Enterprise Architecture Documentation: Current Practices and Future Directions

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Abstract. Over the past decade Enterprise Architecture (EA) management matured to a discipline commonly perceived as a strategic advantage. Among others, EA management helps to identify and realize cost saving potentials in organizations. EA initiatives commonly start by documenting the status-quo of the EA. The respective management discipline analyzes this so-called current state and derives intermediate planned states heading towards a desired target state of the architecture. Several EA frameworks describe this process in theory. However, during practical application, organizations struggle with documenting the EA and lack concrete guidance during the process. To underline our observations and confirm our hypotheses, we conducted a survey among 140 EA practitioners to analyze issues organizations face while documenting the EA and keeping the documentation up to date. In this paper we present results on current practices, challenges, and automation techniques for EA documentation in a descriptive manner.

Keywords: Enterprise Architecture (EA), automated EA documentation, survey, model maintenance

1 Introduction

Organizations are challenged with increasing complexity of their IT-landscapes through rapidly changing market requirements and globalization. At the same time, information technology (IT) is shifting from a modest service provider to an enabling driver for new business models. Organizations require solutions for the management of these challenges and therefore need to adapt their IT management practices [1, 2]. Enterprise Architecture (EA) and the corresponding management function are promoted to improve the alignment of business and IT, to realize cost saving potentials,

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and, at the same time, to increase availability and failure tolerance [3–5]. An EA model covers business as well as IT aspects to provide a holistic view of an organization and supports decision makers with relevant information. Development and maintenance of an EA rely on sound and up-to-date information on the organization's architecture. EA models typically embody infrastructure components, business applications, business processes, and the relationships among them [6]. Gathering respective information entails a large amount of work. Our experiences from several industry projects show that enterprises easily have several thousands of applications. Due to the sheer amount of these artifacts in an EA, respective EA documentation endeavors are regarded as time consuming, cost intensive, and error-prone [7, 8].

Existing research efforts in the EA documentation field are very scarce. Several publications mentioned the problem of EA data collection in practice. These are elaborated in detail in the following section. However, empirical evaluations on the application of EA documentation in organizations are necessary to obtain an overview of current practices and challenges organizations face when documenting their EA. Experience gained from projects with our industry partners confirmed our assumption that organizations struggle documenting the current state of the EA. These observations build the starting point for the research conducted in this paper.

The main contributions in this paper are findings from a survey with 140 organizations from Canada, Germany, Great Britain, India, New Zealand, South Africa, Switzerland, USA, and others. The survey targets the current EA documentation processes applied in organizations and challenges interwoven with the EA documentation. Our findings are used to validate identified challenges from literature. These findings also include the organization of teams that perform the documentation and the applied EA documentation strategies. In addition, we provide resilient statistics on the use of automation techniques in organizations as a foundation for ongoing research efforts in this field [9].

The contribution of this paper is threefold. First, the results can be used to derive future research directions in the documentation of EA information. Second, we provide an empirical basis of the currently applied techniques for EA documentation in organizations. We highlight automated data collection practices and compare these findings against literature. Third, we validate several research hypotheses for EA documentation that target to better understand the success factors of EA documentation.

2 Related Work

Several efforts in EA research literature have targeted the identification of challenges in the EA practice. Lucke et al. conduct an extensive EA literature review to identify current issues of the discipline [10]. Major findings in their study are a "lack of governance in EA projects" since it is challenging to manage a "plethora of stakeholders". Typically, EA takes place across multiple organizational units and the coordination thereof is also challenging. Other social aspects such as mismatched communica-

tion during collaboration and group specific languages are cited by Lucke et al. They also detail how a different understanding of requirements is challenging, especially when different roles are involved.

In line with Lucke et al., Buckl et al. [11] detail the supply and demand perspectives modeling information consumer and provider roles. In [12], Raadt et al. speak of an "ivory tower" syndrome when too complex models are implemented describing the real world rather abstractly. This also refers to the social aspect of different groups with different background knowledge. In addition, Lucke et al. highlight that a shared understanding is crucial for a successful EA endeavor. They underpin a wrong vision shared "may create a good architecture for the wrong business". Lack of experienced architects and missing resources are also mentioned. Lucke et al. further claim that there is insufficient support by current EA tools, especially when it comes to the collection and maintenance of "this diverse collection of entities".

Kaisler et al. [7] published a practitioner paper describing problems experienced in EA management with a focus on technical and modeling aspects rather than social aspects. Other issues are described by Chuang et al. in [13] ranging from difficulties to get the buy-in from stakeholders over discussions about budgeting EA to an ownership problem of an EA endeavor since these are often seen as IT initiatives.

In [14], Franke et al. present a survey among 168 EA practitioners. The authors focus on companies located in Central Europe and present information on how long companies applied EA management and how business/IT alignment is perceived. They further show results illustrating how business and IT concerns are met. However, the survey rather focuses on the big picture of EA management than on EA documentation.

When focusing on EA documentation, Lam [15] and Shah [16] describe that people tend to use specific tools to produce models for different purposes. The same holds true for maintaining them, such that, from a knowledge management perspective, EA often ends up with "poor documentation" of EA information or rationale of decisions [10]. Hauder et al. [17] exemplify some of these problems by a hands-on approach employing two operative systems. They further provide a literature study, and seek to synthesize automated EA documentation problems into four categories, namely data, transformation, business & organizational and tooling challenges.

Several authors also describe documentation of relevant EA information. In [18], Schekkerman highlights that required information "may not exist or may not [be] accurately represented". In this case he advises that the EA team should "develop a strategy to create the needed documentation" and store it into an EA repository. A more detailed guide is given by Hanschke [19]. She highlights the ongoing characteristic of the EA documentation process, introduces data types and involved roles during the "data provision process". In [20], Ernst introduces a pattern-based approach that captures methods, information, and visualizations found in EA management practice. Ernst's pattern-based approach highlights the documentation of design rationale, i.e., selection of best-practice patterns. Above outlined approaches remain rather abstract when the EA documentation process is faced with challenges.

Recent research efforts have focused on automation mechanisms to improve EA documentation. The research group around Farwick et al. [21] also outlines problems with EA documentation. As a reaction to an error-prone and time-consuming process, they seek to take EA documentation one step beyond the status quo using automation mechanisms [22]. Farwick et al. aim to collect EA information out of productive systems, e.g. via monitoring tools, crawlers, and sniffers. In [23], Buschle et al. implement a similar idea using a vulnerability scanner. In [9], Buschle et al. take the automated EA documentation to productive IT environments. They analyze a productive Enterprise Service Bus (ESB) and show to which extent data therein covers information of an EA model. In particular, the coverage of the ArchiMate model is illustrated. Grunow et al. [24] investigate such data sources concerning data quality aspects with a focus on EA information.

To the authors' best knowledge, up till now, an extensive survey on the state-of-the-art of EA management focusing on EA documentation does not exist.

3 Research Methodology

Given the limited literature on EA documentation and its practical relevance to industry, an exploratory survey across multiple enterprises and industries has been conducted. The aim is to get a first picture on how EA data is collected in organizations. From our experience in the field, we additionally formulated four initial research hypotheses to validate our observations.

As outlined in the introduction, we witnessed that many organizations struggle in keeping their EA models up-to-date [10]. Since an outdated EA model diminishes the value of EA this can be a major obstacle for EA initiatives. Hence, in order to evaluate our observation, we formulate the first research hypothesis:

Hypothesis 1. *Documentation of the EA is a major challenge for EA initiatives in organizations.*

In addition, we noticed differences in the documentation success depending on the team organization structures, such as centralized or federated EA teams [25]. Thus, we intend to confirm this observation with the following hypothesis.

Hypothesis 2. *Efficiency and effectiveness of EA documentation depend on the team organization.*

Tools for modeling the EA range from mere drawings to sophisticated web-based EA modeling tools [26]. Although the problem of EA data collection is widely known, the tool vendors only recently started to include explicit support for collaborative and process-based data collection. To analyze the dependency between the perceived model quality and the used tool we formulate the following hypothesis.

Hypothesis 3. *EA documentation requires an adequate tool support.*

A very recent trend in EA research literature and practice is the use of automated EA documentation techniques [9, 22]. With the following hypothesis we wanted to test if current automation efforts in practice have a positive effect on the manual labor needed to keep the EA model up-to-date.

Hypothesis 4. Automation techniques decrease the effort of EA documentation.

To evaluate our hypotheses we compiled an online questionnaire to elicit the current practices and challenges in EA documentation and to test our hypotheses. In addition, we added questions on the usage of automation techniques to gain more insights on the current usage of automation. After designing the questionnaire, we performed a pretest. To do so, the questionnaire was completed by three researchers in the field of EA not involved in creating the questionnaire. Subsequently, the questionnaire has been adapted according to their feedback and suggestions. The final version of the questionnaire has been published as an online survey that was available for 14 days. We sent over 1100 survey invitations via e-mail to EA related experts. The list of experts has been compiled during EA projects we performed with industry partners in recent years. In addition, the survey has been announced in well-known online forums on Xing[1], LinkedIn[2], and Ning.com[3] related to EA or strategic IT management topics. We received 179 answers in total with participants from inter alia Canada, Germany, Great Britain, India, New Zealand, South Africa, Switzerland, and USA. 39 participants (~22%) dropped out during the questionnaire or answered on behalf of the same organizations resulting in 140 completed answers for the evaluation. Table 1 illustrates the distribution of the industry sectors of the organizations in the survey. Finance is the largest sector with 30% followed by IT, Technology with ~19%, and Communications and Government with ~8% respectively.

In order to receive relevant information we targeted participants working in EA management or related fields in the industry. We made sure that only one representative of each organization was included by filtering by duplicate organizations. Table 2 illustrates the participants divided by job title. The largest groups in our survey consist of Enterprise Architects with ~52% and Enterprise Architect Consultants with ~19%. The consultants were asked to accomplish the survey with respect to a specific customer. Among the participants are also ~6% in an upper management position (CxOs) as well as Project Managers, Software Architects, and Software Developers. In addition, we asked the participants on their individual working experience in EA management and the experience of the organization with EA management. The majority of participants have experience in EA management of 4 years or less and only very few organizations have more than 10 years of experience in this field. As a result and in line with [1] this confirms that EA management is still a young topic for organizations with only few very experienced professionals and organizations.

[1] http://www.xing.com (Group *Enterprise Architecture Management*), last accessed: August 8th 2012.

[2] http://www.linkedin.com (Group *The Enterprise Architecture Network*), last accessed: August 8th 2012.

[3] http://enterprisestewards.ning.com, last accessed: August 8th 2012.

Table 1. Organizations by industry sector

Industry Sector	n	% of all
Finance	42	30.00%
IT, Technology	27	19.29%
Communications	11	7.86%
Government	11	7.86%
Education	8	5.71%
Manufacturing	8	5.71%
Transportation	8	5.71%
Services	6	4.29%
Retail	5	3.57%
Health Care	5	3.57%
Agriculture	2	1.43%
Construction	2	1.43%
Other	5	3.57%

Table 2. Participants by job title

Job Title	n	% of all
Enterprise Architect	73	52.14%
Enterprise Architect Consultant	26	18.57%
Software Architect	9	6.43%
Project Manager	6	4.29%
CTO	5	3.57%
IT Manager	5	3.57%
Business Analyst	3	2.14%
CIO	3	2.14%
Software Developer	3	2.14%
CFO	1	0.71%
Software Development Manager	1	0.71%
Other	5	3.57%

Above outlined hypotheses are evaluated and discussed in Section 6 based on the presented data set. We apply Pearson's chi-square test to validate dependencies among respective dimensions in our data set.

4 Enterprise Architecture Management in Organizations

In this section we provide results from the first part of the survey with general questions on EA management in organizations including results on the modeled state and EA challenges organizations are faced with. Results are discussed against the background of current EA literature. The organizations were also asked further questions beyond the scope of this paper, e.g. applied frameworks and tools.

Enterprise Architecture Management Function. The information on the EA contains infrastructure components, business applications, business processes, and their relationships. An EA endeavor commonly comprises the current state of the EA, derives multiple planned states, and heads towards a long-term target state [27]. Typically, it starts with the documentation of information to capture the current state of the EA [28] as the foundation for the alignment of future states. In our survey, the participants were asked to classify their organization according to the currently modeled state of their EA. Fig. 1 illustrates the modeled states across all industry sectors and individually by the sectors Finance, Government, and IT, Technology. The results indicate differences in the modeled states of the EA management functions. While only 45.71% of all organizations modeled a long-term target state in total, the majority of the Finance sector (52.38%) as well as the IT, Technology (66.67%) sector modeled this long-term target state.

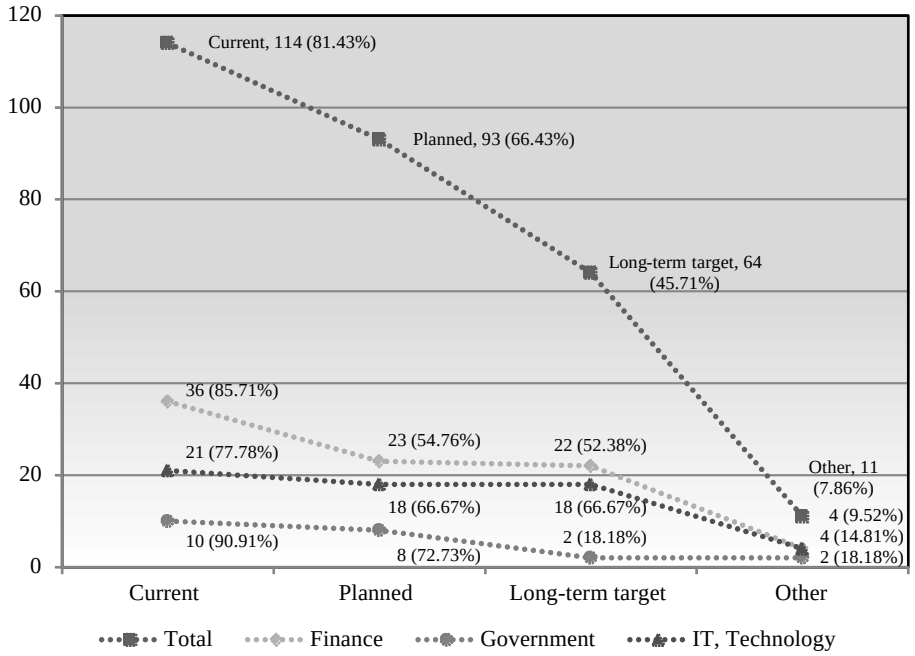

Fig. 1. Modeled state of the EA management function in organizations

Key Challenges in Enterprise Architecture Management. EA research literature lists many positive effects that the implementation of an EA function may have on organizations [29]. However, recent literature suggests that these benefits can only be realized if a certain maturity of the EA function is achieved [30, 31]. On their way towards a higher EA maturity level (see also [5]), organizations struggle with a variety of challenges that reduce the overall perceived success of an EA endeavor [7, 10]. The first part of our survey aimed at getting an explorative picture of the most frequent challenges that EA teams are facing. The participants were asked to select the key challenges they are facing in their EA effort, with multiple selections possible. In addition, the participants could give detailed descriptions of the rationale behind their selections and add other challenges that were not present for selection. Table 4 shows the results of this question. The first result is that only a small percentage of the participants (7.14%) stated that they are not facing any specific challenge. This is a strong indicator that most organizations still struggle with the implementation of EA despite the wide availability of EA frameworks (cf. Section 2), best practices collections [19, 20], tools [26] and the increasing experience of practitioners.

The two most frequently selected challenges address efforts of EA data collection and the quality of the resulting model. Both were selected as one of the key challenges by 55% of the participants. This supports our findings of a recent survey as well as interviews with practitioners [8] and other literature [10], which indicated that the effort of manual EA documentation is a major issue in today's organizations. Howev-

er, it needs to be mentioned that the title of the survey indicated the topic of automated EA documentation. This might have led to a bias that directed practitioners who have problems with their data collection process to take the survey. Less participants mentioned insufficient tool support as a key challenge (34.29%). Tool support has been identified as one of the key challenges in the literature [7, 10]. However, the recent years have brought improvements to the maturity of EA tools [26]. 31.43% of the participants selected "No management support" as one of their key EA challenges. This has also been identified by various publications on EA challenges [7, 10]. The results of our survey indicate that the management support varies by industry sector, e.g. 18.18% in the government sector and 50% in the transportation sector. The Finance, Insurance, Real Estate sector almost resembles the mean with 33.33%. These numbers show that about one third of the EA initiatives are struggling to get management support that is of utmost importance to realize changes in organizations. One reason for this might be the perceived low return on investment (ROI) of EA initiatives. Still 25.71% of the participants selected this as a key issue. Several of the respondents also explicitly mentioned difficulties to measure the ROI in an optional free-text answer. The perceived ROI, the complexity and rapid changes in the real world architecture may lead to difficulties to motivate people. The existence of data silos and missing tool integration were also mentioned several times. This is another indicator that better tool support can improve the overall EA documentation.

Table 3. Key EA challenges organizations are facing

Team Organization	**n**	**% of all**
Huge effort of data collection	77	55.00%
Bad quality of EA model data (actuality, consistency, completeness, etc.)	77	55.00%
Insufficient tool support	48	34.29%
No management support	44	33.43%
Low return on investment	36	25.71%
Other	32	22.86%
No specific challenge	10	7.14%

5 Current Practice of Enterprise Architecture Documentation

In order to grasp the current practices of EA data collection and challenges organizations face, we asked several questions regarding the team structures, collection processes, and data collection triggers. The answers show that manual data collection is still prevailing, and the maturity of most data collection processes to keep the EA model up-to-date is generally low.

Team Organization. First, we asked the participants about the team organization for the data collection (cf. Table 5). About 46% stated that EA data is collected by a central EA team that gathers the data from the stakeholders in the organizational units and from existing documentation. About 42% of the surveyed individuals answered that data is collected by both, a central EA team as well as federated teams that work

in the organizational units. A small fraction of 10% stated that data is only collected from stakeholders in other organizational units. 35 participants that mentioned a centralized team also stated a large effort in the data collection. 38 participants declared a 'hybrid' collection approach, i.e. EA data providers in the organizational units and a central EA team. Those also stated a large effort of the data collection.

Table 4. How are the teams for the EA data collection organized?

Team Organization	n	% of all
Collected by central EA team	64	45.71%
Both, collected by centralized and federated teams	59	42.14%
Collected by stakeholders in other organizational units (federated EAM)	14	10.00%
I don't know	3	00.02%

Data Collection Strategy. In another series of questions we intended to elicit the actual practice of collecting EA data that are shown in Table 5. We asked the participants to describe how the EA data collection currently is organized and performed in their organizations. The typical practice for 76% of the participants is to manually inspect the content of existing applications and databases. Approaches entailing interaction between people (physical or virtual) are applied less frequently. These are interviews with stakeholders (68%), interactive modeling workshops with stakeholders (~53%) as well as questionnaires (~37%). Interestingly, ~35% of the participants replied that the data they use for manual entry in an EA tool is partially collected automatically.

Table 5. How is the manual EA data collection organized? (Multiple choices were possible.)

Type of Collection	n	% of all
Manually from applications/databases	95	76.00%
Manually via interviews	85	68.00%
Manually modeled in workshops	66	52.80%
Manually via questionnaires	46	36.80%
Partially collected automatically	44	35.20%

Table 6. Does your organization have a dedicated and specified process description for the data collection?

Process Available	n	% of all
No	99	71.00%
Yes	33	23.00%
I don't know	8	6.00%

Maturity of Data Collection Processes. One of the most striking findings of our survey is the result regarding the EA data collection process that can be seen in Table 6. Only 23% of the participants state they have a reference process description of their EA data collection endeavors. 71% stated they have no process description to keep the EA data up-to-date. This implies data is collected in an ad-hoc manner in these organizations. Given these figures, we argue that many organizations may improve the data collection efficiency with clearly defined processes describing the responsibilities, actions and triggering events.

Data Collection Triggers. In order to keep the EA model in-sync with the reality, enterprise architects have to be aware of changes affecting the EA. Table 7 shows the

result of triggering events initiating a manual update of the EA model. As expected, most architects rely on periodic checks with key stakeholders that provide data on specific parts of the architecture (55.71%). Further triggers organizations use are: acquisition of new products (44.28%), new application releases (42.86%), project completion (42.86%), and the introduction of new processes (39.29%). Note that these triggers rely on very good communication of the architects with stakeholders, which possibly takes place across different organizational units. Obviously, in cases where this communication is hindered updates might be delayed. Communication in the opposite direction, i.e. from the data providers to the architects, is less common with 32.86%. This could be attributed to the problem of providing benefits for data providers in the EA context [32]. 21.43% of the participants stated that they have been confronted with mergers and acquisitions that have led to an update of the EA model. It is obvious that such massive changes to the EA should lead to manual changes of the EA model. Perhaps not all participating organizations went through a merger or acquisition which would explain the low frequency of this trigger. The two least mentioned triggers refer to technical assistance of triggering. Only 17.14% stated that their data collection process is supported by a ticketing or task list system that allows triggering tasks for other stakeholders, although this has been recommended by literature from practice [19, 33]. Even fewer organizations leverage change event triggers from information systems like project completion events from project management tools (13.57%).

Table 7. What are triggering events for updating contents of your EA model? (Multiple choices were possible.)

Triggering Events	**n**	**% of all**
Periodic checks by enterprise architects with data providing stakeholders	78	55.71%
Acquisition of new products (applications, hardware, etc.) trigger model updates by enterprise architects	62	44.29%
New application releases trigger model updates by enterprise architects	60	42.86%
Project completion/inception triggers EA update process	60	42.86%
Introduction of new business processes trigger model updates by enterprise architects	55	39.29%
Data providers contact the enterprise architects on changes in the real world Enterprise Architecture	46	32.86%
Mergers & Acquisitions trigger model updates by enterprise architects	30	21.43%
A ticketing/task list (application) is used to manage EA change requests by different stakeholders	24	17.14%
Change in external tool automatically triggers manual update task (e.g. project completion in project management tool)	19	13.57%

Data Collection Challenges. Since the majority of organizations mention a huge effort of data collection and bad quality of the EA model data as key challenges in their organizations, the specific data collection challenges are of interest. Table 8 gives an overview of the major EA documentation challenges. The largest amount (62.14%) of organizations struggle to collect data in their organization since it is regarded as very time consuming. This confirms the findings presented in [8] and [7]

that data collection is a time consuming task. This goes in hand with difficult to acquire data (49.29%). Many organizations also struggle with the actuality of the EA model. 44.29% rate resulting quality as insufficient. This assumption is underpinned by 27.14% that mention the real world EA changes too quickly to synchronize the EA model. Only a very small part of 4.29% stated that they face no specific challenges.

Table 8. EA documentation challenges of organizations

Triggering Events	**n**	**% of all**
It is very time consuming to collect the data	87	62.14%
Information is difficult to acquire	69	49.29%
Sufficient EA model actuality is not achieved	62	44.29%
Information is not available	56	40.00%
It is difficult to get hold of the right stakeholders as data providers	54	38.57%
The information is too fine grained	43	30.71%
Real world EA changes too quickly to synchronize EA model	38	27.14%
It creates inconsistencies in the model	34	24.29%
Other	14	10.00%
No specific problems	6	4.29%

Automated Data Collection. The survey presented in [34] indicated that about one fourth of the survey participants use automation mechanisms in order to update their EA tool. The survey at hand, with a much larger dataset supports this finding with 19.29% of the participants stating that they use some form of automation to update their EA tool (cf. Table 9). The majority of the participants rely on manual input of collected EA data.

Table 9. Has your organization implemented some form of automated update mechanism for your EA tool?

Automation	**n**	**% of all**
No	91	65.00%
Yes	27	19.29%
I don't know	2	1.43%
No EA tool in use	20	14.29%

Table 10. How is automation technically implemented in your organization? (Multiple choices were possible.)

Implementation	**n**	**% of all**
Excel Import	12	27.27%
Relational Database Import	9	20.45%
CSV Import	8	18.18%
SOAP Web Service Interface	5	11.36%
XML Import	5	11.36%
REST Web Service Interface	4	9.09%
XMI Import	0	0.00%
I don't know	1	2.27%

Of the 27 respondents who apply automated updates the majority make use of file import mechanisms of their EA tool. The mentioned file types are Excel (~27%), CSV (~18%) and XML (~11%). A much smaller part makes use of web services (SOAP ~11%, REST ~9%) to collect external data. Table 10 summarizes all import mechanisms currently applied in the organizations for automating EA documentation. This supports the findings of Matthes et al. that most EA tools only support the simple non-recurring import from files such as Excel, XML, or CSV [26].

6 Discussion and Key Findings

As presented in Section 4 our survey shows that organizations face diverse EA challenges. One of the key challenges seems to be the EA documentation. This goes in line with our first hypothesis (cf. *Hypothesis 1* in Section 3) such that our empirical basis confirms that the majority of EA initiatives struggle with the EA documentation in adequate quality. In our data set ~77% (n=108) participants stated that they either have to apply a huge effort in collecting data or their data is of bad quality.

We also provide empirical ground for *Hypothesis 2* and are able to state that federated EA teams struggle less with the collection of EA data in adequate quality than centralized teams. To analyze this and the following hypotheses we applied a *chi square goodness of fit test*. We evaluated whether federated teams and mixed teams are struggling with bad quality and data collection effort of their EA model in as many cases as centralized teams (cf. **Table 4**). Here the frequencies for participants not struggling with bad EA model quality are 11, 28, and 24, respectively. These numbers indicate that federated teams struggle less with bad EA model quality. In fact, the null hypothesis can be rejected, based on our data set with $\chi(1)^2 = 10{,}428, p = .015 (p \leq .05)$. Thus, we can confirm that federated teams perform better in keeping the quality of EA models high. In terms of data collection effort we calculated a similar result. In this case we tested whether federated teams struggle as often as centralized teams with the data collection effort. Here the frequencies are *federated*=10, *both*=21 and *centralized*=29 for which no huge effort in data collection was indicated. These numbers again indicate that federated teams perform better with data collection. The goodness of fit test resulted in $\chi(1)^2 = 9{,}730, p = .021 (p \leq .05)$. Thus, we can again reject the null hypothesis and state that federated teams struggle less with the data collection effort. This supports the use of federation for EA data collection as proposed by Fischer et al. [25].

Referring to *Hypothesis 3*, we can state that a successful EA documentation endeavor requires an adequate tool support. In this case we received significant results correlating cases where inadequate tool support and the time consuming nature of EA data collection was reported. Of the 48 participants reporting insufficient tool support, 39 (~%81) also reported the time consuming nature of EA data collection and of the 92 participants that do not report inadequate tool support, 54 (~%58) report high data collection effort. Our null hypothesis in this case states that as many participants state time consuming nature of data collection as inadequate tool support. The goodness of fit test allows us to reject this null hypothesis with $\chi(1)^2 = 7{,}195, p = .007 (p \leq .05)$. Thus, we can state that the effort of data collection depends on adequate tool support.

In *Hypothesis 4* we stated that the use of automated data collection techniques decreases the effort of EA documentation. Here our null hypothesis states that participants who have implemented automated data collection mechanisms and those who have not equally complain about the time consuming nature of EA documentation. Of the participants 91 who have not implemented automation 64 (~70%) complain about

the time needed to collect the data. In the 27 cases where automation has been applied only 12 (~44%) complain about this. This indicates that automation actually has a positive effect of the collection time. The goodness of fit test results with $\chi(1)^2 = 6{,}086,\ p = .014 (p \leq .05)$. Thus, our empirical results confirm the use of automated EA data collection mechanisms reduces the effort of manual collection.

Summarizing the results of the survey, we can state that the data collection is still a major problem in most organizations. Besides organizational issues, low maturity of data collection processes and missing tool support for automated data collection seems to be the root source. Thus, our observations go in line with Hauder et al. [17].

7 Conclusion and Outlook

Presented findings of the survey draw a picture of current practices and challenges in EA management with regard to EA documentation and applied automation mechanisms. The presented results show that many organizations struggle with keeping the quality of their EA models high and that documentation processes have a low maturity in general. We showed that federated teams, appropriate tool usage, and automation techniques have a positive effect on the efficiency of EA documentation efforts.

Within our survey, we explicitly asked the participants about their problems which might have led to a bias. Correlations shown are limited to 140 participants and thus have to be proven to hold true by further research.

Future work could also draw similarities to other organizational functions where documentation problems occur. A major problem in EA documentation seems to be the absence of defined processes or best-practices for documenting an EA. Further research could address this issue by identifying and synthesizing patterns and best-practices used in industry to collect EA information. Our survey identified a portion of organizations already implementing automated EA documentation. It is up to further research to show the extent these automation endeavors collect EA information. In the light of the presented results, we argue that means for reducing the amount of manual EA documentation labor have to be researched. In our future work, we will particularly investigate means for team collaboration and automation mechanisms to improve EA documentation. We will address organizational challenges and technical challenges for automation support. In line with Buschle et al. [9], Hauder et al. [17], and Grunow et al. [24], further research could also analyze particular data sources of operative IT environments for automated EA information. These research efforts could not only focus on technical EA layers but also higher layers with data sources such as project portfolio management tools. With such information, respective tool support could improve automated data collection and thus facilitate EA documentation initiatives.

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