensity and impact of pressure on use, managers easily develop the matrix for EA artifacts in their organization and can derive specific approaches based on our suggestions.

So far we did not distinguish between different kinds of pressure that can exist in practice. Future research should analyze this dimension intensively in order to improve and break down the pressure-based approaches. We discovered that pressure plays a major role for use and utility of EA artifacts and suggested approaches. Additional future research might focus on benefit creation. Currently we analyze the impact the use intensity of one artifact has on benefit creation. It would be helpful for research and practice to identify groups of EA artifacts and analyze their joint impact on the creation of specific benefits. So far we did not evaluate the results in practice. Thus the effectiveness, the efficiency, and the risks of pressure-free and especially pressure-based approaches for influencing EA artifact use intensity should be evaluated within in-depth case analyses. Additional work should also research further factors that might impact the use behavior of EA users and discover measures that foster voluntary use rather than use under pressure. Based on the identified four groups of EA artifacts and the derived approaches for influencing EA artifact use intensity (i.e., run-time management), the next step of our research project aims at identifying specific design principles (i.e., certain means to achieve a desired end [42] at build-time) for the use-centric design of EAM systems.

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