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RESEARCH PAPER

The Structuring of Enterprise Architecture Functions in Organizations

Towards a Systematic Theory

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Abstract Enterprise architecture (EA) practice is a complex set of organizational activities enabling well-coordinated business and IT planning. Organizationally, EA practices are implemented by specialized EA functions, which have existed in many companies in some or the other form for decades. However, the problem of structuring EA functions according to the specific needs of organizations received almost no attention in the literature. To address this gap, 47 organizations and their EA functions were analyzed. Using the grounded theory method, the study develops a comprehensive theoretical model explaining the dependence between the relevant properties of organizations and the structures of their EA functions, including the appropriate numbers of architects, their specialization and structural alignment. This study offers arguably the first full-fledged theory on the structuring of EA functions and also addresses multiple practical questions that are likely to be asked by IT leaders willing to establish EA functions in their organizations.

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1 Introduction

Enterprise architecture (EA) is a collection of special documents, typically called artifacts, describing various aspects of an organization from an integrated business and IT perspective (Kotusev 2019; Niemi and Pekkola 2017). An EA practice is a multifaceted organizational activity that implies using EA artifacts to facilitate joint business and IT planning and eventually improve business and IT alignment (Ahlemann et al. 2012a, b; Kotusev 2021). Adopting EA practices also helps organizations cope with complexity (Beese et al. 2022), boosts their IT capabilities (Ahlemann et al. 2021) and provides many other direct and indirect benefits (Niemi and Pekkola 2020).

Organizationally, EA practices are implemented by dedicated EA functions, which drive all EA-related planning processes and control mechanisms (Beese et al. 2023; Hobbs et al. 2012). EA functions may employ architects of various denominations most popular of which include chief architects, enterprise architects, domain architects and solution architects (FEAPO 2018; van der Raadt and van Vliet 2008). The structure of EA functions may also vary depending on the organizations they are serving (Hobbs et al. 2012; Hornford et al. 2022).

Specialized organizational functions responsible for joint business and IT planning, commonly known today as EA functions, have existed in organizations for decades. For instance, the first architecture functions were established in large organizations a very long time ago, around the late 1960s (McLean and Soden 1977). However, academic research on EA functions has been rather scarce and many questions relevant to EA functions in organizations still remain largely unexplored. From a practical point of view, even the basic questions like "how many architects does an organization need?" have no substantiated answers, not to speak of more advanced ones, e.g. "how exactly should the EA function be structured?". Theoretically, these and similar questions are essential for understanding the institutionalization and operationalization of EA practices in organizations (Ajer et al. 2021b; Kohansal and Haki 2021a).

Generally, limited academic and industry literature on EA functions either prescribes simplistic universal reference models allegedly applicable to all organizations despite the potential order-of-magnitude differences in their size and structure (Behara and Paradkar 2015; TOGAF 2018; van der Raadt et al. 2008), or discusses some discrete archetypes of EA functions often substantiated only by anecdotal evidence (FEAPO 2018; Hobbs et al. 2012; Niemann 2006). Therefore, the problem of structuring EA functions in organizations remains understudied. Even though EA functions seemingly exist in about two-thirds of large organizations (Alaeddini et al. 2017; Ambler 2010; Preisker et al. 2023), the available EA literature offers no consistent theories explaining various aspects of their structuring.

To address this gap, in this study we focus on the problem of structuring EA functions in organizations. Specifically, our research question can be formulated as follows: "What properties of organizations determine the structure of their EA functions, how and why?" As a result of our research, we aim to develop a systematic theory explaining the dependence between the relevant properties of organizations (e.g. size, industry sector and business diversity) and various aspects of their EA functions (e.g. size, architecture positions and their specific structure).

This paper continues as follows: (1) we discuss the notion of EA, the practice of using EA, EA functions in organizations and then formulate our research question, (2) we describe the research design, data collection and analysis procedures, (3) we introduce the identified concepts relevant to structuring EA functions, (4) we describe theoretical propositions explaining the relationships between the concepts and present the resulting theoretical model, (5) we discuss our findings in light of the existing literature, (6) we describe the contribution of our findings to theory and practice, and (7) we conclude the paper.

2 Literature Review

As part of our literature review, we discuss the notion of EA and its domains, the practice of using EA and its activities, EA functions in organizations and their structure, and then explain the motivation and research question of this study.

2.1 Enterprise Architecture

Enterprise architecture (EA) is generally a very complex concept having multiple different meanings. For example, recently Saint-Louis et al. (2019) identified 160 diverse definitions of the term "enterprise architecture" used in the literature. Early sources tend to understand EA primarily as a comprehensive blueprint, or a set of blueprints, defining the relationship between business and IT (Richardson et al. 1990; Spewak and Hill 1992; Zachman 1997). Later sources more often understand EA broader as an entire process (Lapkin et al. 2008), practice (FEAPO 2013) or discipline (Gartner 2013) of joint business and IT planning.

For the purposes of this paper, we define EA in a way aligned with its original meaning as some explicit descriptions (Richardson et al. 1990; Spewak and Hill 1992), but adjusted to the actual empirical realities as "a collection of special documents (EA artifacts) describing various aspects of an organization from an integrated business and IT perspective intended to bridge the communication gap between business and IT stakeholders, facilitate information systems planning and thereby improve business and IT alignment" (Kotusev 2019, p. 112). Conceptually, EA artifacts can be viewed, first of all, as boundary objects between different communities of practice where the representatives of these communities inscribe their interests (Abraham et al. 2015; Kotusev and Kurnia 2021; Kotusev et al. 2023b) and also as powerful instruments of knowledge management (Kotusev et al. 2023a).

Most EA artifacts used in practice represent graphical models providing different views of organizations and their IT landscapes. These artifacts can be created using various techniques and approaches to enterprise modeling (Sandkuhl et al. 2018), e.g. business capability modeling (Kotusev and Alwadain 2023) and variability modeling (Rurua et al. 2019). They can also leverage specialized modeling languages and notations. For instance, popular EA-specific languages include newer ArchiMate (Lankhorst 2017; Wierda 2017) and older ARIS (Scheer 1992; Scheer et al. 2006). Other formal languages that can be used for creating EA models include business process-oriented BPMN (Silver 2012; White and Miers 2008) and system architecture-oriented UML (Fowler 2003; Holt and Perry 2010). However, EA artifacts can take other, non-graphical forms as well. For example, such EA artifacts as principles, policies and guidelines are purely textual and do not use any visual modeling approaches (Haki and Legner 2021; Kotusev 2021). Similarly, asset inventories and technology inventories use simple tabular formats and cannot benefit from any enterprise modeling techniques either EA on a Page (2022).

EA and its artifacts describe different domains of organizations relevant from the perspective of business and IT alignment. These domains typically include business, applications, data, infrastructure and often some other domains, like integration and security (Behara and Paradkar 2015; Kotusev 2021; Niemi and Pekkola 2017; Winter and Fischer 2006).

2.2 Enterprise Architecture Practice

An EA practice, often also called EA management (EAM), is a multifaceted organizational activity that implies using EA artifacts to facilitate decision-making and improve business and IT alignment (Fallmyr and Bygstad 2014; Kotusev 2017a; Rahimi et al. 2017). Besides various EA artifacts, an EA practice involves many other diverse elements including communication processes, governance bodies, approval procedures, measurement techniques, modeling languages, specialized and general-purpose software tools (Ahlemann et al. 2012a, b; Kotusev 2021). Theoretically, an EA practice represents a social practice of cross-community interaction and collective decision-making empowered by EA artifacts as material boundary objects (Dale and Scheepers 2020; Kotusev and Kurnia 2021).

An EA practice is an overarching endeavor that permeates various alignment processes at different levels of the organizational hierarchy (Kotusev 2020a). For example, Kotusev (2021) shows that an EA practice includes three different but interrelated processes: (1) strategic planning, where the desired future course of action for the organization is determined, (2) initiative delivery, where the preferred implementation options for specific IT initiatives are determined and then the respective solutions are delivered, and (3) technology optimization, where the existing IT landscape is analyzed and various technical rationalization suggestions are formulated. Similarly, Ahlemann et al. (2012a) argue that EA practices are closely interrelated with three key organizational processes: (1) strategic planning (Radeke et al. 2012), (2) project life cycle (Lux et al. 2012) and (3) operations and monitoring (Legner et al. 2012).

Other authors also discuss various organizational activities related to or integrated with an EA practice, including strategic planning (Azevedo et al. 2015; Blomqvist et al. 2015; Parker and Brooks 2008; Simon et al. 2014), portfolio management (Lankhorst et al. 2010; Makiya 2008; Quartel et al. 2012; Riempp and Gieffers-Ankel 2007) and implementation of IT systems (Armour and Kaisler 2001; Dale 2013; Foorthuis et al. 2012, 2016). Kurnia et al. (2021b) articulate eight distinct activity areas constituting an EA practice: business capability modeling, roadmapping and portfolio planning, IT asset management, opportunity assessment, project governance, communication and coordination, consulting and mentoring, audit of mergers and acquisitions. Generally, an EA practice implies defining an organization-wide strategic direction, then shaping a more itemized investment portfolio and finally delivering all planned initiatives in an optimal manner (Ahlemann et al. 2012a, b; Kotusev 2021; Ross et al. 2006).

Importantly, EA practices are always organization-specific in their details and contingent on various factors that determine their optimal setup in different circumstances (Aier et al. 2011; Buckl et al. 2012; Haki et al. 2012; Leppanen et al. 2007; Park et al. 2013; Riege and Aier 2008; Saha et al. 2009). For instance, Park et al. (2013) identify four key design factors influencing their configuration: centralization, modularity, standardization and open platform. Leppanen et al. (2007) present a more comprehensive contingency framework for EA practices. Saha et al. (2009) articulates four design models of EA practices: technology standardization, technology differentiation, business standardization and business differentiation. Aier et al. (2011) identify three distinct clusters of approaches to EA: active balanced, business-oriented and passive IT-oriented. Haki et al. (2012) distinguish four different archetypes of EA practices: modeling-driven, strategic IS, governance and architecture paradigm.

2.3 Enterprise Architecture Functions in Organizations

The EA function is an organizational function responsible for implementing an EA practice by driving all the EA-related activities (Hobbs et al. 2012; van der Raadt and van Vliet 2008) and establishing appropriate control mechanisms over downstream IT projects (Beese et al. 2023; Schilling et al. 2018). EA functions typically report to CIOs or other equivalent senior IT leaders, e.g. CTOs, IT directors or vice presidents of technology (Aziz and Obitz 2007; Carr and Else 2018; Manwani and Bossert 2016).

EA functions imply certain architecture positions and employ architects of various denominations to fill these positions, e.g. chief architects, enterprise architects, domain architects and solution architects (van der Raadt and van Vliet 2008). However, there is no single standard classification of architecture positions and different organizations often establish their own unique positions for architects under peculiar titles that may be inconsistent even within the boundaries of the same organization (FEAPO 2018; Wierda 2017; Woods and Rozanski 2012). As Woods and Rozanski (2012, p. 1) point out, "There is little consensus in the academic community or amongst practitioners as to the responsibilities of the many different types of architect we encounter – or indeed, what they should even be called". EA functions also host specialized architecture governance bodies consisting of architects and responsible for making significant EA-related planning decisions and granting approvals, e.g. enterprise architecture council and architecture review board (Hobbs et al. 2012).

Some sources offer rather elaborate reference models for organizing EA functions (Behara and Paradkar 2015; Bolton 2003; TOGAF 2018; van der Raadt et al. 2008). For instance, Bolton (2003) defines specific architecture positions, governance committees, their responsibilities and reporting structures to be established in organizations as part of EA practices. Likewise, van der Raadt and van Vliet (2008) describe EA functions in terms of concrete architecture roles, governance bodies, their duties and cooperation patterns. In the same vein, TOGAF (2018) presents a fairly sophisticated reference model for EA functions addressing most of its key aspects. Longepe (2003), Schekkerman (2008) and van't Wout et al. (2010) also provide detailed suggestions as to what exactly actors and bodies should be involved in EA practices.

Other sources, however, acknowledge that the structure of EA functions can vary depending on the organizations they are serving (Boar 1999; Carbone 2004; FEAPO 2018; Hobbs et al. 2012; Hornford et al. 2022; Niemann 2006; Turner et al. 2009). For example, Niemann (2006) distinguishes four general types of EA functions reflecting different degrees of power distribution between the central IT unit and its subunits: centralized, diversified, distributed and decentralized. Hobbs et al. (2012) identifies four distinct models of EA functions: centralized model, decentralized model, centers of excellence model and hybrid (or federated) model. Hornford et al. (2022) provide three variants for positioning the EA capability in organizations: function-centric, IT-centric and strategy-centric. FEAPO (2018) articulates four patterns of architecture team structures: organizing by project, organizing by domain, organizing by strategy and organizing by segment. Lastly, Turner et al. (2009) describe three postures of EA functions observed in different organizations: architecture as a liability, architecture as an asset and architecture as a service.

2.4 Research Motivation and Question

Although the problem of structuring EA functions in organizations received some attention in the existing EA literature, the respective publications arguably do not offer a systematic, evidence-based view of the subject and provide only inconclusive answers to many important questions about EA functions. For instance, Kotusev (2017b) identified 44 publications relevant to EA functions in the body of EA literature. However, most of the available publications on EA functions are of semi-academic or non-academic origin.[1] Furthermore, many of them are non-empirical in nature. These publications either contain general speculative discussions of EA functions and their roles (Hausman and Cook 2010; Shah and Kourdi 2007), or offer purely prescriptive "how-to" recommendations of unverified empirical validity promoted by industry gurus (Boar 1999; Carbone 2004; Longepe 2003; Niemann 2006; Schekkerman 2008; van't Wout et al. 2010).

More importantly, many publications on EA functions provide certain universal suggestions or reference models of EA functions allegedly suitable for all organizations (Behara and Paradkar 2015; Bolton 2003; TOGAF 2018; van der Raadt et al. 2008). However, because EA is practiced in organizations of disparate sizes, structures and industries (Gregor et al. 2007; Hungerford et al. 2009; Tamm et al. 2015; Toppenberg et al. 2015; Venkatesh et al. 2007), any one-size-fits-all prescriptions regarding the single "right" design of the EA function can be viewed only skeptically.

Although some publications on the subject recognize the existence of different archetypes of EA functions (FEAPO 2018; Hobbs et al. 2012; Hornford et al. 2022; Niemann 2006; Turner et al. 2009), the classifications for EA functions and architecture positions that they propose weakly correlate with each other and, thus, do not provide a consistent and systematic view on the problem of structuring EA functions. At the same time, in-depth descriptive case studies of EA practices in diverse organizations (Gerber et al. 2007; Kotusev 2018; Kotusev et al. 2016; Murer et al. 2011; Rees 2011; Smith and Watson 2015; Smith et al. 2012) demonstrate significantly different configurations of EA functions that arguably cannot be reduced to a few simple conceptual patterns or evident generalities.

To summarize, the existing EA literature essentially provides only some speculative discussions of EA functions, various anecdotal prescriptions for establishing the "proper" EA function, separate case studies of real EA functions and a few largely inconsistent taxonomies for EA functions. Consequently, it would be fair to say that presently a consistent theory explaining the structuring of EA functions in different organizations is missing. In other words, the available literature does not offer an evidence-based explanation of the dependence of the structure of EA functions on the properties of organizations.

EA has been adopted by the majority of large organizations a rather long time ago (Ambler 2010). As van der

[1] In fact, by 2023, we are not aware of any single article in a reputable academic journal that addresses specifically the problem of structuring EA functions in organizations. For this reason, our literature review on EA functions relies heavily on semi-academic publications, practitioner books and other grey literature as the only available sources of information.

Raadt et al. (2007, p. 1) put it, “Almost every self-respecting organization (private or public) of considerable size has at least one, but often various, architecture functions”. Bente et al. (2012, p. 279) concur with this observation: “There is hardly any large company in the world that does not have an EA team, whatever it is called in the respective organization”.[2] Nevertheless, many practical questions related to EA functions that can be considered elementary are still obscure. How many architects does an organization need? What positions should they occupy? How exactly should its EA function be structured? These and similar basic questions, surprisingly, remain without any definite answers in the EA literature. At the same time, clearly defined architecture roles, their responsibilities and hierarchy are a must for the effective institutionalization of EA practices in the organizational organism (Ajer et al. 2021b; Dang and Pekkola 2020; Kohansal and Haki 2021a; Weiss et al. 2013). Accordingly, the general research question of this study can be formulated as follows: “What properties of organizations determine the structure of their EA functions, how and why?” (The structuring of architecture governance bodies is out of the scope of this research).

3 Research Design

The problem of structuring EA functions remains an insufficiently studied area of the EA discipline. Except for certain general suggestions (e.g. more complex companies require more complex EA functions), the current literature arguably does not offer well-developed theories that can be used to guide the research on EA functions. For this reason, the grounded theory approach (Charmaz 2006; Glaser and Strauss 1967; Strauss and Corbin 1998) is adopted in this study to build a theory explaining the structuring of EA functions from scratch. Since this study requires collecting and analyzing qualitative data (e.g. the roles of architects and their responsibilities) as well as quantitative data (e.g. the size of organizations and their EA functions measured in some or the other way) to answer its research question, the grounded theory analysis conducted as part of this study embraces both types of data (Walsh 2015).

3.1 Data Collection

Basically, source data for this research was collected by interviewing EA practitioners from multiple organizations and clarifying the structures of EA functions established within these organizations. This data was accumulated gradually from a series of in-depth studies of different aspects of an EA practice carried out by the authors during the period from 2014 to 2021 (Kotusev and Kurnia 2019; Kotusev et al. 2020, 2022, 2015; Kurnia et al. 2020, 2021a, b), which included a mix of (1) comprehensive case studies with several interviews and documentation analysis, (2) “mini-case studies” with only one or a few interviews and possibly some documentation analysis and (3) individual interviews with EA practitioners.

Overall, our dataset comprises 96 one-hour interviews with the representatives of 44 Australian and 3 New Zealand organizations, or 47 organizations in total. From the standpoint of EA functions, these organizations range from almost the smallest possible ones with only two architects to very large ones employing more than two hundred architects. Our dataset, thus, covers nearly the full size spectrum of EA functions, except for extremely large organizations with hundreds of architects, whereas small organizations with less than 20–30 IT staff typically do not have dedicated EA functions.

For our studies, organizations were selected based primarily on theoretical sampling considerations (Glaser and Strauss 1967; Strauss and Corbin 1998) with the intention to embrace the broadest possible spectrum of configurations in terms of size, industry and structure. In those organizations where more than one interviewee participated in our studies, these interviewees were also selected through theoretical sampling intended to cover different levels of architecture positions, e.g. enterprise, domain and solution.

All the interviews with EA practitioners were guided by semi-structured interview protocols that included standardized questions covering various quantitative and qualitative aspects of organizations, their EA functions and respective architecture positions. Specifically, in the beginning of the interviews, all participants were asked to estimate the total number of employees working in their organizations, the number of their IT staff and the total number of all architects working in their EA functions.[3] The interviewees were also asked to outline the high-level business structure of their organizations. Then, the participants were asked to list the specific positions for architects existing in their organizations, report the exact number of architects occupying these positions and describe their roles and responsibilities in the context of their EA

[2] Recent surveys by Capgemini Invent reveal that EA exists as an established corporate function in about 68% (Karmann et al. 2019), 67% (Preisker et al. 2020), 61% (Preisker et al. 2022) and 73% (Preisker et al. 2023) of large organizations across the globe.

[3] In difficult cases, we intended to find out the effective numbers of full-time equivalent (FTE) people actually doing the work taking into account various part-timers, temporary contractors and external outsourcers.

practices. Finally, the participants were asked various in-depth questions intended to clarify different aspects of their work deemed relevant to our studies, e.g. zones of responsibility, activities, stakeholders and artifacts. Thereby, for every organization, we reached a saturated view of its EA function, including its size, structure and composition, existing architecture roles, their organizational scopes and concrete responsibilities.

After the interviews, the information collected from the interviewees was complemented with the annual revenues of their organizations (the vast majority of them were public organizations with detailed official reports openly available on their websites on the Internet) and the employee numbers provided by the interviewees were double-checked accordingly. These efforts resulted in a considerable dataset covering multiple diverse organizations and including the following information for each organization: (1) total employee headcount, (2) the number of IT staff, (3) annual revenue, (4) basic business structure, (5) the total number of architects, (6) the list of architecture positions with their brief descriptions and (7) the number of architects for each position. The full list of organizations included in our dataset with their basic properties is provided in Table 1.

Hence, our final dataset consisted of 47 organizations with complete, consistent and reliable information on their essential parameters and the parameters of their EA functions. This dataset was taken as an empirical basis for this study.

3.2 Data Analysis

The dataset described above was subjected to the regular grounded theory analysis procedures (Corbin and Strauss 1990; Strauss and Corbin 1998). Because this dataset was gathered as a result of multiple successive data collection efforts, as mentioned earlier, our data analysis alternated with data collection, especially at the later stages of this research. This approach provided a certain degree of parallelism in data collection and analysis implied by grounded theory (Corbin and Strauss 1990; Strauss and Corbin 1998).

One of the notable specifics of this study is that the accumulated dataset included both qualitative and quantitative data, and the analysis was intended to uncover potential relationships between them. The qualitative part of the dataset included primarily the interview transcripts with the descriptions of the business structure of the studied organizations as well as the descriptions of the structures and compositions of their EA functions. The quantitative part of the dataset included all numerical information on the studied organizations and their EA functions, i.e. numbers of employees, IT staff and architects of different denominations.

It is important to notice that grounded theory as an analytical approach is principally indifferent to the nature of source data (Glaser and Strauss 1967). It can be used to analyze quantitative data combined with qualitative data as part of mixed-methods studies (Walsh 2015), or even to analyze purely quantitative data (Glaser 2008), and is actually applied for this purpose in IS research (Miranda et al. 2015). At the same time, this study should not be considered a mixed-methods study (Agerfalk 2013; Kaplan and Duchon 1988; Venkatesh et al. 2013) since it does not leverage any quantitative data collection techniques (e.g. structured surveys), but rather as a purely qualitative study partially based on quantitative data.

Qualitative data in this study has been analyzed via standard grounded theory coding procedures: open coding, axial coding and selective coding (Corbin and Strauss 1990; Strauss and Corbin 1998). As part of these procedures, fragments of the interview transcripts describing the business structures of organizations, the structures of their EA functions and the responsibilities of different architecture positions have been coded to identify relevant concepts and understand their relationships. Importantly, most of the respective codes and concepts are already well-known from the existing EA literature and do not provide any novel insights on their own; it is only the relationships between these concepts and quantitative characteristics of organizations that represent new theoretical findings. Illustrative samples of the applied coding procedures with original quotes, identified codes and resulting concepts are shown in Table 2.

Quantitative data in this study has been analyzed by calculating simple proportions and correlations between various parameters of organizations and their EA functions (e.g. the ratio of architects among employees, the dependence between the number of architects and revenue, etc.) and relating these values to the concepts identified in the qualitative data. The primary goal of these quantitative procedures was to identify principal conceptual relationships existing between the numbers and structures, rather than achieving statistical rigor or mathematical exactness. As noted by Miranda et al. (2015, p. A3), "With quantitative grounded theory, the benchmark is novelty and coherence of insights rather than statistical rigor". Glaser and Strauss (1967) argued that significance tests are *not* necessary for quantitative grounded theory:

> *"Testing the statistical significance of an association between indices presents a strong barrier to the generation of theory while doing nothing to help it, since the resulting accuracy [...] is not crucial. These tests direct attention away from theoretically*

Table 1 List of organizations constituting the dataset of this study

#	Industry sector	Number of interviews	Annual revenue[a]	Staff (total)	IT staff (total)	Architects (total)	Architects (solution)
1	Banking	7	17,300 (2020)	40,000	3000	120	100
2	Banking	5	17,600 (2020)	40,000	5500	235	200
3	Banking	1	1500 (2020)	7000	500	24	12
4	Delivery	6	7500 (2020)	32,000	900	65	40
5	Delivery	1	880 (2019)	7600	500	21	15
6	Diversified	1	690 (2020)	2600	120	5	3
7	Education	9	1370 (2019)	8000	500	20	16
8	Education	2	790 (2020)	5000	200	4	3
9	Education	1	1250 (2020)	5000	250	14	10
10	Education	3	2400 (2020)	9500	400	28	20
11	Education	2	980 (2020)	3500	200	4	3
12	Education	1	390 (2020)	4500	130	9	8
13	Energy	2	14,700 (2019)	6000	575	39	28
14	Energy	2	2000 (2020)	1100	200	9	7
15	Energy	1	12,900 (2018)	3700	500	30	20
16	Finance	1	190 (2020)	250	40	3	2
17	Finance	1	1400 (2019)	7000	800	7	4
18	Finance	1	1150 (2020)	400	200	8	7
19	Finance	1	110 (2020)	400	150	6	5
20	Government	1	N/A	2500	100	5	4
21	Government	1	N/A	2500	400	17	12
22	Government	2	N/A	8500	600	14	10
23	Government	2	N/A	10,000	250	8	3
24	Government	1	N/A	1500	110	10	5
25	Government	2	N/A	1750	800	30	20
26	Government	1	N/A	2500	30	2	1
27	Healthcare	1	1140 (2020)	3500	150	9	8
28	Healthcare	1	2100 (2018)	20,600	150	2	1
29	Healthcare	1	1270 (2020)	14,500	210	7	6
30	Insurance	2	18,900 (2021)	17,000	1800	60	45
31	Insurance	1	8800 (2020)	10,000	550	25	20
32	Insurance	1	5300 (2019)	5000	1250	14	9
33	Marketing	1	640 (2020)	2500	600	28	20
34	Mining	2	3000 (2020)	3800	250	11	4
35	Public Services	1	N/A	2100	60	4	2
36	Public Services	2	N/A	17,000	350	18	12
37	Public Services	1	N/A	200	50	5	2
38	Public Services	1	N/A	9000	400	17	14
39	Retail	4	38,200 (2019)	110,000	2000	25	20
40	Retail	2	2900 (2019)	14,000	300	7	3
41	Telecom	7	2800 (2019)	6000	2000	80	56
42	Telecom	5	21,600 (2021)	35,000	4000	182	150
43	Transport	1	2900 (2021)	2000	300	18	13
44	Transport	1	950 (2020)	2200	75	3	2
45	Utilities	1	2000 (2020)	1000	150	6	1
46	Utilities	1	730 (2020)	2000	100	12	8
47	Utilities	1	2950 (2021)	4000	500	27	22

[a]All numbers are provided in millions of Australian dollars (AUD)

interesting relationships that are not of sufficient magnitude to be statistically significant" (Glaser and Strauss 1967, p. 200)

The application of the grounded theory procedures described above allows to construct a sound theoretical model explaining general regularities observed in EA functions of various organizations across the industry.

Table 2 Illustrative samples of the applied coding procedures

Interviewee quote	Identified code (s)	Resulting concept (s)
"[In our EA function] we have an alignment to those [EA] domains [1]. Conceptually, we have an enterprise architect in infrastructure [2], one in applications [3], one in data and integration [4] and one in business [5]" (Organization #7)	[1] Domains [2] Infrastructure EA [3] Application EA [4] Data EA [5] Business EA	Domain alignment, domain-based positions
"There are a number of chief architects [1] that are aligned to the lines of business [2]. […] They all have one or two principal architects [3] reporting to them and then there is a big pool of solution architects [4] who work on projects [5]" (Organization #4)	[1] Chief architects [2] Lines of business [3] Principal architects [4] Solution architects [5] Project work	Business area alignment, business area-based positions, three-tier hierarchy, solution-level work
"[Our organization] has an enterprise architecture team [1], a solution architecture team [2] and they also have a number of application architects that are narrow domain-specific architects, but they are not considered a part of the inner architecture team […]. [We have] approximately 15 architects [3] where there are two enterprise [4], dozen solution [5] and the boss [manager of architecture] [6]" (Organization #39)	[1] Enterprise architects [2] Solution Architects [3] Number of architects [4] Number of EAs [5] Number of SAs [6] Architecture manager	No Alignment, Generic Positions, Two-Tier Hierarchy

4 Theoretical Concepts

As this study addresses the structuring of EA functions in organizations, it naturally deals with two focal entities: organizations and EA functions. Each of these entities has a number of salient properties of varying sophistication that turned out relevant in the context of this research. In total, our analysis has identified 16 properties important for understanding the patterns of structuring of EA functions. Some of these properties are rather trivial, atheoretical and do not require special definitions, some properties are long well known from classical organization theory (Bedeian and Wren 2001; Shafritz et al. 2015), while others are highly EA-specific and come from the specialized literature on EA functions reviewed earlier. For the purposes of theory building, these properties of organizations and EA functions represent substantive concepts that provide the necessary basis for theorizing and allow formulating specific theoretical propositions explaining logical relationships between them.

4.1 Relevant Properties of Organizations

The properties of organizations relevant to this study include revenue, size, IT size, industry, business diversification, operating model and geographical distribution.

4.1.1 Revenue (Trivial)

Revenue is the total amount of income generated by the organization during a financial year from the sale of its goods and services to the market. Annual revenue is used nearly universally in the business and EA literature for characterizing the scale of organizations.

4.1.2 Size (Trivial)

Size is the total number of people employed by the organization. Similarly to revenue, size is ubiquitously used in the management literature as a simple and intuitive indicator of the scale of organizations.

4.1.3 IT Size (Trivial)

IT size is the total number of IT specialists employed by the organization. Unlike size and revenue, IT size is not used particularly often as a measure for characterizing the scale of organizations.

4.1.4 Industry (Trivial)

Industry is the type of business activities that the organization fulfills. Industry affiliation is considered important as a contextual factor in IS research (Chiasson and Davidson 2005) and has diverse effects on organizations from the standpoint of their management (Qu et al. 2011), operations (Mendelson and Pillai 1999) and performance (Powell 1996).

4.1.5 Business Diversification (General)

Business diversification is the extent to which the organization is diversified in terms of its products, services and markets (Ansoff 1958; Chandler 1962). Pursuing diversification strategy requires a multidivisional organizational structure with relatively autonomous business units (Chandler 1962; Pitts 1977) and renders complex effects on corporate performance and profitability (Palepu 1985; Rumelt 1982).

4.1.6 Operating Model (General)

Operating model is the necessary level of process standardization and data integration between the business units that determines the most fundamental requirements to the enterprise-wide IT platform (Ross et al. 2006; Weill and Ross 2009). Generally, the factors of differentiation and integration of business operations have long been recognized as critical for organizational design (Galbraith 1973; Lawrence and Lorsch 1967a, b) as well as for the design of corporate IT infrastructure (Gunton 1989; van Rensselaer 1985).

4.1.7 Geographical Distribution (General)

Geographical distribution is the extent to which the organizational units are dispersed geographically over different regions, countries or continents (Bartlett and Ghoshal 2002; Ghoshal and Bartlett 1990). For territorially distributed organizations, the internal differentiation of their units and the physical distance between them complicate routine subsidiary-headquarters communication (Ghoshal et al. 1994; Ghoshal and Nohria 1989).

4.2 Relevant Properties of EA Functions

The properties of EA functions relevant to this study include size, job scope, horizontal specialization, vertical specialization, domain alignment, business area alignment, spatial alignment, enterprise-level work and solution-level work.

4.2.1 Size (Trivial)

Size is the total number of architects employed by the EA function. The headcount of architects represents essentially the only natural, intuitively understandable and easily measurable indicator of the scale of EA functions.

4.2.2 Job Scope (General)[4]

Job scope is the circle of responsibilities and decisional autonomy assigned to specific organizational positions. The scope of duties is delineated by those decisions made by individuals at their own discretion versus those decisions imposed on them by the organization (Simon 1944, 1947).

[4] This property and the next properties of horizontal and vertical specializations are certainly applicable to organizations as well, but in the context of this study they are relevant only to EA functions.

4.2.3 Horizontal Specialization (General)

Horizontal specialization is the extent to which different organizational positions are separated based on their areas of proficiency (Barnard 1938; March and Simon 1958; Simon 1947). From an economic point of view, horizontal specialization in organizations is equivalent to the well-known principle of the division of labor (Weber 1947).

4.2.4 Vertical Specialization (General)

Vertical specialization is the extent to which different organizational positions are separated based on their levels in the administrative hierarchy (Simon 1944, 1947). Vertical specialization is not as widely discussed as horizontal one, but is necessary for ensuring coordination, accountability and expertise in decision-making (Simon 1944, 1947).

4.2.5 Domain Alignment (EA-Specific)

Domain alignment is the extent to which architecture positions in EA functions are aligned with different layers of the stack of EA domains, e.g. business, applications, data, integration, infrastructure and security (Behara and Paradkar 2015; Kotusev 2021; Winter and Fischer 2006). Alignment with EA domains represents a "standard" approach to organizing architects promoted, for instance, by TOGAF (2018).

4.2.6 Business Area Alignment (EA-Specific)

Business area alignment is the extent to which architecture positions in EA functions are aligned with different business areas, e.g. lines of business, business divisions, functions or capabilities. Aligning architects with business areas is distinguished as one of the possible ways of organizing EA teams by FEAPO (2018) and clearly observed in some organizations (Smith et al. 2012).

4.2.7 Spatial Alignment (EA-Specific)

Spatial alignment is the extent to which architecture positions in EA functions are co-located with different geographical units, e.g. the head office and foreign subsidiary branches. The idea of aligning architects with physical business locations is embodied in all sorts of distributed, federated and decentralized models of organizing EA teams (Hobbs et al. 2012; Niemann 2006). Basically, the alignment of architecture positions with different EA domains, business areas and geographies represents one of the EA-specific manifestations of horizontal specialization discussed earlier.

4.2.8 Enterprise-Level Work (EA-Specific)

Enterprise-level work is the relative volume of work performed by architects for defining the global strategic direction for business and IT, above individual change initiatives (Ahlemann et al. 2012a, b; Kotusev 2021; Kurnia et al. 2021a). This work includes, for example, developing core diagrams, modeling business capabilities, defining target states, roadmapping and project portfolio planning (Kotusev 2021; Kurnia et al. 2021b; Ross et al. 2006).

4.2.9 Solution-Level Work (EA-Specific)

Solution-level work is the relative volume of work performed by architects for defining the structure of separate IT initiatives in a way consistent with the global direction (Ahlemann et al. 2012a, b; Kotusev 2021; Kurnia et al. 2021a). This work includes, for example, presenting possible initiative implementation options, helping with business cases, developing conceptual solution overviews and then detailed technical solution designs (Beijer and de Klerk 2010; Kotusev 2021). Basically, the division of architectural work into enterprise and solution levels represents one of the EA-specific manifestations of vertical specialization discussed earlier.

5 Theoretical Propositions

The grounded theory procedures resulted in 14 theoretical propositions explaining the relationships between the 16 properties of organizations and EA functions introduced above. Based on the nature of related concepts, these propositions can be grouped into three broad categories: volume, specialization and alignment.

5.1 Volume Propositions

Volume propositions represent a group of related theoretical propositions addressing the aggregate *volume* of architectural work required by organizations. In particular, these propositions explain the size of EA functions in terms of the overall number of architects working for organizations as well as the proportions of enterprise- and solution-level architectural work performed by them.

5.1.1 Sizing of Enterprise Architecture Functions

The size of EA functions evidently correlates with the scale of organizations, i.e. larger organizations tend to employ more architects. Among all the typical parameters of organizations characterizing their scale, the best determining factor of the size of their EA functions turned out to be their IT size, i.e. the number of their IT staff. Specifically, the collected "statistics" demonstrates a rather clear and straightforward linear dependence between the number of architects and the total number of employees related to IT.[5] On average, in organizations from our dataset, architects constituted around 4–5% of their IT workforce,[6] or about one architect for every 20–25 IT specialists (see Table 1). This conclusion can be summarized into the following theoretical proposition:

Proposition 1.1: *The size of the EA function grows proportionally with the IT size of the organization.*[7]

At the same time, other "usual suspects" often used in the literature for characterizing the scale of organizations actually do not determine the size of EA functions with any acceptable precision. For instance, both the size and

[5] Mathematically, the correlation coefficient between the numbers of architects and IT staff was ~ 0.96, though it is important to realize that this study focuses on *conceptual* accuracy, rather than on numerical precision, as explained earlier, and therefore this and all other numbers in this study should be considered primarily as subjects for qualitative interpretation.

[6] The precise ratio of architects was ~ 4.74%. Our calculations also show that the relative numbers of architects in organizations correlate with the years of data collection from 2014 to 2021 with a coefficient of ~ 0.05, which might possibly indicate a weak trend towards the increasing prevalence of architects across the industry over time.

[7] This proposition is not as obvious as it seems because the previously available evidence was contradictory and inconclusive. For example, "Forrester found that 84 percent of companies it surveyed had centralized enterprise architecture groups of fewer than 10 people, regardless of company size" (Koch 2005, p. 40), whereas Obitz and Babu (2009, p. 14) made a rather different observation: "While large firms do tend to have larger enterprise architecture teams, they do not grow proportionally with the size of the IT department or the company size". Keller (2005, p. 9) referred to META Group's estimate of the size of EA teams of "5–7 people" as well as to industry benchmarks assessing their size "between 0.5% and 1% of IT staff". Reese (2008, p. 166) argued that the size of EA functions depends primarily on their role: "The architecture department can be sized appropriately with an understanding of the overall role enterprise architecture plays within the broader scope of I/T. If enterprise architecture also runs the project management office (PMO) for I/T, then the department is likely to be as large as fifty or more resources. In the case where the PMO resides outside of architecture, the architecture staffing level is normally between fifteen and thirty people". By contrast, Preisker et al. (2023, p. 12) reported that the number of architects depends chiefly on the landscape complexity: "Surprisingly, the need for a specific number of architects isn't directly proportional to the organization's size. Instead, it is determined by the complexity of the holistic architecture, including elements like business model artifacts, the spectrum of applications in use, and the array of technological components deployed".

revenue of organizations turned out to be only loosely related to the size of their EA functions,[8] seemingly due to the lack of their direct connection with the realm of IT.[9] These conclusions can be summarized into the following theoretical propositions:

Proposition 1.2: *The size of the EA function does not depend directly on the size of the organization.*

Proposition 1.3: *The size of the EA function does not depend directly on the revenue of the organization.*[10]

5.1.2 Proportions of Architectural Work

Evidence from the collected dataset indicates that the proportions of both enterprise-level work and solution-level work within the overall volume of necessary architectural work stay constant and do not depend on the size of EA functions or any other factors. In large companies, these proportions are manifested explicitly in the numbers of employed solution and non-solution architects (see Table 1), while in small organizations they are manifested more implicitly in the descriptions of how architects actually allocate their time between different activities, e.g. "I am an enterprise architect, but I am heavily involved in projects as well" (the separation of responsibilities between architects is discussed later in the subsequent propositions).

In terms of their relative volume, enterprise-level planning seemingly constitutes around one-fourth of all architectural work, while the remaining three-quarters of architectural work represent solution-level activities. For example, for organizations from our dataset employing 20 or more architects (where the responsibilities of architects were clearly delineated, as explained later), the ratio of solution architects to non-solution architects was about three to one (see Table 1),[11] while in smaller organizations the descriptions of responsibilities similar to "I am 80% solution and 20% enterprise architect" were very common. These conclusions can be summarized into the following theoretical propositions:

Proposition 1.4: *The proportion of necessary enterprise-level work stays constant and does not depend on the size of the EA function.*

Proposition 1.5: *The proportion of necessary solution-level work stays constant and does not depend on the size of the EA function.*

5.2 Specialization Propositions

Specialization propositions represent a group of related theoretical propositions addressing the occupational *specialization* of architects in EA functions required by organizations. In particular, these propositions explain the formal specialization of architecture positions as well as the informal division of responsibilities between architects.

5.2.1 Vertical Specialization of Architecture Positions

The available evidence suggests that larger EA functions require higher vertical specialization of architects manifested in a greater number of tiers in the hierarchy of their architecture positions. Put it simply, the more architects an organization employs, the more tiers of architecture positions it is likely to have. Small organizations typically employ only one or a few peer architects focusing essentially on an entire organization, i.e. they have only one tier of architecture positions (Organizations #11, #14, #26 and #28). By contrast, large organizations may have a multitier hierarchy of architects linked with subordination relationships, where higher-level architects cover broader organizational scopes and vice versa. For example, in one of the largest organizations included in our dataset (Organization #41) four distinct tiers of architecture positions can be articulated: solution tier (focus on separate IT solutions), program tier (focus on change programs consisting of multiple related IT solutions), business area/domain tier (focus on broad organizational areas that may have multiple change programs) and corporate tier (focus on the

[8] Specifically, the correlation coefficients between the numbers of architects and the total staff headcount and annual revenue were only ~ 0.44 and ~ 0.56 respectively, where non-commercial organizations to which the notion of revenue is inapplicable were excluded from the corresponding calculations. Besides that, as the adoption of IT by organizations increases over time and their relative IT spendings are constantly growing (Kappelman et al. 2021), companies with the same revenue in different time epochs are likely to have different volumes of IT estate, making the use of revenue as a reliable measure in a broad time context highly problematic.

[9] Other potential candidate indicators for characterizing the size of organizations would be their overall budgets and IT budgets, where IT budgets seem especially promising as a size measure in the EA context. However, budgets are often not widely publicized or even kept secret and, thus, can be difficult to know or estimate. Moreover, because of the order-of-magnitude differences in IT salary levels between different countries, the use of budgets as a universal measure in the global context is highly problematic. At the same time, various financial indicators of size, like market value, do not characterize organizations from an operating point of view and cannot be relied upon.

[10] These propositions are also not that obvious. In fact, most EA surveys (BiZZdesign 2023; Obitz and Babu 2009; Preisker et al. 2020; Schneider et al. 2015) and many case studies (Labusch et al. 2018; Mocker et al. 2015; Smith et al. 2012; Venkatesh et al. 2007) quantitatively characterize organizations exclusively in terms of their number of employees and annual revenue, as if these measures are informative about their EA practices.

[11] The precise average fraction of solution architects in architecture teams was $\sim 73.4\%$

whole company with all its areas). Quantitatively, it can be speculated that in hierarchies with a constant span of control at each tier, the necessary number of tiers can be estimated as a logarithm of the total number of people included in the hierarchy. This conclusion can be summarized into the following theoretical proposition:

Proposition 2.1: *Larger EA functions require higher vertical specialization of architecture positions in terms of their hierarchical tiers.*

5.2.2 Horizontal Specialization of Architecture Positions

Larger EA functions also require higher horizontal specialization of architects manifested in a greater number of distinct architecture positions at one hierarchical tier. Put it simply, the more architects an organization employs, the more architecture positions at the same tier it is likely to have. At the one extreme, the smallest organizations from our dataset (Organizations #11, #14, #26 and #28) employed only one denomination of architects acting largely as "jacks-of-all-trades" across all business areas and EA domains. At the opposite extreme, the largest organizations from our sample (Organizations #1, #2, #4, #30, #41 and #42) had, at the middle tiers of the hierarchy, many specialized architecture positions focusing on different business areas (e.g. digital channels, customer management and payments processing) and technology domains (e.g. cloud, servers, storage and networks). This conclusion can be summarized into the following theoretical proposition:

Proposition 2.2: *Larger EA functions require higher horizontal specialization of architecture positions in terms of their subject areas.*

5.2.3 Division of Responsibilities Between Architects

Larger EA functions imply narrower job scopes for their architects as measured by their circle of concerns. In other words, the more architects an organization employs, the more clearly delineated their responsibilities are (importantly, the formal existence of different architecture positions in EA functions is not always equivalent to the actual separation of duties as their practical activities can overlap). For example, some of the studied organizations employed only a single permanent architect who combined all architectural responsibilities in one role, i.e. personally accomplished all enterprise- and solution-level planning (Organizations #26 and #28). In other small organizations, EA functions included one or a few enterprise architects and a team of subordinate solution architects, but their responsibilities largely overlapped, i.e. enterprise architects were also involved in IT projects and solution architects contributed to global planning efforts (Organizations #6, #16, #19, #20, #29 and #35). Or, enterprise-level planning was fulfilled collectively by solution architects (Organizations #11 and #14):

> *We have no people with a formal title of enterprise architect and this is a conscious choice, although to some extent our solution architects have a dual role of what enterprise architects would do as well in other organizations. This is why not a lot of the work that I do has to do with future initiatives rather than the actual delivery of current systems, but there is a planning component* (Organization #11)

By contrast, in large EA functions, architects had much more clearly defined zones of responsibility. In these EA functions, solution architects focused only on specific IT solutions, while other architects had non-overlapping organizational scopes and focused only on planning their own segments with little or no involvement in other areas or solutions (though, collaborating when necessary). This conclusion can be summarized into the following theoretical proposition:

Proposition 2.3: *Larger EA functions require narrower job scopes for architects in terms of their areas of responsibility.*

5.3 Alignment Propositions

Alignment propositions represent a group of related theoretical propositions addressing the structural *alignment* of architects in EA functions required by organizations. In particular, these propositions explain the alignment of architecture positions with business areas, EA domains, requirements of the operating model, business geography and industry specifics.

5.3.1 Possibility of Alignment

The available evidence indicates that meaningful alignment of architecture positions in EA functions with the specific needs of organizations is achieved specifically through their horizontal specialization. In other words, it is the horizontal specialization of architects in terms of their subject areas that provides the foundation for any reasonable forms of their structural alignment. For example, in the studied organizations, the subject areas of different architecture positions partly "mirrored" the structure of the business, e.g. different lines of business, core business functions or capabilities. At the same time, hierarchical tiers of architecture positions ensuing from their vertical specialization did not demonstrate any noteworthy features that can be attributed to the business structure, like pronounced differences in the span of control at different hierarchical tiers (Mintzberg 1983). This conclusion can be summarized into the following theoretical proposition:

Proposition 3.1: *Structural alignment of architecture positions with the needs of organizations is enabled specifically by their horizontal specialization.*

5.3.2 Alignment with Business Areas

EA functions of organizations with more diversified business activities tend to align their architecture positions more with different business areas (this and the following propositions refer mainly to positions based specifically on *horizontal* specialization, as per Proposition 2.2). Put it simply, the greater the diversity of the business, the stronger the business alignment of architects is required to cope with this diversity. For example, relatively simple organizations with a single core line of business from our dataset (e.g. universities and some public service organizations with a narrow focus) had little or no business area-specific architecture positions (Organizations #7, #9, #21, #22, #24 and #36). The entire scope of their business operations and underlying information systems was typically covered by a single or a few closely collaborating architects. On the contrary, larger organizations with diversified business operations (Organizations #2, #4, #5, #13, #15, #30, #31, #41, #43 and #45), and especially companies with several disparate lines of business, employed specialized architects focusing on different business areas, e.g. retail architects and wholesale architects:

> *[Our company] is separated along different lines of business. There is [line of business A] and [line of business B], there is [line of business C] and [line of business D]. They operate effectively as separate lines of business. There are four or five different lines of business and there is a couple of shared functions. [...] There are enterprise architects of which I am one. There are five of us and each one looks after a line of business within the organization. So, I look after [line of business C], someone else looks after [line of business A], etc.* (Organization #31)

Higher conceptual complexity of the business naturally requires dedicated professionals deeply immersed in its intricacies. Concentrating their efforts on specific business areas allows architects to better understand the specifics of these areas:

> *[The most critical success factor for an architect is] understanding the business. You have to understand the business. [...] As I said, we have line-of-business architects who are specifically there for this reason: they are aligned with the business. They stay close to the business and they are always in touch with what is going on* (Organization #15)

Diversified business, thus, demands specialized architects with a pointed focus on its different areas. This conclusion can be summarized into the following theoretical proposition:

Proposition 3.2: *Architecture positions in EA functions of more diversified organizations are more aligned with different business areas.*

5.3.3 Alignment with EA Domains

EA functions of organizations with less diversified business activities tend to align their architecture positions more with different organization-wide EA domains. Put it simply, the simpler the business, the more the domain alignment of architects is beneficial for its global optimization. For example, the structures of most EA functions in organizations with a single dominant line of business from our dataset (e.g. universities and some public service organizations with a narrow focus) were closely aligned with the traditional EA domain model (Organizations #7, #9, #21, #22, #24 and #36), i.e. they usually employed business architects, application architects, data architects, infrastructure architects and often also integration architects and security architects responsible for rationalizing the respective EA domains across the entire organization:

> *We have a principal architect who is the manager, principal enterprise architect. And then we have a domain architect for security, a domain architect for information, a domain architect for business, a domain architect for integration and infrastructure and a domain architect for application. So, six of those* (Organization #36)

By contrast, organizations with diversified business operations (e.g. consisting of disparate business functions or lines of business) employed fewer domain architects (Organizations #2, #4, #5, #13, #15, #30, #31, #41, #43 and #45) and when these architects were present, they focused predominantly on purely technical EA domains unrelated to specific business functionality, most typically on integration, infrastructure or security (this issue is elaborated further in the next proposition). This conclusion can be summarized into the following theoretical proposition:

Proposition 3.3: *Architecture positions in EA functions of less diversified organizations are more aligned with different EA domains.*

5.3.4 Alignment with Operating Models

The structure of EA functions in organizations aligns with their operating models. An operating model in this context is understood specifically in the way defined by Ross et al. (2006, p. 25) as "the necessary level of business process integration and standardization for delivering goods and services to customers". Ross et al. (2006) distinguish four different operating models: diversification (implies low process standardization and integration across different business units), coordination (implies low process standardization, but high process integration), replication (implies high process standardization, but low process integration) and unification (implies high process standardization and integration across different business units). These two dimensions of operating models – standardization and integration – essentially define the structure of EA functions in terms of necessary architecture positions.

Namely, business process standardization across different business units clearly relates to the presence of specialized architects focusing on different business areas, as suggested by Proposition 3.1 described earlier. On the one hand, organizations operating according to the models that imply low process standardization (i.e. diversification and coordination) require dedicated architects to serve their individual business units (often independent lines of business and interrelated business functions respectively). On the other hand, companies implementing the operating models with high process standardization (i.e. replication and unification) may not need such architects and instead employ only "general" business and application architects embracing all their business activities. Similarly, organizations with operating models that imply high data integration (i.e. coordination and unification) are likely to benefit from employing specialized data architects to define common information models and exchange formats for all their business units.

For example, Organization #4 runs several lines of business with disparate processes, i.e. has low process standardization across its business units. At the same time, these lines of business share much information, particularly customer data, and market their services under a common brand, i.e. have high data integration between each other:

> *We are trying to position [our company's title] as the brand in the market. We use the concept of [our title] as a brand and we want all products to be branded [the same]. So, regardless of whether they are a [line of business A] product or a [line of business B] product or a [line of business C] product, we want customers to interact with [us] through [the same] brand* (Organization #4)

Consequently, Organization #4 implements the coordination operating model with low process standardization, but high data integration. Accordingly, its EA function has a mixed structure where dedicated architects concentrate on different lines of business in terms of their processes and applications, but architects for data and integration serve all lines of business, which exactly reflects the standardization and integration requirements of the adopted operating model:

> *It is a bit of a hybrid structure. [Each line of business] has a chief architect and, under these chief architects, there are sometimes one or two principal architects. [...] There are also five enterprise architects that are looking at very top-level, true enterprise-wide domains like customer, like information management, like infrastructure and so on* (Organization #4)

Only organization-wide infrastructure architects can arguably be beneficial to all organizations as the infrastructure domain relates neither to process standardization nor to data integration requirements, though in entirely decentralized companies business units may even need to deploy completely different IT infrastructure. Hence, organizations with more "consolidated" (i.e. more highly standardized and integrated) operating models may need more domain architects to focus on EA domains whose "contents" are common to all their business units, as suggested by Proposition 3.2 described earlier. Put it simply, an operating model with its standardization and integration requirements defines which EA domains should be planned globally by the respective domain architects and which EA domains should be planned locally in business units by architects knowledgeable in the specific activities of these units. This conclusion can be summarized into the following theoretical proposition:

Proposition 3.4: *Architecture positions in EA functions are aligned with the process standardization and integration requirements of the adopted operating models.*

5.3.5 Alignment with Business Geographies

Decentralized and geographically distributed organizations (e.g. doing diverse or independent businesses in different countries) tend to have distributed EA functions aligned spatially with their business geography. However, their EA functions still gravitate more to their corporate head offices, being less diffused geographically than the organizations themselves. For example, all multinational companies from our sample (Organizations #1, #2, #30 and #34) hosted their core EA teams at their headquarters, though some individual architects or local architecture teams were often also present at their major overseas locations. One of these companies (Organization #1) tried operating with physically dispersed EA functions in the past, but found it problematic and moved to a more co-located model:

> *Before, each one of [our business units] had its own architecture unit. [...] And there also was the enterprise architecture group here [at the head office]. But we always had challenges like they want to do their own thing, they want to do their own thing, that guy buys different technology to this guy here. So, what we have done is pulled all these guys out and now we are all sitting here. [...] What we are trying to do is align with the bank's strategy. So, from the strategy standpoint, I think we are better organized, but from the delivery standpoint we may not be* (Organization #1)

EA functions are more strategic than operational functions and much of architectural planning in organizations is strongly linked to their strategic business planning. For this reason, architects, and especially those responsible for enterprise-level planning, are usually co-located with key business decision-makers, in the proximity of top-level corporate officers accountable for overarching long-range planning.[12] Placing senior architects together also helps leverage global synergies in technology-related choices. And yet, because of the need to make local architectural decisions in different points of presence, a certain degree of the geographical distribution of EA functions is required. This conclusion can be summarized into the following theoretical proposition:

Proposition 3.5: *EA functions of geographically distributed organizations are aligned spatially with the business geography, but gravitate towards their head offices.*

5.3.6 Industry Influence on Structure

The available evidence suggests that the industry in which organizations operate actually does *not* influence the structure of their EA functions in any particular fashion. Among all organizations analyzed in this study representing very diverse industry sectors (see Table 1), no articulate industry-specific patterns of structuring EA functions were identified. Although the impact of industry was noticeable in some other aspects of their EA practices (e.g. planning horizon and stakeholder rotation), the structure of their EA functions proved to be industry-neutral. This conclusion can be summarized into the following last theoretical proposition:

Proposition 3.6: *The structure of the EA function does not depend directly on the industry of the organization.*

5.4 Integrative Theoretical Model

The 16 relevant properties of organizations and EA functions and the 14 theoretical propositions explaining the relationships between them described above can be unified into a comprehensive theoretical model explaining the structuring of EA functions in organizations. For better clarity, all the properties can be classified into (1) determinative/dependent variables that either influence or are influenced by other variables and (2) inert/independent variables that, contrary to intuition, actually do not interact with other variables. The resulting theoretical model demonstrating the identified relationships between the properties of organizations and EA functions is presented in Fig. 1.

6 Discussion of Findings

The findings of this study in the form of 14 theoretical propositions and the integrative theoretical model (see Fig. 1) can be put in the context of the existing EA literature, though the current theoretical base on EA functions and their structuring is rather scarce and inconclusive. Some theoretical propositions articulated in this study rather clearly relate to the previous observations made in the literature, while other propositions enter a completely new "territory" unexplored earlier, at least to the best of the authors' knowledge.

6.1 Number of Architects

Propositions 1.1, 1.2 and 1.3 suggest that the size of EA functions in terms of the number of architects correlates directly with the total number of IT staff, but only weakly relates to other common measures of the organizational scale, i.e. the overall number of employees and annual revenue. Intuitively, the dependence between the size of organizations and their EA functions is perfectly sensible (though, no earlier academic studies clearly articulated this dependence and characterized it in quantitative terms). However, the fact that such popular measures as annual revenue and the number of employees proved to be poor predictors for the number of architects arguably requires a detailed explanation. Previously, a number of surveys (Kappelman et al. 2018, 2017, 2020, 2019; Weill and Woerner 2010; Weill et al. 2009) demonstrated that

[12] As Mintzberg (2009, p. 28) wittily notices, "We can talk all we like about a global world, but most organizations – even the most international of corporations – tend to remain rather local at their headquarters".

organizations operating in different industries vary greatly from the perspective of their IT spendings. Specifically, the IT budgets of companies in some industry sectors represent a much higher percentage of their annual revenues than the IT budgets of companies from other sectors. For example, the survey of Weill et al. (2009) shows that organizations in the finance and services industries spend about 7.4% and 6.8% of their annual revenues on IT respectively, while companies in the mining and manufacturing industries spend on IT only 2.0% and 1.8% of their revenues. Weill and Woerner (2010) even explicitly distinguish between digital industries (banking, financial services, media, IT software, IT services and telecom), which, according to their survey, spend on average 7.2% of their revenues on IT, and non-digital industries (all other industries), which spend only around 3.3% on IT.

The subsequent yearly surveys of the Society for Information Management (SIM) provide a very similar picture. For instance, the survey of Kappelman et al. (2017) shows that organizations in the consulting, education and IT services industries spend 13.4%, 8.9% and 8.8% of their revenues on IT, while those in the retail, consumer goods and energy industries spend only 2.3%, 1.8% and 1.6%. The survey of Kappelman et al. (2018) shows that IT services, non-for-profit and financial organizations spend 15.9%, 11.6% and 9.7% of their revenues on IT, while those in the energy, construction and retail industry sectors spend only 1.9%, 1.6% and 1.4%. The survey of Kappelman et al. (2019) shows that organizations in the finance, IT services and education industries spend 10.8%, 9.9% and 9.8% of their revenues on IT, while those in the energy, manufacturing and automotive industries spend only 1.8%, 1.8% and 1.2%. Finally, the survey of Kappelman et al. (2020) shows that companies in such industries as IT services and consulting, financial services, insurance and banking, IT hardware and software spend from 8.7 to 17.7% of their revenues on IT, while those in the manufacturing, food services, hospitality, leisure, tourism and energy industry sectors spend only from 1.6 to 1.8%. Therefore, organizations in the finance, professional

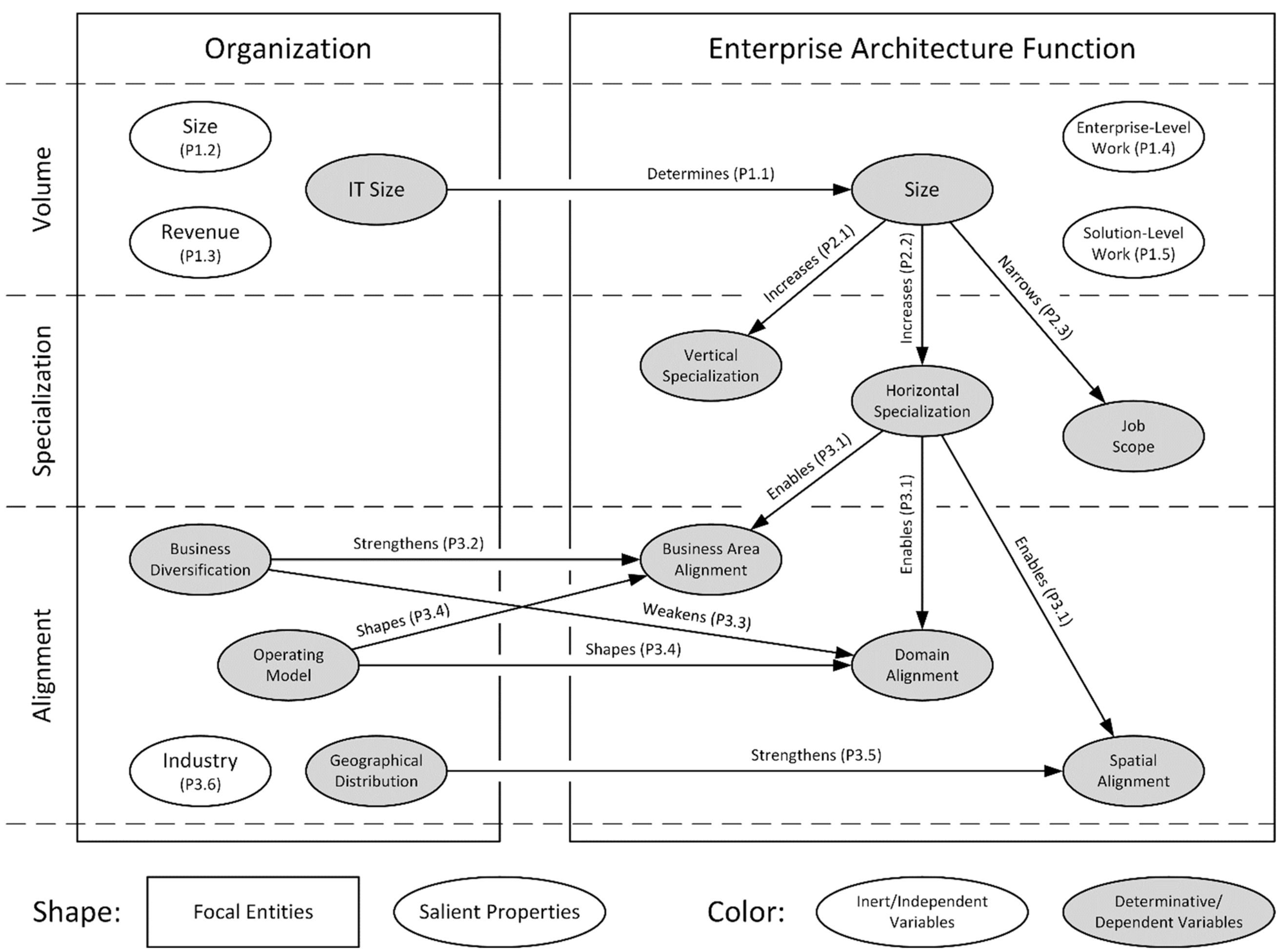

Fig. 1 An integrative theoretical model explaining the structuring of EA functions

services and education industries consistently lead the ranks of heavy IT investors (relative to their revenues), while companies in the manufacturing, retail and energy industries consistently lag behind, and the difference between their IT expenditures as the percentage of their revenues may be fivefold or even higher. In light of these statistics, it may not be surprising that the annual revenue itself barely determines the scale of the corporate IT landscape. Although the available statistics relate only to revenue, the same conclusions can arguably be safely generalized to other financial indicators as well (e.g. total assets) due to their evident industry specificity.

The ratio of IT staff to the total number of employees is also highly industry-specific. Although no relevant industry statistics are known to the authors, for the organizations from our dataset the percentage of IT staff varied from $\sim$ 2% or less in retail, healthcare and some public service organizations to $\sim$ 20% or more (up to 50% in the most extreme case) in financial companies and some governmental agencies. Therefore, it is also not surprising that the total number of employees cannot be taken as a reliable measure of the size of the IT landscape either.

6.2 Specialization of Architecture Positions

The findings of this study, and specifically Propositions 2.1 and 2.2, suggest that the diversity of architecture positions existing in organizations is proportional to the size of their EA functions. Although this fact naturally follows from the "famous" principle of the division of labor (Barnard 1938; March and Simon 1958; Simon 1947; Weber 1947), it is largely ignored in the current EA literature. On the one hand, it is not uncommon to see rather sophisticated reference models of EA functions proposed in the literature that define a concrete number of levels of architecture (most often three, enterprise level, domain level and solution level, e.g. van Steenbergen and Brinkkemper (2009)) and specific positions for architects corresponding to these levels (Behara and Paradkar 2015; TOGAF 2018; van der Raadt et al. 2008), as if these models can be applied to all organizations regardless of the number of architects they employ.

On the other hand, the existing EA literature arguably does not acknowledge the fact that the responsibilities of different types of architects often significantly overlap. For example, the available EA literature (FEAPO 2018; Strano and Rehmani 2007; van der Raadt and van Vliet 2008) often articulates a strict border between different architecture positions clearly outlining the circle of their responsibilities, e.g. the difference between enterprise architects and solution architects. However, in practice, many architects devote roughly equal portions of their time to enterprise- and solution-level planning activities and, thus, cannot be related to any pure "archetype" of architects described in the literature.

Generally, the extant literature on architecture positions arguably provides an overly simplistic view of the subject with concrete position specifications and their precisely delineated scopes often in a one-size-fits-all manner, whereas the reality is rather different and actually implies a continuum of complexity ranging from lonely "jack-of-all-trades" architects responsible for all aspects of planning to very sophisticated multilevel functions with several distinct architecture positions and their numerous subcategories.

6.3 Structure of Enterprise Architecture Functions

The findings of this study, and specifically Propositions 3.2, 3.3 and 3.4, suggest that the structure of EA functions in organizations can vary, depends on the degree of business diversification and is largely determined by the operating models adopted by organizations. The available EA literature, at first sight, provides contradictory recommendations regarding the structure of EA functions. Some of the existing EA publications prescribe the "classical" domain-based structure for all EA functions (Behara and Paradkar 2015; TOGAF 2018), while other publications (Hobbs et al. 2012; Niemann 2006) distinguish different levels of decentralization of EA functions across the business units. Our conclusions help resolve this apparent discrepancy and indicate that both these options can actually be viable depending on the circumstances and organizational specifics. Namely, the domain-based structure of EA functions can be efficient for relatively simple, single-activity organizations, while decentralized EA functions are more appropriate for complex organizations with diverse business activities.

Moreover, our conclusions regarding the relationship between the structure of EA functions and the operating models further enhance our understanding of EA functions and allow switching from discussing the centralization or decentralization of EA functions to the centralization or decentralization of *specific EA domains*. This new perspective explains when and why some EA domains should be centralized but others decentralized as well as the prevalence of hybrid structures of EA functions in most large organizations, where architects focused on business processes and underlying applications tend to be decentralized, but infrastructure architects are more often centralized. Although the frequent alignment of architects either with specific business areas or with separate technical EA domains is recognized by some authors (van Steenbergen and Brinkkemper 2009; Woods and Rozanski 2012), these authors do not explain what factors influence this alignment.

Our conclusions on the need for centralization/decentralization of different EA domains in different operating models are also congruent with the conclusions of Weill and Ross (2008) regarding the IT governance mechanisms necessary for different operating models. Overall, thinking about separate EA domains instead of entire EA functions from the perspective of architecture teams and their composition offers a much more detailed and fine-grained view of EA functions.

Also, as per Proposition 3.6, the structure of EA functions does not depend on the industry of organizations. Together with the previous observation of Kotusev (2019) that the sets of utilized EA artifacts are also industry-independent, this proposition furthers the view that the general mechanisms of EA practices are universal and industry-neutral.

6.4 Other Case Studies of Enterprise Architecture Functions

The existing EA literature provides a limited number of case studies of organizations with EA practices that describe, among other aspects, their EA functions (Gerber et al. 2007; Murer et al. 2011; Rees 2011; Smith et al. 2012). These descriptions illustrate and confirm many of the theoretical propositions formulated in this study.

For example, Gerber et al. (2007) describe the EA practice in a large bank with diverse business activities. As a large, complex and diversified organization, it has a sophisticated three-level EA function that combines the decentralization of functional EA domains (i.e. business and applications) to accommodate the business complexity and the centralization of supporting EA domains:

> *Our approach is to establish a hierarchy of business-aligned Enterprise Architects and functional and non-functional domains. The functional domains (e.g. Cash Management, Loans Management) cover the IT landscape from a business point of view, whereas the non-functional domains deal with overlapping concerns such as security or integration. On the next level, projects build new business solutions* (Gerber et al. 2007, p. 24)

Rees (2011) describes the EA practice in the Western Australia Police. As a medium-sized organization having essentially a single "line of business", it has a centralized two-level EA function aligned structurally to the typical EA domains, i.e. business, application, information and technology.

Murer et al. (2011) also describe the EA practice in a large bank with diverse business activities and geography of operations. As a large, complex and diversified organization, it has an elaborate multilevel EA function that is strongly aligned with different business areas and geographies, though with the centralized planning of infrastructure.

Finally, Smith et al. (2012) describe the EA practice in a rather large insurance company having five separate lines of business. Unsurprisingly, its EA function is also split into five semi-independent teams according to the business boundaries and consists of architects closely aligned with the respective lines of business:

> *[The company] has a federated business structure with both enterprise and line of business (LOB) functions. Each of its five LOBs has its own CIO who reports jointly to [the global CIO]. Similarly, [the] EA function is also federated, with both enterprise and LOB components* (Smith et al. 2012, p. 76)

These case study reports highly correlate with the findings of our study on the structuring of EA functions and more or less clearly support all the theoretical propositions related to the specialization and alignment of architecture positions.

7 Contribution of this Study

The developed theory explaining the structuring of EA functions in organizations (see Fig. 1) provides both a theoretical and practical contribution to the EA literature.

7.1 Theoretical Contribution

This study makes a significant theoretical contribution to the EA literature by providing arguably the first available full-fledged theory explaining the dependence between the properties of organizations and the structure of their EA functions. Specifically, the developed theory represents theory for explanation and prediction that says "what is, how, why, when, where, and what will be" and "has both testable propositions and causal explanations" (Gregor 2006, p. 620). On the one hand, all the formulated theoretical propositions can be easily converted into testable statements that can be confirmed or rejected statistically, for example, through structured surveys. On the other hand, for each theoretical proposition, some logical explanation of the underlying mechanisms substantiating the proposition has been provided (however, for some propositions, such as 1.1, 2.1, 2.2 and 3.1, these mechanisms are fairly transparent, largely self-evident or follow straight from broader organization theory).

Surprisingly, the question of how to organize the EA function, which is nowadays faced essentially by all medium and large organizations, has not been addressed appropriately in the EA discipline. For instance, the existing literature on EA functions, for the most part, offers either prescriptive one-size-fits-all reference models of EA functions that do not take into account possible differences between organizations (Behara and Paradkar 2015; TOGAF 2018; van der Raadt et al. 2008), or only some unsystematic ideas on how EA functions in different organizations might look like, often based only on anecdotal evidence (FEAPO 2018; Hobbs et al. 2012; Hornford et al. 2022; Niemann 2006; Turner et al. 2009).

The theory on the structuring of EA functions developed in this study addresses this gap, connects numerous "dots" together and organizes various haphazard observations on the suitable structure of EA functions into a consistent logical picture. As opposed to some discrete archetypes of EA functions prevalent in the extant literature, our model presents a continuous view of the subject and explains the relationship between the relevant properties of organizations and the appropriate design parameters of EA functions that may need to be adjusted to meet the specific needs of organizations. Furthermore, the resulting theory arguably addresses all aspects of EA functions important from the perspective of their structure including the number of architects, the diversity of their positions and the shape of the function.

Besides that, our findings contribute to the current EA institutionalization and operationalization discourse (Ajer et al. 2021b; Dang 2021; Dang and Pekkola 2020; Kohansal and Haki 2021a; Weiss et al. 2013). Given the benefits of institutionalization (Ajer et al. 2021a; Brosius et al. 2018; Weiss et al. 2013), as well as the dangers of deinstitutionalization (Kohansal and Haki 2021a, b), this issue can be regarded as one of the central issues of the EA discipline. At the same time, the institutionalization and operationalization of EA practices in organizations are unthinkable without establishing consistent architecture roles and clearly defining their responsibilities, so that EA-related planning processes and control mechanisms become an integral part of a routine, widely accepted way of getting things done (Beese et al. 2023; Schilling et al. 2018). In this light, our study explains what EA functions adequate for the needs of specific organizations may look like to enable the effective institutionalization of respective activities in their decision-making organisms.

7.2 Practical Contribution

This study also offers an evident practical contribution to the EA discipline. In particular, it answers many essential questions that will inevitably be asked by any IT leaders willing to establish an EA practice in their organizations. How many architects do we need to hire? How many of them should be solution architects? How exactly do we need to structure the EA function? Do we need to align architects to our business divisions or EA domains? Do we need to have a more sophisticated, hybrid structure? All these questions currently have no substantiated answers in the available EA literature. The findings of our study either answer these questions directly, or at least provide some empirically substantiated foundation and conceptual framework for thinking based on which these answers can be derived from the specific needs of an organization.

Moreover, the findings of this study allow formulating the following simple three-step method for designing EA functions in organizations: sizing, structuring and fine-tuning. First, organizations should roughly estimate the necessary size of their EA functions. It can be easily done by dividing the total number of their IT staff by 20–25 (taking 4–5% as an approximate average number of architects) and then assuming that three-fourths of this number will be solution architects and the remaining one-fourth will be non-solution architects focusing on broader organizational scopes. Second, organizations should define the appropriate structure of their EA functions. For this purpose, organizations should determine their operating models and then, based on the respective process standardization and integration requirements, understand which EA domains should be planned centrally and which business units require dedicated architects to focus on their unit-specific processes. This understanding will guide the allocation of non-solution architects to different business and domain areas of organizations corresponding to their genuine business needs. Third, organizations should try operating with the newly designed EA functions and fine-tune the functions based on the actual experience to accommodate the practical realities. A more detailed description of this method is provided by Kotusev (2020b).

8 Conclusion

This study aimed to address the existing gap in the EA literature related to an insufficient understanding of EA functions in organizations. In particular, the existing EA literature does not provide meaningful answers even to relatively basic questions relevant to EA functions, e.g. how many architects organizations should employ, what positions they should occupy and how exactly the function should be structured. To address this gap, we collected relevant quantitative and qualitative information on 47 organizations and their EA functions and then analyzed this information via the grounded theory method to uncover consistent generalities and develop a comprehensive theory explaining the structuring of EA functions in organizations.

The resulting theory is arguably the first theory related to the structuring of EA functions that can be found in the available EA literature. Our theory explains various dependencies between some parameters of organizations, most importantly their size and business structure, and relevant parameters and design options of EA functions, e.g. the number of architects, specifics of their positions, centralization and decentralization of architects focusing on different EA domains. We believe that the theory developed in our study currently represents the only existing full-fledged theory on the subject. Our theory also makes an important practical contribution by providing empirically substantiated answers to many questions that are likely to be asked by most, if not all, IT leaders responsible for establishing EA practices in organizations.

Arguably the most significant limitation of our study that needs to be acknowledged relates to the inherent subjectivity associated with the use of the grounded theory method as an approach to data analysis. For instance, Strauss and Corbin (1998, p. 43) argue that “a state of complete objectivity is impossible and that in every piece of research […] there is an element of subjectivity” and “we emphasize that it is not possible to be completely free of bias” (Strauss and Corbin 1998, p. 97). For this reason, we consider a certain degree of subjectivity in our data interpretation as the most considerable risk to the validity of our findings.

On the whole, theoretical propositions formulated in our study seem to be industry-neutral and generalizable to other organizations with EA functions (Lee and Baskerville 2003; Seddon and Scheepers 2012). However, because the vast majority of organizations included in our dataset are Australian, our findings and propositions can potentially be biased by certain “fashions” in structuring EA functions prevalent in the Australian industry. Needless to say, all the resulting propositions have yet to be validated statistically on larger samples.

In our study, we identified a number of general regularities explaining the structures of EA functions in many diverse organizations. However, far from all aspects of EA functions can be considered fully understood. For example, although the number of architects in organizations seems to be roughly proportional to their total IT headcount, possible factors determining the magnitude of positive or negative deviations of this number from a certain industry-average ratio (e.g. the volume of investments in new IT projects, the percent of the IT budget spent on “keeping the lights on”, maturity, innovativeness, etc.) still remain rather unclear and represent important directions for future research. Or, the questions related to measuring the organizational scope that a single architect can comfortably handle also remain rather shadowy. We believe these and other similar questions represent promising directions for future research on EA functions in organizations.

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