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**Enterprise Architecture Principles:
Literature Review and Research Directions**

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Abstract. *This report presents a literature review on enterprise architecture principles. It consists of twelve articles published in journals and conference proceedings on enterprise architecture. The results show that there are various gaps in the research literature: No accepted definition of enterprise architecture principles has emerged yet. There is disagreement on the question of how to describe and formalize the connection of architecture goals, principles, and implications. A detailed conceptual framework that could serve as a basis for conducting quantitative research is still lacking. Business principles, IT principles and enterprise architecture principles are often mixed up. Research into generic design principles is still in its infancy. The review illustrates the necessity to conduct more in-depth research on enterprise architecture principles. We describe conceptual foundations and provide guidance for further research in this field.*

Keywords: *enterprise architecture, architecture principles, design principles, representation principles, design rules, literature review*

1 Introduction

Enterprise architecture has gained considerable attention both from academia and industry [Aier et al. 2009], [Bernus et al. 2003], [Kappelman 2010], [Lankhorst 2009], [Lankhorst, Johnson 2007], [Schekkerman 2008], [Winter, Fischer 2007]. The term architecture is defined as the “fundamental organization of a system embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution” [IEEE 2000], [ISO/IEC 2007]. Accordingly, we define enterprise architecture as the fundamental organization of an enterprise embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution.

Enterprise architectures serve various purposes. They provide direction for the design, deployment and assessment of technological and managerial developments [Malhotra 1996], [Richardson et al. 1990]. They facilitate analyzing and representing essential elements of an enterprise [Schekkerman 2008]. Enterprise architectures help to integrate and standardize the often fragmented information systems and business processes into a coherent information infrastructure [Ross et al. 2006], [Sowa, Zachman 1992], [The Open Group 2009], [Zachman 1987]. They provide guidelines for the evaluation of technology plans [Richardson et al. 1990] and help to direct the development of the enterprise as a whole and its IT portfolio in particular [Lankhorst 2009]. Enterprise architectures provide guidance for IT strategy, IT government, and business-IT alignment [Aier, Gleichauf 2009]. Enterprise architectures are usually structured by layers, views, and principles.

According to the Oxford Dictionary of English a principle – among other explanations – is (1) a fundamental truth or proposition serving as the foundation for belief or action, (2) a rule or belief governing one’s personal behaviour, (3) a general scientific theorem or natural law, (4) a fundamental source or basis of something.

In the context of enterprise architecture, however, “a precise definition of the concept of principles as well as the mechanisms and procedures needed to turn them into an effective regulatory means still lacks” as van Bommel et al. point out [van Bommel et al. 2007, p. 49]. Goikoetxea adds “a major challenge facing the design and assessment of architectures of very large systems today is ... the presentation and publication of agreed-upon design principles in the enterprise architecture community” [Goikoetxea 2004, p. 6].

As a matter of fact, when conducting an initial examination of publications on enterprise architecture principles we found various interpretations of the concept. Most authors take individual views leading to inconsistencies in research findings: principles for architectural design are often mixed up with principles for architectural representation. In many publications design rules and guidelines are not clearly distinguished from architectural principles. Moreover, most authors do not seem to distinguish architecture principles from business principles on the one hand and from IT principles on the other.

Compared to the literature on enterprise architecture in general, the number of publications on enterprise architecture principles is limited. This is surprising as various authors [Armour et al. 1999], [Lankhorst 2009], [Richardson et al. 1990], [Schekkerman 2008], [The Open Group 2009], [van Bommel et al. 2006], [Winter, Fischer 2007] reckon architecture principles as pivotal elements of enterprise architectures. Hoogervorst actually equates architecture with principles. He defines architecture “as a consistent set of design principles and standards that guide design” [Hoogervorst 2004, p. 215]. Richardson, Jackson, and Dickson call principles “the most stable element of an architecture” [Richardson et al. 1990, p. 389]. Aside from that, architecture principles are central elements of enterprise architecture frameworks such as FEAF [FEAF 1999], TEAF [TEAF 2000], or TOGAF [The Open Group 2009].

Major purposes of enterprise architecture principles are to provide guidance for describing the current state of an enterprise (description purpose), for prescribing the target state of an enterprise (prescription or design purpose), and for evaluating enterprise architectures or elements of architectures (evaluation or assessment purpose).

The aim of this report is to conceptualize the research area of enterprise architecture principles, to examine prior research, and to uncover areas where more research is needed.

We use the methodology proposed by Webster and Watson [Webster, Watson 2002] to structure our literature review.

The remainder of the report is organized as follows. Section 2 contains conceptual foundations of enterprise architecture principles. Section 3 describes method and findings of our literature review. Section 4 discusses the results and provides directions for further research. In section 5 we summarize our findings and draw conclusions.

2 Conceptual Foundations

In the following sections we describe conceptual foundations of enterprise architecture principles. In section 2.1 we distinguish two facets of architecture principles, namely design principles and representation principles. In section 2.2 architecture principles are integrated in a larger context of goals, constraints, rules, guidelines, and evaluation criteria. Section 2.3 outlines a network of principles with architecture principles as one element. In section 2.4 we differentiate two levels of universality: generic and enterprise-specific enterprise architecture principles. Finally, in section 2.5 we raise research questions that this article attempts to answer.

2.1 Architectural Triangle

In the architecture framework proposed by The Open Group [The Open Group 2009] architecture “has two meanings depending upon the context: 1. A formal description of a system, or a detailed plan of the system at component level to guide its implementation [and] 2. The structure of components, their inter-relationships, and the principles and guidelines governing their design and evolution over time.” [The Open Group 2009] In other words, the term architecture may denote both, the inherent structure of a system and its representation.

Bass, Clements, and Kazman [Bass 2003] elaborate the same idea. They point out, that every system has an architecture, however, not every architecture is explicitly represented. Hence, architecture and architectural representation should be distinguished. The architecture is a conceptual model of the system of interest. The architectural representation is a more or less formal description of the architecture. Figure 1 illustrates the associations of a system, its architecture, and architectural representation in an architectural triangle arranged parallel to the so-called semiotic triangle [Lyons 1977], [Ogden, Richards 1923], [a similar model has been published in Lankhorst 2009, p. 55].

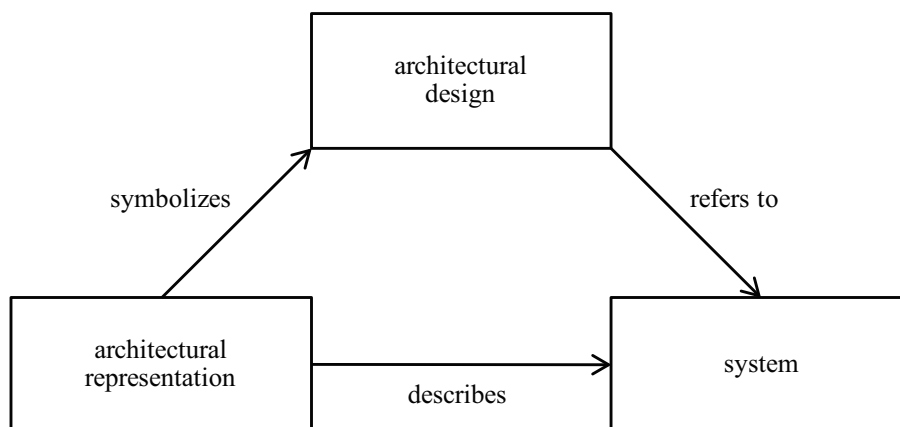


Figure 1: Architectural Triangle

Architecture principles may refer either to the design or to the representation of architectures. We label the first as design principles and the latter as representation principles.

Design principles are fundamental propositions guiding the construction and evaluation of architectures. Examples for design principles are separation of concerns, modularity, and loose coupling. Representation principles are fundamental propositions for describing and modeling architectures, as well as for evaluating architectural representations. Examples for representation principles are understandability, consistency, and completeness.

2.2 Context of Architecture Principles

Principles are means to achieve certain ends. When designing enterprise architectures principles serve to accomplish business, IT, or architecture goals. Constraints (e.g. strategic, financial or technological limitations) may restrict the applicability or validity of architecture principles.

Since principles are usually abstract, high-level propositions they need to be specified in order to guide the development or evaluation of a system. This specification is often realized in the form of rules or guidelines for the development of architectures and evaluation criteria for quality assessment. Schekkerman defines a rule as “a prescription on how something has to be done” [Schekkerman 2008, p. 34]. Guidelines are less rigorous. They provide guidance for behavior but do not call for strict obedience. Evaluation criteria are quality characteristics for the assessment of architectural designs or representations. Figure 2 shows the context of architecture principles.

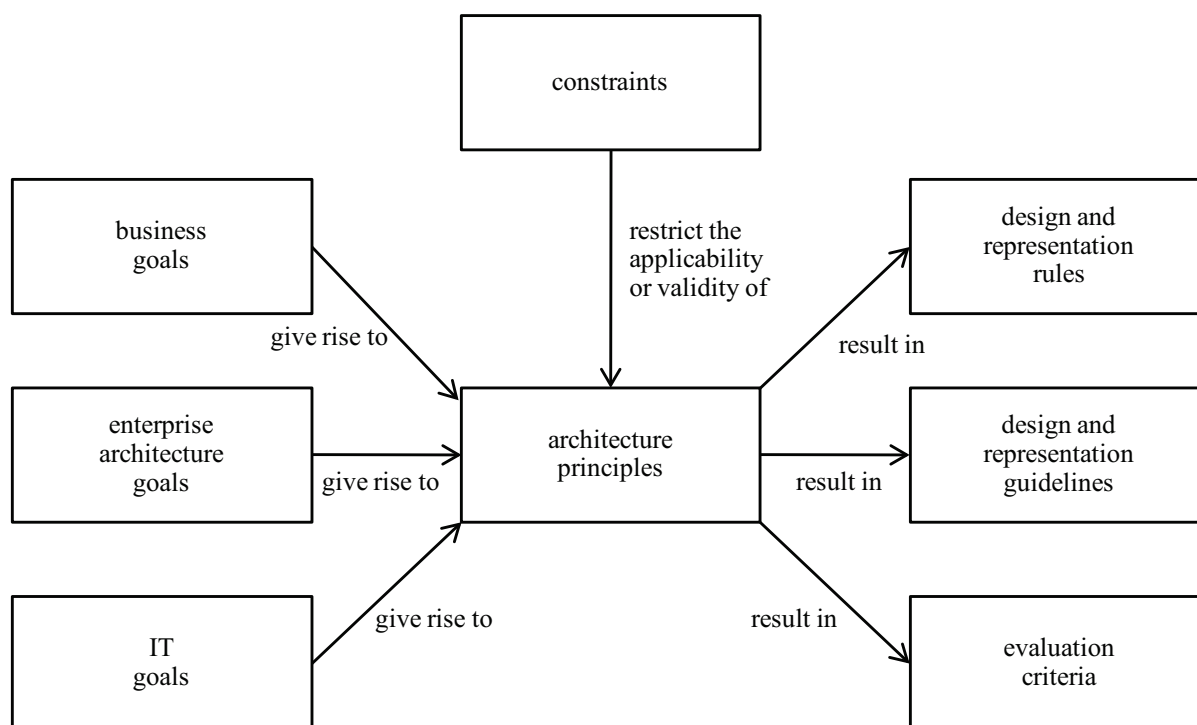


Figure 2: Context of Architecture Principles

Rules, guidelines, and criteria for designing or evaluating architectures should be derived from architecture principles, which in turn should be derived from relevant goals [Lindström 2006].

2.3 Network of Principles

Architecture principles cannot be separated from other related principles. In most companies architecture principles are embedded in a network of associated principles, for example, business and IT principles [Davenport et al. 1989] as well as principles that refer to elements of enterprise architectures such as organization, application, software architecture, data, or infrastructure principles. Figure 3 exemplifies a network of principles.

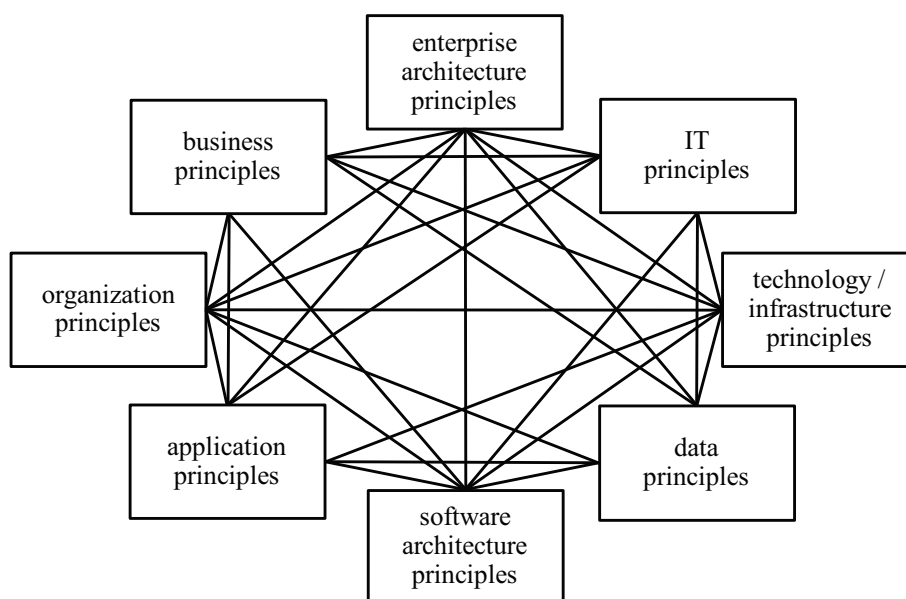


Figure 3: Network of Principles

Existence, differentiation, designation, and interrelation of the particular principles depend on the specific context. Some companies may have IT principles that are superior to enterprise architecture principles, others may not. Some companies may distinguish application principles and software architecture principles, others may not, et cetera.

2.4 Level of Universality of Architecture Principles

Architecture principles in related arenas, such as software engineering or organizational design, are generic propositions that are largely independent from mission, strategy, objectives, constraints, or conditions of a particular enterprise, organizational unit, or project. Examples for software architecture principles are separation of concerns, modularity, loose coupling, and tight cohesion [Witt et al. 1994].

Principles described in the literature on enterprise architecture are often enterprise-specific, i.e. tailored to the needs of the enterprise. For example: “Star Enterprise IT areas will need to collaborate to provide the best service in application development and support, and to eliminate artificial internal competition” [Richardson et al. 1990, p. 389].

2.5 Research Questions

This report attempts to answer the following research questions:

- What are the key findings of prior research on enterprise architecture principles?

- How do scholars and practitioners define architecture principles?
- Is it common practice to distinguish design and representation principles?
- Are architecture principles appropriately connected to architecture goals, design rules, and guidelines? Or are they presented disjointed from the relevant context?
- Which other principles apart from architecture principles are addressed in research articles on enterprise architecture? Do the authors make a clear distinction between architecture principles and other principles, such as IT or business principles?
- Which level of universality do the authors choose? Do they focus on generic architecture principles or on enterprise-specific principles?

3 Literature Review

We used a structured approach recommended by Webster and Watson [Webster, Watson 2002] to identify relevant publications for the review. As a first step, we examined IS journals and IS conference proceedings using the EBSCO database and the Web of Science. We conducted electronic searches in titles and abstracts on the following keywords: “enterprise architecture” and “principle” or “design” or “rule” or “guideline”. In a second step, we extended our search to IS journals and conference proceedings that were not covered by our original search. We ensured that the top 20 journals included in the MIS Journal ranking provided by the Association for Information Systems [AIS 2009] and the WI-Orientierungslisten provided by the Wissenschaftliche Kommission Wirtschaftsinformatik im Verband der Hochschullehrer für Betriebswirtschaft e. V. (commission of German speaking IS scholars) [WKWI 2008] were covered by our search. We also examined titles and abstracts of all papers published in the proceedings of the following conferences: American Conference on Information Systems, European Conference on Information Systems, Hawaii International Conference on System Sciences, International Conference on Information Systems, and Internationale Tagung Wirtschaftsinformatik. These searches identified a total of 42 articles.

After analyzing each article’s abstract, keywords, or the full article when necessary, we excluded 27 articles that did not appear to be concerned with or relevant to enterprise architecture principles. This process provided 15 articles for in-depth review.

In a third step we reviewed the citations in the articles identified in the previous steps to determine prior articles on enterprise architecture principles. A further set of five articles from journals and conference proceedings other than those formally searched was collected and a subset of 20 articles was read in full and coded.

We did not include articles on architecture principles from related research areas such as software engineering or organizational design and engineering. We limited our review to articles focusing on enterprise architecture principles. We did not include articles focusing on principles relating to the process of enterprise architecture development [Malan, Bredemeyer 2002]. We also did not include articles discussing principles for designing or evaluating enterprise architecture frameworks [Martin et al. 2005] or principles for service oriented architecture [Aier, Gleichauf 2009], [Erl 2008]. We excluded all publications that only mentioned the terms architecture principles, design rules, or guidelines without elaborating on these concepts. Out of the 20 coded articles, twelve include passages of interest. They are compiled in the analysis.

3.1 Overview of the Literature

The following section gives an overview of the literature included in our review. The matrix in table 1 shows which research methodologies were used and which elements of the architectural triangle the articles focus on. The first column shows authors and specifies when the articles were published, the second column indicates which research methodologies were used. The fourth column mentions which articles explore design principles. The fifth column shows articles that investigate representation principles. References in table 1 and 2 are arranged in chronological order of publication. Articles that were published first are shown at the beginning of the tables.

Enterprise architecture principles have been objects of research studies for nearly 20 years. Yet the number of academic publications investigating enterprise architecture principles is rather limited. We identified no more than twelve publications that analyze enterprise architecture principles. Only five of these articles ([Bryson 2006], [Lindström 2006], [Richardson et al. 1990], [van Bommel et al. 2006], and [van Bommel et al. 2007]) have their main emphasis on principles. The other seven articles discuss principles among other topics.

Prevalent methodologies used are case studies and conceptual descriptions, one article uses mathematical representation. We did not find any survey that explores development, use, or evaluation of architecture principles in multiple enterprises.

References	Methodology	Focus of Analysis	
		design principles	representation principles
[Richardson et al. 1990]	case study	x	
[Armour et al. 1999]	conceptual	x	
[Goikoetxea 2004]	mathematical representation		x
[Hoogervorst 2004]	conceptual	x	
[Chen, Lillehagen 2004]	conceptual	x	
[Balabko, Wegmann 2006]	conceptual		x
[Wilkinson 2006]	case study	x	
[van Bommel et al. 2006]	conceptual		x
[Lindström 2006]	case study	x	x
[Bryson 2006]	overview of enterprise architecture	x	x
[van Bommel et al. 2007]	conceptual		x
[Winter, Fischer 2007]	case studies		x

Table 1. Methodologies and Focus of Analysis

Most authors focus either on design or on representation principles. We identified only two articles [Bryson 2006] and [Lindström 2006] that address both design and representation principles.

3.2 Definitions of Enterprise Architecture Principles

Table 2 presents definitions of architecture principles covered by our review.

It is remarkable that the term architecture principle is defined in seven articles only ([Armour et al. 1999], [Bryson 2006], [Chen, Lillehagen 2004], [Lindström 2006], [Richardson et al. 1990], [van Bommel et al. 2006], [van Bommel et al. 2007]). Authors of the other five articles do not define the term. One article [Hoogervorst 2004] equates a collection of design principles with enterprise architecture. It is also interesting that only one definition [Richardson et al. 1990] emphasizes that principles may guide design and evaluation of architectures. The other definitions focus on the design purpose (rather than the evaluation purpose) of principles. They ignore that principles can also provide guidance for evaluating architectures.

References	Definitions
[Richardson et al. 1990]	“Principles are an organization’s basic philosophies that guide the development of the architecture. ... Principles provide guidelines and rationales for the constant examination and re-evaluation of technology plans.” (p. 389)
[Armour et al. 1999]	“... simple, direct statements of how an enterprise wants to use IT. These statements establish a context for architecture design decisions by translating business criteria into language and specifications that technology managers can understand and use. Architecture principles put boundaries around decisions about system architecture.” (p. 38)
[Goikoetxea 2004]	-
[Hoogervorst 2004]	(no explicit definition); “collectively the design principles are identified as enterprise architecture” (p. 217)
[Chen, Lillehagen 2004]	“Architecting principles are rules to use when elaborating enterprise architectures.” (p. 1214)
[Balabko, Wegmann 2006]	-
[Wilkinson 2006]	-
[van Bommel et al. 2006] referring to [The Open Group 2009]	“Principles are general rules and guidelines, intended to be enduring and seldom amended, that inform and support the way in which an organization sets about fulfilling its mission.” (p. 1139)
[Lindström 2006]	“Architectural principles define the underlying general rules and guidelines for the use and deployment of all IT resources and assets across the enterprise ...” (p. 2)
[Bryson 2006]	“Architecture principles define the underlying general rules and guidelines for the planning, building, deploying and operating the business, information and technology resources and assets across the enterprise.” (p. 53)
[van Bommel et al. 2007] referring to [The Open Group 2009]	“Principles are general rules and guidelines, intended to be enduring and seldom amended, that inform and support the way in which an organization sets about fulfilling its mission.” (p. 49)
[Winter, Fischer 2007]	-

Table 2. Definitions of Enterprise Architecture Principles

Furthermore, some definitions focus on selected layers of enterprise architectures. They do not seem to consider all layers of enterprise architectures. Some definitions focus on IT (“simple, direct statements of how an enterprise wants to use IT” [Armour et al. 1999]; “rules and guidelines for the use and deployment of all IT resources and assets” [Lindström

2006]), others on business (“rules and guidelines ... that inform and support the way in which an organization sets about fulfilling its mission” [van Bommel et al. 2006] and [van Bommel et al. 2007]). Only three definitions ([Bryson 2006], [Chen, Lillehagen 2004], and [Richardson et al. 1990]) comprise enterprise architecture in its entirety.

No definition explicitly distinguishes design and representation principles.

3.3 Context of Architecture Principles

The context of architecture principles as outlined in section 2.2 is often structured in rationales and implications [Armour et al. 1999], [Richardson et al. 1990] or in goals and rules [Balabko, Wegmann 2006], [Lindström 2006], [van Bommel et al. 2006], [Wilkinson 2006]. A rationale gives an explanation for the principle. It states underlying reasons, in most cases by explaining the principle’s contribution to achieving architectural or business goals. Implications describe potential consequences for those in charge of developing, evaluating or deploying the architecture or elements of the architecture [Richardson et al. 1990]. Accordingly, Hoogervorst claims: “All principles should have a three-fold context: the rationale of the principle, (2) the implications, and (3) key actions necessary for making the principle operational” [Hoogervorst 2004, p. 229]. Richardson, Jackson, and Dickson propose the following structure for describing enterprise architecture principles: (1) principle statement, (2) rationale, and (3) implications [Richardson et al. 1990].

There is wide consensus that principles should be embedded in rationale and implications. No clear consensus, however, seems to have emerged on the question of how to describe and formalize the connection of these concepts. Enterprise architecture principles, rationale and implications reported by Richardson, Jackson, and Dickson [Richardson et al. 1990] are informal statements that leave room for interpretation. Van Bommel et al. comment: “When using architecture principles as the core element in enterprise architecture, informal statements ... arguably do not provide enough precision to concretely limit design space. Therefore, they have limited power as a steering instrument” [van Bommel et al. 2006, p. 1139]. Consequently, they demand “formalizing principles in a rule-like fashion” that are specific, measurable, achievable, relevant, and time-bound (SMART).

Constraints are neglected by ten articles included in our review. This is astonishing because constraints may help researchers and practitioners to correctly assess the principle’s scope and validity. Van Bommel et al. [van Bommel et al. 2006] suggest using constraints when formalizing architecture principles. Chen and Lillehagen [Chen,

Lillehagen 2004] point out architecture principles should be embedded in goals and objectives, constraints, conditions, and challenges.

3.4 Network of Principles

Interdependencies of enterprise architecture principles and other principles, e.g. IT principles or business principles, are not mentioned in ten of the articles included in our review ([Armour et al. 1999], [Balabko, Wegmann 2006], [Bryson 2006], [Chen, Lillehagen 2004], [Goikoetxea 2004], [Hoogervorst 2004], [van Bommel et al. 2006], [van Bommel et al. 2007], [Wilkinson 2006], and [Winter, Fischer 2007]).

Lindström [Lindström 2006] points out, that architectural principles should be derived from business principles which in turn should be derived from business strategy. IT governance and IT strategy principles should be derived from architectural principles. However, the distinction of architecture principles and other principles remains ambiguous. Lindström [Lindström 2006] cites the following architectural principles of Vattenfall, a major European energy provider: “IS/IT Strategy development shall be an integral part of business strategy development.” “Control of development and implementation of IS/IT projects must comply with a corporate common project management model.” Most of the so-called enterprise architecture principles reported in her article resemble IT principles [Davenport et al. 1989]. Lindström does neither distinguish IT principles from enterprise architecture principles nor does she explain criteria of how to tell between IT and architecture principles. The same is true for the principles compiled by Richardson, Jackson, and Dickson [Richardson et al. 1990].

3.5 Level of Universality of Architecture Principles

In our review we found articles that examine generic principles and other articles that report about enterprise specific principles. In a second step we analyzed which level of universality is addressed by the articles focusing on design principles and on representation principles respectively. Table 3 shows the level of universality and the nature of the architecture principles discussed in the articles included in our review.

	design principles	representation principles
generic	[Bryson 2006], [Chen, Lillehagen 2004], [Wilkinson 2006]	[Balabko, Wegmann 2006] [Goikoetxea 2004], [van Bommel et al. 2006], [van Bommel et al. 2007], [Winter, Fischer 2007]
enterprise-specific	[Armour et al. 1999], [Hoogervorst 2004], [Lindström 2006], [Richardson et al. 1990]	

Table 3. Level of Universality and Nature of Architecture Principles

The majority of the articles focus either on enterprise-specific design principles or on generic representation principles. Only three articles elaborate on generic design principles. No article describes enterprise-specific representation principles.

4 Discussion and Research Directions

4.1 Overview of the Literature

Compared to the considerable amount of publications on enterprise architectures in general, the number of articles presenting research findings on enterprise architecture principles is rather low. This is surprising because architecture principles are considered to be essential elements of architectures [IEEE 2000], [ISO/IEC 2007], [The Open Group 2009]. More in-depth research is needed to fully understand issues and challenges involved with developing and deploying enterprise architecture principles.

Scholars exploring enterprise architecture principles seem to focus either on design or on representation principles. We only found two articles [Lindström 2006] and [Bryson 2006] that explicitly address both facets of architecture principles. We suggest that future research takes a more holistic view and analyzes the interrelationship of design and representation principles.

Case studies and conceptual descriptions are the prevailing methodologies when exploring enterprise architecture principles. However, there is a paucity of research modeling the conceptual context of architecture principles, notably architecture goals, constraints and

design rules and guidelines. Furthermore, we could not find any empirical studies covering multiple enterprises.

4.2 Definition of Enterprise Architecture Principles

Our review has shown that no accepted definition of the term enterprise architecture principles has emerged yet. An acceptable definition should cover all layers of enterprise architecture and should not be restricted to particular layers. It should also account for the three major purposes of architecture principles: design, description, and evaluation of systems.

We propose the following definition: Enterprise architecture principles are fundamental propositions that guide the description, construction, and evaluation of enterprise architectures. Enterprise architecture principles fall into two classes: Design principles guide the construction and evaluation of architectures. Representation principles guide the description and modeling of architectures, as well as the evaluation of architectural representations.

We believe that this definition is more complete than definitions proposed by previous publications. However, it should be scrutinized by scholars and practitioners in the field of enterprise architecture to explore whether it can be improved.

4.3 Context of Architecture Principles

Similar to the situation in service design [Aier, Gleichauf 2009] there is no empirical validation of successful architecture principles. We did not find any publication that explores the relationship between deploying architecture principles and attaining architecture goals. Lessons learned when deploying enterprise architecture principles ([Armour et al. 1999], [Lindström 2006], [Richardson et al. 1990], and [Wilkinson 2006]) provide anecdotal evidence at best. Tested knowledge on which architecture principles facilitate the achievement of specific architecture goals would be highly beneficial for the enterprise architecture community.

Research exploring the relation of goals and principles should be based on a theoretical model or conceptual framework. We suggest using the context of architecture principles illustrated in figure 2 as a starting point. This would help to analyze which architecture principles may contribute to the achievement of relevant goals while simultaneously

considering constraints that might restrict the applicability or validity of the principles. It can be assumed that effectiveness and efficiency of architecture principles is highly dependent on the specific conditions. We therefore encourage research which investigates the influence of contextual factors on the success of enterprise architecture principles.

Research findings from organization science could provide valuable insights. Romme and Endenburg, for instance have explored construction principles and design rules for organizational design. They point out that principles emphasize “the importance of a certain type of solution in view of certain values or goals (e. g., ‘to achieve A, do B’)” and “design rules are elaborate solution-oriented guidelines for the design process (e.g., ‘if condition C is present, to achieve A, do B’)” [Romme, Endenburg 2006, p. 288].

More research is needed to answer the question of how to describe and formalize the connection of enterprise architecture principles, rationale and implications. We assume that practitioners would prefer informal statements while scholars would favor formalized statements.

4.4 Network of Principles

The interrelationship of enterprise architecture principles and other principles has not yet been examined in detail. Obviously it is difficult to clearly distinguish enterprise architecture principles from IT principles or business principles.

We do not know whether and how companies distinguish these categories of principles. More research is needed to answer the question whether this distinction is helpful and how it can be achieved.

4.5 Level of Universality of Architecture Principles

The level of universality of enterprise architecture principles describes whether these principles are generic and fundamental propositions that are independent from a particular context or whether they are tailored to the needs of a specific company or project. We were astonished about the fact that only three articles describe generic design principles for enterprise architectures. We had expected that two decades of research on enterprise architectures would have yielded more knowledge on design principles that are independent of the specific circumstances of a particular enterprise. Future research should

elaborate on this topic. It should be analyzed in detail whether there are generic design principles that are applicable to all layers of enterprise architectures.

Adjacent research areas may provide helpful insights to answer this question. Research into software engineering and software architecture has yielded considerable findings on architecture principles ([Bass 2003], [Witt et al. 1994]). Scholars in organizational design and engineering ([Goold, Campbell 2002], [Romme, Endenburg 2006]) have explored principles of how to design and to describe enterprises. Research on service oriented architectures has produced valuable knowledge on architecture principles ([Aier, Gleichauf 2009], [Erl 2008]). Systems architecting [Rechtin 1992] may also provide helpful insights of how to design architecture principles.

Individual researchers [Vernadat 1996] have attempted to transfer principles from related fields of research to enterprise architecting. However, these endeavors are only first steps. They do not seem to be mature. We need more research on how to convey architectural principles from related research areas to the field of enterprise architecture.

5 Summary and Conclusion

We reviewed titles and abstracts of 42 articles on enterprise architecture. Based on this review, we attempted to condense key findings of prior research into enterprise architecture principles. We identified only twelve articles that elaborate on architecture principles. Merely five of these articles have the major focus on enterprise architecture principles.

The results of our review show that there are various gaps in the research literature: No accepted definition of enterprise architecture principles has emerged yet. Design and representation principles often are not explicitly distinguished. There is disagreement on the question of how to describe and formalize the connection of architecture goals, principles, and implications. A detailed conceptual framework that could serve as a basis for conducting quantitative research is still lacking. Business principles, IT principles and enterprise architecture principles are often mixed up. Research into generic design principles is still in its infancy.

Our literature review illustrates the necessity to conduct more in-depth research on enterprise architecture principles. We suggest the following options for future research:

1. **Investigating generic enterprise architecture design principles.** Findings on generic design principles are meager in the field of enterprise architecture. Adjacent research areas, such as software architecture or organizational design and engineering, have produced valuable knowledge on generic design principles. It would be highly interesting to explore whether there are generic design principles that are applicable to all layers of enterprise architectures. In a second step, scholars could address the question under which circumstances specific principles may contribute to the achievement of particular enterprise architecture goals.
2. **Exploring the issues of enterprise architecture principles from more theoretical perspectives.** Organizational design and engineering, design science, and systems engineering are examples for research areas that may provide helpful guidance.
3. **Extending the basis of case studies.** There are only few publications that describe practical experience with enterprise architecture principles. Since this research field has not yet been explored in detail and theoretical foundations are meager we need more explorative research. More case studies might help to shed light on key issues and success factors when formulating and deploying architecture principles.
4. **Conducting quantitative research.** When a detailed conceptual framework for exploring enterprise architecture principles is elaborated quantitative research should be conducted. Surveys covering multiple enterprises in various industries could help to assess whether enterprise architecture principles converge to a coherent set of generic principles or whether these principles need to be tailored to the specific needs of the particular enterprise.
5. **Guidance for the process of developing and improving architecture principles.** While this article provides a fundament for exploring enterprise architecture principles, our work provides little guidance about the process that leads to developing and improving architecture principles. Who, for instance, should be involved in this process and who should be in charge of shaping and enforcing principles? What tools are helpful for facilitating this process?

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