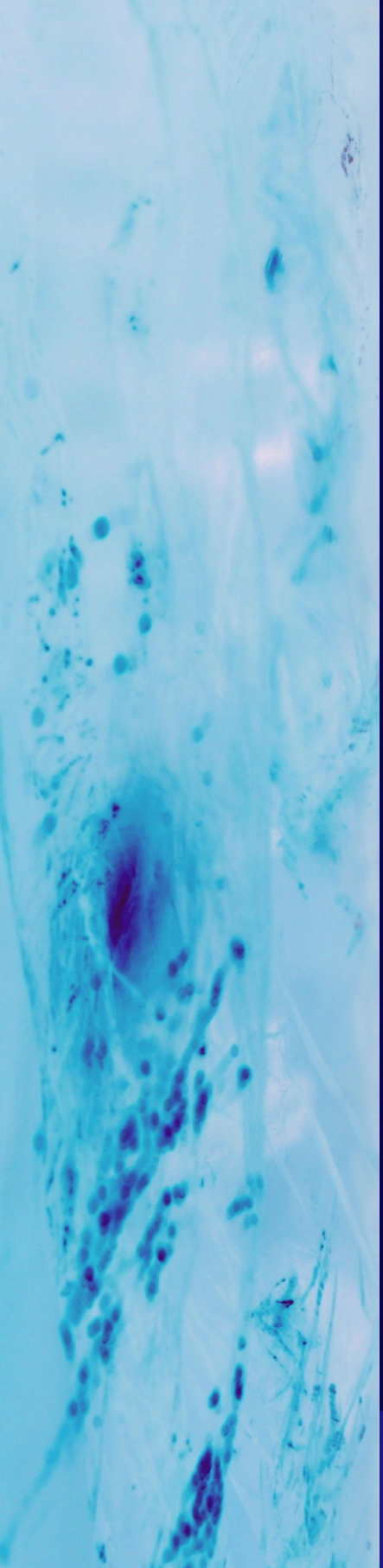
Ralph Foorthuis

Project Compliance with Enterprise Architecture



Project Compliance with Enterprise Architecture

Ralph Foorthuis

Project Compliance with Enterprise Architecture

Doctoral thesis.

Utrecht University, Utrecht, The Netherlands.
Department of Information and Computing Sciences,
Organization and Information.
V20120925.

ISBN	978-90-393-5834-4
Author	Ralph Foorthuis
Cover	Ralph Foorthuis and Ingrid Meus
Keywords	Enterprise Architecture, Compliance, Projects, Effectiveness, Conformance, Organizational Performance, Benefits

Project Compliance with Enterprise Architecture

Conformiteit van projecten onder Enterprise Architectuur
(met een samenvatting in het Nederlands)

PROEFSCHRIFT

ter verkrijging van de graad van doctor
aan de Universiteit Utrecht op gezag van
de rector magnificus, prof. dr. G. J. van der Zwaan,
ingevolge het besluit van het college
voor promoties in het openbaar te verdedigen op
woensdag 17 oktober 2012 des middags te 4.15 uur

door

Ralph Marcel Foorthuis

geboren op 7 december 1974
te Amsterdam

Promotor: prof. dr. S. Brinkkemper

Co-promotor: dr. R. Bos

Dit proefschrift werd mede mogelijk gemaakt door het CBS (Centraal Bureau voor de Statistiek) en UWV (Uitvoeringsinstituut Werknemersverzekeringen).

Preface

While studying at the University of Amsterdam in the late 1990s and the early 2000s, I was already well-aware that conducting academic research would be something I would pursue all the way. However, after finishing two master's degrees, I felt I had already spent too much time in a university setting and that I needed to obtain experience in the 'real' world. During my time as a systems analyst and business architect at Statistics Netherlands (CBS), the idea of someday writing my doctoral dissertation was being kept very much alive by the research-oriented culture of the organization and the large number of colleagues walking around holding or busy earning a PhD. After a period of searching for a convenient position at a university, I decided to combine my research activities as an external researcher with my job at Statistics Netherlands and, in a later stage, at UWV. Although this would surely mean investing a significant amount of my spare time in my dissertation, which it did, I have never regretted this decision. Looking at our publications being referenced, I am also happy by the fact that the different studies in this doctoral thesis have been picked up by the international IS community.

Many people have in some way contributed to my research throughout the years. I would therefore like to thank Frank Hofman, Marlies van Steenbergen, Nino Mushkudiani, Abby Israëls, Ingrid Meus, Priscilla Chandrasekaran, Deirdre Giesen, Wiel Bruls, Erika Streefland, Leo Pruijt, Brigitte Burgemeestre, Ronald Weldam, Pascal van Eck, Tjalling Gelsema, Annemarie Koomen, Remko Helms, Marcel Koers, Wiekram Tewarie, Gerrit Zijlmans, Peter Struijs, Barteld Braaksma, Ronald Batenburg, Guido van den Heuvel, Robbert Renssen, Peter van Nederpelt, Lieneke Hoeksma, Marc Houben, Slinger Jansen, Nico Brand, Jurriaan van Reijsen, Ilja Heitlager, Michael van Eck, Dick Kroeze and Maarten Emons.

I also wish to express my gratitude to the members of the reading committee, who have made time to judge and comment on my dissertation: Anne Persson, Robert Winter, Erik Proper, Hans van Vliet and Marc Lankhorst.

Furthermore, thanks to Vivian, Barend, Roel, Jeroen and Lydia for asking about my progress and of course to my nieces Nikki and Jade Foorthuis for forcing me to play with them and not think about my research for a while.

Finally, I owe a debt of gratitude to Sjaak Brinkkemper and Rik Bos for their continuous assistance throughout the years. Sjaak, thank you for your practical guidance on conducting academic research and for your open mind. Thank you, Rik, for your sharp comments and detailed reviews.

Ralph Foorthuis, July 2012

Contents

Chapter 1

Introduction

1.1 Motivation

During the last three decades, the discipline of Information Systems (IS) has yielded a substantial amount of publications on the topic of architecture. The initial focus was on systems and software architecture of individual information systems (e.g. Zachman, 1987; Kruchten, 1995; Youngs et al., 1999). Publications in the 2000s increasingly focused on organization-wide IT and Enterprise Architectures (e.g. Lankhorst et al., 2005; Ross, Weill and Robertson, 2006; The Open Group, 2003). Enterprise Architecture (EA) aims to achieve coherent and goal-oriented organizational processes, structures, information provision and technology (cf. Boh and Yellin, 2007; Richardson, Jackson and Dickson, 1990; Ross et al., 2006; The Open Group, 2009; Wagter, Berg, Luijpers and Steenbergen, 2005). Achieving this enterprise-level coherence and focus should result, amongst others, in reducing complexity, realizing business/IT alignment, integrating processes and systems, and reaping organization-wide benefits (ibid.).

Enterprise Architecture is thus a relatively young field in the Information Systems discipline. Nonetheless, a significant amount of academic and practitioner writings have been published on topics such as EA frameworks (Zachman, 1996; Goedvolk et al., 1999; Macaulay, 2004; Greefhorst et al., 2006; Winter and Fischer, 2007), the activities to undertake when developing an Enterprise Architecture (The Open Group, 2009; CIO Council, 2001; Department of Defense, 2009), and how to describe and model architectural aspects (Lankhorst et al., 2005; Bernus, 2003; Jonkers et al., 2004; Steenbergen and Brinkkemper, 2008; Koning et al., 2009).

However, such publications pertain to the development of an Enterprise Architecture, not to actually working with EA, nor to the value obtained from it in practice. Indeed, several crucial and interrelated topics have not yet received much attention in academia. A first topic is how EA prescriptions (i.e. norms) should be applied and implemented in practice. EA models and principles have no value if they are not purposefully used in the organization (cf. Persson and Stirna, 2001). Research on this topic should not only contribute processes and

deliverables for EA practice, but also best practices for initiatives that need to conform to a given, predefined Enterprise Architecture. Although it is a topic that has received some attention from practitioners (e.g. Wagter et al., 2005; The Open Group, 2009; Florida Department of Transportation, 2006), it has not received much serious attention in the academic community.

A second and related topic that has not been the topic of much research is the role of projects in working with EA. However, projects are of crucial importance in several ways. First, it is unlikely that the organization-wide benefits claimed for EA, such as business/IT alignment and integrated processes, can be achieved without projects (Wagter et al., 2005; Foorthuis et al., 2008a, 2008b). In order for the EA to yield these benefits, the organization's business processes and IT systems should be consistent with the high-level architectural guidelines and constraints. Specific, local projects that design and implement these processes and systems should therefore also conform to the EA. A second reason why research on EA-related projects is relevant and important, is that Enterprise Architecture is claimed to provide them directly with value in several ways. Working with EA is said to improve project success, to reduce project risk, duration and complexity, to speed up the initialization of a project and to reduce project costs and risks (Pulkkinen and Hirvonen, 2005; Bucher et al., 2006; Wagter et al., 2005; Mulholland and Macaulay, 2006; Capgemini, 2007). As a result, the topic of project compliance with an overall architecture has been identified as an important research area (Bandara et al., 2007; Foorthuis and Brinkkemper, 2007). In addition to the process models, deliverables and best practices mentioned above, important issues in this context are how projects relate to EA conceptually and what contribution projects make, if any, to achieving the claimed EA benefits.

A third topic that has not yet received much attention in academia is what compliance with EA entails, both conceptually and practically. Interesting and related questions in this context are how compliance can be encouraged and how it can be assessed. Although some publications touch on this topic (Boh and Yellin, 2007; The Open Group, 2009), not much scientific research has been conducted to investigate these questions.

A fourth issue in want of academic attention is the lack of quantitative research. Most studies are qualitative in nature. Although these are very valuable, there is also a place for studies covering many organizations and situations simultaneously. Furthermore, empirical studies in which hypotheses regarding EA are tested have not been conducted frequently. As a consequence, the need for hypothesis testing on the topic of Enterprise Architecture has been identified in the IS research community (Boh and Yellin, 2007; Kappelman et al., 2008; Niemi, 2006). This not only holds for the three previously mentioned topics in this section, but also for other EA issues.

Arguably, research that addresses these four issues can in the current era be expected to deliver more important contributions than publications on Enterprise Architecture frameworks, development of an organization's EA, or modeling of EA concepts. The latter are simply conditional for being able to actually use and especially benefit from EA, which is where the added value of architecture should lie in practice.

1.2 Research Questions

Based on the research topics identified in the previous section, the main research question of this dissertation is:

> *MRQ*: *What are effective practices for working with projects that are required to comply with Enterprise Architecture, and what benefits and drawbacks are induced by compliance?*

This question will be studied both from the perspective of projects and from that of wider organizational stakeholders. In order to address the main research question, it was broken down into several separate research questions and sub-questions. Given the research aim, this study necessarily has to deal with different levels and, as a consequence, demands a clear understanding of the architectures at those levels: Enterprise Architecture, Domain Architecture, Project Architecture, Project Start Architecture and Software Architecture. Therefore, the first research question focuses on the various architectures at the project level and how these relate to the higher-level architectures:

> *RQ1*: *What are appropriate definitions of the various architectures at the project, domain and enterprise level, and what are their interdependencies and contents?*

By answering this question we lay foundations for the remainder of our research. This includes definitions of several types of architecture and the position of project artifacts (i.e. deliverables such as Software Architecture Documents and Use Case Models). The next question can therefore focus on projects actually working in the context of EA. Not only is it implied in the literature that projects complying with EA are necessary to gain organization-level benefits, such as business/IT alignment and achieving organization-wide goals, but projects themselves are also said to benefit from EA directly. It is thus necessary to have EA-related practices for projects and architects working

in the context of EA, and as such to encourage compliance with EA prescriptions. However, few scientific publications discuss the topic, and those we did find merely scratch the surface. Therefore, the second research question of this dissertation is:

RQ2: *What best practices can be identified for projects that have to comply with EA?*

Research questions 1 and 2 will yield a set of useful but rather fragmented architectural practices and artifacts. A next step is thus to take these practices and artifacts to formulate a coherent model for deliverables in projects applying EA prescriptions. The goal of such an endeavor is twofold. First, a practical model of the EA-related artifacts, and the processes and roles that create them, provides organizations with a (semi-)structured approach to carry out projects conforming to higher level architectures (i.e. Enterprise and Domain Architectures). Second, by adopting an appropriate theoretical perspective in order to understand projects and to identify and justify relevant new project artifacts, we learn more about the nature of projects conforming to EA. Therefore, the third research question is:

RQ3: *What artifacts are relevant for projects conforming to EA, how are they related to EA, and how are they created and tested on conformance?*

Since Enterprise Architecture is conceptualized here as prescriptive in nature, it is important that projects actually comply with the norms prescribed by the EA. Assessing them on conformance is crucial here, as the large survey study of chapter 7 shows not only that project compliance with EA is positively associated with various strategic benefits, but also that the most important determinant of conformance is in fact conducting compliance assessments of projects (see also Foorthuis et al., 2010). However, little research has been conducted on the issue of how to assess whether projects are in fact compliant. It should thus be investigated what the core aspects of testing projects on EA compliance are. In addition, an approach for organizations to carry out EA compliance assessments needs to be developed. Therefore the fourth research question is:

RQ4: *How can projects, and the business and IT solutions they deliver, be assessed on compliance with a prescriptive EA?*

In order to find an answer to research question 4, the key concepts of EA compliance assessments will first be identified. Subsequently, the process by which EA compliance testing can be carried out will be described. Finally, several compliance checks that can be utilized in the assessment process will be presented.

Research questions 2 to 4 aim at developing practices to work with projects in the context of EA. In addition to these ways for dealing with a higher-level architecture, many claims have been made by both practitioners and academics regarding the benefits of working with EA. These practices and claims can be viewed as hypotheses in demand of testing, as not much quantitative studies on EA have yet been conducted. It is thus necessary to critically and empirically verify various hypotheses regarding EA conformance and benefits in the context of projects. Therefore, the fifth research question is:

RQ5: *What benefits can be gained by conforming to EA, and what are the most effective techniques for achieving conformance?*

To answer research question 5, we will address several issues. First, we study what techniques are applied in practice to stimulate projects to conform to EA. Second, we identify the benefits that EA yields in practice, for both individual projects and the enterprise as a whole. Third, we investigate if there are any differences between EA users and EA creators in terms of their evaluative perceptions. Finally, we study which of the applied techniques have the largest effects on achieving conformance, and what the effect of conformance is on the EA benefits.

During the research project it gradually became clear that compliance in general is a problematic issue for organizations. On the one hand, organizations have to deal with stricter legal demands, industrial best practices, security concerns, ethical codes of conduct and EA prescriptions (MacLean and Behnam, 2010; Short and Toffel, 2010; OCEG, 2009; Cleven and Winter, 2009; Harris and Cummings, 2007). On the other hand, they experience difficulties implementing their compliance management approaches (Hurley, 2004; Sadiq and Indulska, 2008; MacLean and Behnam, 2010), possibly due to a lack of awareness of the full spectrum of actions that can be taken (cf. Straub and Welke, 1998). The research conducted for this dissertation also made clear that both the compliance tactics (i.e. compliance stimulating techniques such as training and penalties) that comprise these approaches and the concept of compliance itself have been described in the extant literature in a fragmented

manner and from very different perspectives. Consequently, there is a need for a structured overview of generic ways for stimulating compliance. The sixth research question therefore is:

> *RQ6*: *What compliance tactics can be used by an organization to increase, achieve or maintain compliance with internal and external norms?*

Such an overview, presented as a typology, provides both practitioners and scholars with a comprehensive base of generic and 'atomic' tactics. These tactics can be combined in a coherent fashion when developing a compliance strategy.

1.3 Key Concepts

This section will briefly introduce and define some key concepts on which subsequent chapters will elaborate (see especially chapter 6). Although we do not know of any structured overviews of concepts in the context of applying EA prescriptions in projects, we do use in our overview concepts from several well-known approaches for EA (e.g. The Open Group, 2009; Lankhorst et al., 2005) and projects (e.g. Project Management Institute, 2004; Kruchten, 1999; Rational, 2003). Our key concepts are visually depicted and interrelated in Figure 1.1. We define *Enterprise Architecture* as the high-level set of views and prescriptions that guide the coherent design and implementation of processes, organizational structures, information provision and technology within an organization or other socio-technical system (Foorthuis et al., 2008a; 2008b). An *enterprise*, in this context, can be taken to mean the entire organization, a division or even a network of organizations (cf. The Open Group, 2009). *Views* typically provide insight into the context and meaning of a system, and its fundamental elements and their interrelationships. As such, views can depict both the as-is and the to-be situation. A *prescription* can take the form of a principle, model or policy statement (cf. Lankhorst et al., 2005; The Open Group, 2009; Steenbergen, 2011). They are norms focusing solely on the fundamentals of the to-be situation and thus provide generic solution guidelines and constraints, both for high-level, enterprise-wide endeavors (*enterprise prescriptions*) and more localized change initiatives (*project prescriptions*). In this research it is especially the latter type that is of importance. Prescriptions have several properties and are often interrelated. We will discuss this in more detail in chapters 3 and 6. Chapter 6 will also describe concepts required for compliance assessments.

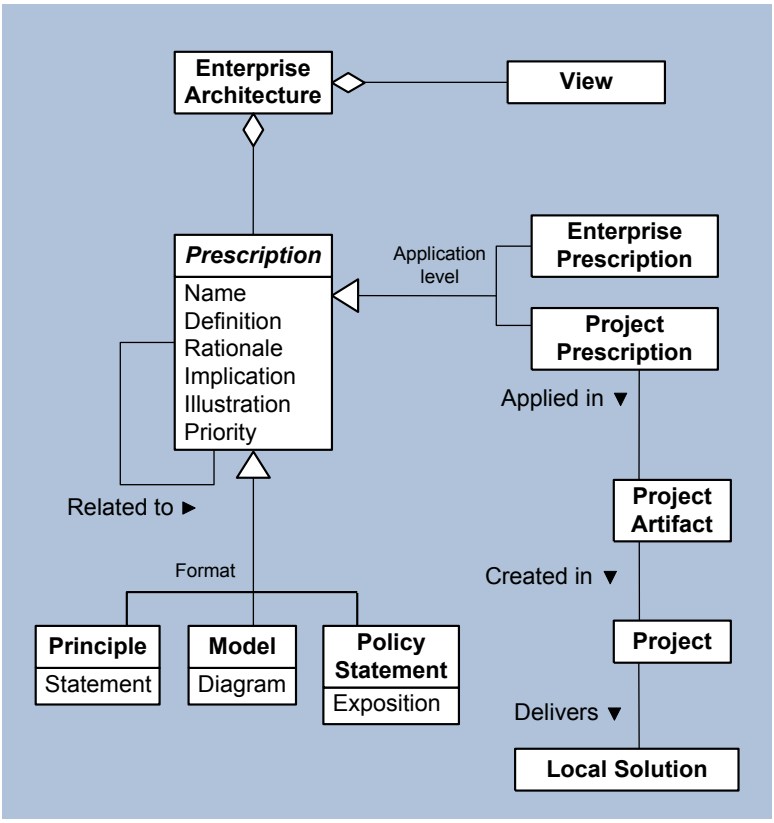


Figure 1.1. Key concepts

In the context of this research project, the aforementioned change initiatives take the form of projects. A *project* is a temporary endeavor undertaken to deliver a *local solution*, i.e. a unique product, service or result (Project Management Institute, 2004). In other words, a project has to generate one or more desired end results. In addition, it will create *project artifacts*, which are intermediate deliverables or working products such as software architecture documents (cf. Rational, 2003; Kruchten, 1999). This dissertation focuses on what could be referred to as 'local' projects, which are initiatives carried out for a specific organizational unit or process, and thus affect only a specific part of an enterprise. In essence, this simply refers to a regular project, as most of the projects carried out are more or less local in scope. In the context of this dissertation, a project has to comply with EA prescriptions. As such, it is not considered to be part of the direct implementation of the EA itself (as could be the case with e.g. an enterprise-wide service bus delivering generic information

services, implemented by means of an enterprise-level project). Instead, these more localized projects may serve other interests than enterprise-wide goals and thus may not be intrinsically motivated to comply (Malloy, 2003).

We define *compliance* as the extent to which there exists a state of accordance between an actor's behavior or products on the one side and predefined, relevant and explicit prescriptions on the other (cf. Zaelke et al., 2005; Kim, 2007; Faure and Lefevere, 2005; Foorthuis et al., 2012; Mitchell, 1996; Abdullah et al., 2009). Except for chapter 8, in the context of this thesis these prescriptions are mostly EA-related norms. We will use the term *conformance* as a synonym for compliance, unless explicitly specified otherwise. One major way in which compliance is dealt with is by ensuring consistency of the project's artifacts with the EA's prescriptions. An organization can use *compliance tactics* for this purpose, which are measures that can be taken, or techniques or mechanisms that can be used, to encourage compliance of relevant organizational actors (Foorthuis and Bos, 2011).

1.4 Ontology and Epistemology

The philosophical stance adopted in this dissertation is mostly akin to critical realism (cf. Mingers, 2004; Bhaskar, 1997; Blaikie, 1993; Zachariadis et al., 2010; Miles and Huberman, 1994; Dobson, 2001). In terms of *ontology*, this research assumes a real world, existing and acting independently of scientists' knowledge of it. This holds for physical entities – regardless of whether or not these are created by human actors – and social entities alike. In their existence, for which different levels can be acknowledged, these types of phenomena may affect actors – regardless of whether or not the actors are conscious of these effects. Natural entities and laws exist independently of the activities of humans. Social entities, however, can exist independently of our knowledge of it, but are not independent of our actions, as they are created and in their use reproduced and transformed by our practices. Once created, however, social structures can become relatively stable and independent, both enabling and constraining our actions. This is similar to physical entities such as computer hardware, i.e. objects not only created by human actors, but the properties of which (e.g. processing power and amount of memory) also enable and restrict users' actions. Even though physical and social entities and mechanisms exist in a real world, this should be seen as distinct from the events they generate. It should in this context also be noted that, although this research acknowledges real entities, people will always have their own interpretations of these entities, which will form the basis for action. Furthermore, there are (aspects of) concepts that are inherently social and subjective, regardless of the way they are

observed, and which per definition do not exist independently of an observer's knowledge of them. The meaning that people attribute to the world is therefore a significant factor of social life that cannot be ignored.

In terms of *epistemology*, knowledge is viewed not as absolute and universal, but as relative and socially and historically situated. Even though there exists a real world, we do not have immediate access to it, as there is no such thing as direct, atheoretical and objective observation of empirical 'facts'. Furthermore, efficacious entities and mechanisms may lie dormant, and even when they generate events, human actors may not be present or sufficiently capable of observing them. What we can do, however, is propose hypothetical entities for unexplained phenomena that, if they exist and act in reality as theorized, would indeed cause what we observe. Following this logic, science is able to explain observable phenomena with reference to underlying structures and mechanisms. However, we cannot definitively prove our theories of the world, since it will always be possible to create alternative and competing explanations. What the scientific community can do is disprove some of these theories and support others, and gradually build up and improve on our knowledge in this ongoing process. A complicating issue in this context is the fact that the practice of science is very much a social process. Furthermore, a problem faced by social scientists is the fact that we cannot obtain closure of social systems in the same way that the natural sciences can artificially close natural systems in controlled laboratory settings.

1.5 Methodology

This section will describe the research approach used for this doctoral thesis. An overview of methods will be presented first. Subsequently, the rationale behind our pluralist approach, which combines four research methods, will be explicated.

1. Canonical action research

Chapters 2 to 4 describe studies employing canonical action research. The principal researcher participated in several real-life projects as a business and systems analyst, as such conducting analyses and designing systems. Participating in real projects ensures maximum relevance and allows for discovering and experimenting with new techniques. Conforming to the five principles of canonical action research, which includes following an iterative process model, ensures scientific rigor. Research data were collected by keeping a daily research diary, recording audio, taking minutes of discussions, and analyzing documents (e.g. EA artifacts and presentations).

2. Statistical analysis

Two chapters describe studies that use statistics. Chapter 6 describes how several compliance assessments of projects were conducted independently by two researchers. Cohen's Kappa, a measure for inter-rater agreement, was used to verify whether these two independent assessments yielded similar results. The research described in chapter 7 is a comprehensive survey study on compliance with and benefits of working with Enterprise Architecture. The research data (n=293) are analyzed with various statistical techniques, including binomial testing, chi-square testing and ordinal regression analysis.

3. Structured literature review

Chapter 8 describes a study employing a structured literature review for identifying compliance tactics and strategic insights. A total of 134 publications have been reviewed for this purpose. The literature review was multidisciplinary in nature, as a topic can be enriched by exposing it to distinct and potentially relevant theoretical backgrounds. The disciplines drawn upon are those of management and business studies, law and political science, information systems, philosophy, organizational sociology, economics and accounting, engineering, and social psychology. Using first-level coding and pattern coding processes, a typology of compliance tactics was created.

4. Focus groups

In addition to canonical action research, chapter 3 also makes use of focus group interviews. With this technique, data can be collected through group interaction. The interaction in focus groups lets participants both query each other and explain themselves, yielding articulations on normally unarticulated assumptions. When adjunctive to other methods, this technique can be used in valuable ways. First, focus groups can yield insights that were missed by the action research method. Second, by discussing the findings of the action research approach in focus group interviews, opportunities arise to deepen existing knowledge. In short, the goal of the focus groups is to extend (obtain new data) and enrich (get practitioner feedback on) the action research findings. Three focus group sessions were held, each focusing on specific organizational roles (e.g. analysts or architects). The discussions in the focus groups were audio recorded and transcribed verbatim. These transcribed recordings were subsequently coded during the analysis.

Mixed method approach

Tashakkori and Teddlie (1998) define a mixed method approach in terms of two dimensions. The first dimension is *equal status* versus *dominant-less dominant* designs. The second dimension is *sequential* versus *parallel* designs. Taking

these two dimensions into account, the research project as a whole is an *equal status sequential mixed method study*. We contend that qualitative and quantitative methods are of equal importance in this dissertation. Within the individual study described in chapter 3, however, canonical action research has been used more extensively than focus groups. Considering the second dimension, the overall study's approach is sequential in the sense that qualitative and quantitative methods have been employed in different stages. Qualitative approaches, namely action research and focus groups, have been used in the first phase (chapters 2 to 6) to explore the domain of Enterprise Architecture and projects. Several practices and models for practitioners were also devised in this stage, resulting in hypotheses to be tested in the next phase.

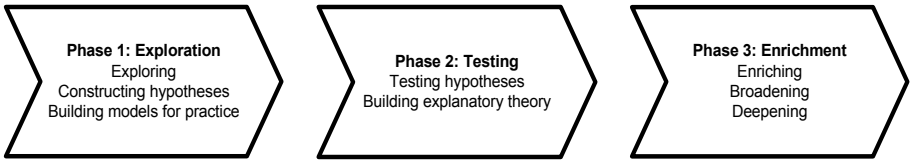


Figure 1.2. Research phases

In the second phase (chapter 7) quantitative research has been used to include a large number of respondents from a wide variety of settings to test several hypotheses (both from the previous research phase and other authors) and build a detailed explanatory theoretical model. The qualitative-quantitative order of phases 1 and 2 is especially relevant when a topic is hitherto relatively unexplored (Tashakkori and Teddlie, 1998), which is the case in our study. The final phase of the research (chapter 8) was used to capitalize on insights gained during the previous stages to conduct a large structured literature review, and as such to provide a broadened and enriched multidisciplinary overview of internal compliance.

1.6 Dissertation Outline

This section briefly describes the chapters comprising this dissertation.

Chapter 1. Introduction

The first chapter describes the motivation of the research project, the research questions, the philosophical stance, the methodology and the chapters of this dissertation.

Chapter 2. A Framework for Enterprise and Project Architecture

This chapter introduces concepts used in subsequent chapters. To lay the foundations for the research, a theoretical framework is presented in which different types of architecture are defined and interrelated in the context of working with EA. The types of architecture described are: Enterprise Architecture, Domain Architecture, Project Architecture, Project Start Architecture (PSA) and Software Architecture. Well-known project artifacts (e.g. Use Case Models and Software Architecture Documents) are positioned within this framework to provide concrete examples. This work has been published in the Journal of Enterprise Architecture, Vol. 3, No. 4, pp. 51-63, November 2007.

Chapter 3. Best Practices for Projects Conforming to EA

Based on the framework of chapter 2, this chapter identifies best practices for performing business and systems analysis in projects that are required to comply with Enterprise Architecture. The study is conducted using two qualitative methods, namely canonical action research and focus groups. The empirical study resulted in seven observations and ten best practices. This work has been published as a journal article in Enterprise Modelling and Information Systems Architectures, Vol. 3, No. 1, pp. 36-47, July 2008.

Chapter 4. An Artifact Model for Projects Conforming to EA

As the artifacts of chapter 2 and the practices of chapter 3 constitute rather fragmented knowledge, this chapter presents a coherent model for projects that have to adhere to Enterprise Architecture. The model features project artifacts, their mutual relationships, their relationship with EA, and the processes in which they are created and tested on conformance. An Activity Theory lens is used to demonstrate the crucial mediating role that artifacts have in projects and to identify and justify the new EA-related artifacts introduced in this research. Two Canonical Action Research studies are used to empirically support the model. The model describes several practices which will be tested more rigorously in chapter 7, such as encouraging conformance by working with a PSA, active involvement of architects, compliance assessments and providing advice. This work has been presented at the conference The Practice of Enterprise Modeling, and published in Proceedings of PoEM 2008, IFIP WG 8.1 Working Conference, LNBIP 15, pp. 30-46, Springer.

Chapter 5. A Process Model for Project Members Conforming to EA

This chapter details the high-level model presented in chapter 4. This high-level model focuses on two levels, viz. the project and its environment, and on the interaction between project members inside the project. The process model of

chapter 5 focuses instead on a more detailed level, i.e. the actions of an individual organizational role. This work has been published as an appendix to the artifact model of chapter 4, as a Technical Report of Utrecht University, ISSN 0924-3275.

Chapter 6. Compliance Assessments of Projects Adhering to EA

One of the crucial tasks identified in the models presented in chapters 4 and 5 is conducting compliance assessments. This refers to reviewing baselines comprised of project artifacts, such as Software Architecture Documents and Use Case Models, and determining their consistency with EA prescriptions. However, not much research has been conducted on this topic. This chapter therefore focuses on how to assess projects on compliance with an Enterprise Architecture that provides high-level solution guidelines and constraints. The core elements, process steps and compliance checks of EA conformance testing are discussed, based on the insights presented in chapters 4 and 5 and a literature review. Furthermore, an empirical case is reported in which a real-life project was assessed on conformance. In addition, a case is made for the inherently subjective nature of EA compliance testing. This work has been published in the Journal of Database Management, Vol., 23, No. 2, April-June 2012.

Chapter 7. EA Conformance and Benefits

Both in the previous chapters and in publications by other researchers and practitioners, various claims have been made regarding the benefits that EA delivers not only for the *organization* as a whole but also for individual *projects*. Therefore, this chapter presents the statistical findings of a survey study (n=293) carried out to empirically test these claims. First, it is investigated which techniques are used in practice to stimulate conformance to EA. Secondly, it is studied which benefits are actually gained. Thirdly, it is verified whether EA creators (e.g. enterprise architects) and EA users (e.g. project members) differ in their perceptions regarding EA. Finally, it is investigated which of the applied techniques most effectively increase project conformance to and effectiveness of EA. A multivariate regression analysis demonstrates that three techniques have a major impact on conformance: carrying out compliance assessments, management propagation of EA and providing assistance to projects. Although project conformance plays a central role in reaping various benefits at both the organizational and the project level, it is shown that a number of important benefits have not yet been fully achieved. This work has been presented at the Thirty First International Conference on Information Systems and published in the Proceedings of ICIS 2010.

Chapter 8. Tactics for Internal Compliance: A Literature Review

In this chapter the general concept of compliance is investigated more deeply and from a broader perspective, by studying relevant literature from various fields. The research of the previous chapters made clear that the elementary compliance stimulating tactics that organizations can use for achieving internal compliance have been described in a fragmented manner and in the literatures of distinct academic disciplines. Therefore, by studying 134 publications in a multidisciplinary structured literature review, this chapter offers three contributions. First, a typology of 45 compliance tactics is presented, delivering a comprehensive and rich overview of elementary ways for bringing the organization into compliance. Secondly, an overview of fundamental concepts in the theory of compliance is provided, forming the basis for the framework developed in this study for positioning compliance tactics and for analyzing or developing compliance strategies. Thirdly, insights for moving from compliance tactics to compliance strategies are presented. A preliminary version of the framework for compliance tactics has been presented at the Governance, Risk and Compliance of Information Systems workshop and published in the CAiSE 2011 Workshop proceedings (GRCIS 2011), LNBIP 83, pp. 259–268, Springer. The typology of tactics and guidelines for developing compliance strategies have been presented in an article, which has been submitted to a journal.

Chapter 9. Conclusions

In this chapter the answers to the main research question and the derived research questions are formulated. In addition, the main contributions of the research are presented. Limitations of the research are also discussed and suggestions for further study are presented.

Chapter 2

A Framework for Enterprise and Project Architecture

Little scientific research has as yet been conducted on projects conforming to Enterprise Architecture (EA). To lay foundations for such research, this chapter presents a theoretical framework for defining the Project Architecture (PA) in the context of working with EA. One constituent of the PA is the Project Start Architecture (PSA), which ensures the local project is bounded by the EA and/or Domain Architecture (DA). We start with explicating the context of a PSA in terms of its relation to the EA and DA. Subsequently, we define the PA in terms of three dimensions. The first dimension contains four aspect areas. The second dimension features four abstraction levels. The third dimension contains two project content categories: the PSA (containing prescriptions inherited from the EA and/or DA) and the PED (the Project Exclusive Design, containing the fundamental analysis and design artifacts that have been created specifically for the project). A real-life case is used to help illustrate and validate the theoretical framework. Additionally, a mapping with RUP artifacts is presented to further clarify the framework of the PA with examples of well-known analysis and design artifact types.[1]

2.1 Introduction

The young field of Enterprise Architecture (EA) has attracted quite some attention over the last few years, and numerous articles have been published. Surprisingly, little scientific research has yet been conducted on the topic of carrying out specific, local projects conforming to an EA. A local project is a

1 This work has been published as: Foorthuis, R.M., Brinkkemper, S. (2007). *A Framework for Local Project Architecture in the Context of Enterprise Architecture*. In: Journal of Enterprise Architecture, Vol. 3, No. 4, pp. 51-63.

project that affects only a specific part of an enterprise. Such a project has to conform to EA prescriptions and, therefore, is not part of the (implementation of the) EA itself. Research on local projects is a highly relevant research area, since EA is claimed to provide projects with value in a number of ways. Working with EA is said to improve project success, to reduce project risk, duration and complexity, to speed up the initialization of a project and to reduce project costs (Bucher et al., 2006; Wagter et al., 2005; Capgemini, 2006). However, scientific evidence for these claims is still missing. Before research can validate them, clear definitions of architectural concepts at the project level are required. Miscommunication about terms such as *Architecture, Project Architecture, Project Start Architecture* and *Software Architecture* is a risk both organizations and the scientific community run when discussing architecture in projects conforming to EA. Therefore, the research question in this chapter is:

> *What are appropriate definitions of the various architectures at the project, domain and enterprise level, and what are their inter-dependencies and contents?*

The goal of this chapter is to contribute to clear concepts of architecture when applying them in the context of local projects that should adhere to an EA. In our explorative study, we hope to start a discussion on the nature of Project Architecture (PA), Project Start Architecture (PSA) and other types of architecture at the project level. Furthermore, our aim is to lay foundations for – and to stimulate further research on – the topic of project conformance to EA.

This chapter proceeds as follows. In the following section we state our view on EA and position the PSA in the context of this larger picture. Next, we present a three-dimensional framework for the local Project Architecture, of which the PSA will be one of the constituents. The framework will be illustrated by presenting examples from a real-life case and a mapping with well-known software engineering artifacts (i.e. project deliverables or work products). In the subsequent section we explain the research approach we have applied for creating a real-life PSA, which we use to help illustrate and validate this part of our theoretical framework. In the final section we state our conclusions.

2.2 View on Enterprise Architecture

The IEEE standard 1471-2000 defines *architecture* 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". We define *Enterprise Architecture* according to Bucher et al. (2006) as: (1) the fundamental organization of a government agency or a corporation, either as a whole, or together with partners, suppliers and/or customers, or in part (business units), as well as (2) the principles governing its design and evolution.

Located at a high level of abstraction, the EA focuses on the essentials of the enterprise, which, in contrast to specific solutions, are relatively stable over time. Also, the high-level view on the enterprise enables its management to pursue a strategy that is optimal for the company as a whole, instead of local optimizations. The EA, then, should provide an integrated and coherent view on the enterprise, aligning business, information and IT, and guiding specific projects. As a consequence, the EA assists in achieving the enterprise's essential business and IT objectives (Richardson et al., 1990; Lankhorst et al., 2005; Boh and Yellin, 2007).

Prescriptions are used in EA to provide constraints and direction. As such, they are the means by which the EA (and possibly Domain Architectures) influence projects. Prescriptions can take various forms. They can be text-based *principles* that state a generic requirement, or they can be graphical *models* that depict a generic process or structure which can be refined by the project which takes them as a starting point. They can also be more elaborate *policy statements*. Prescriptions will evolve but should be relatively stable over time.

2.2.1 Architecture Framework

An architecture framework is a conceptual structure to analyze an enterprise and to structure both an architecture and its design process. Such a framework often takes the shape of a two-dimensional matrix. The cells in the matrix describe the content elements of the architecture and their relationships. It therefore provides an overview and helps to identify required analysis or design artifacts, such as information models or documents containing fundamental principles.

A number of architecture frameworks exist and as a starting point we will use a framework based on IAF, or the Integrated Architecture Framework (Goedvolk et al., 1999; Macaulay, 2004; Capgemini, 2006). IAF is relevant for our research for several reasons. First, it features a well-known and widely accepted categorization of aspect areas (see the next section for details). Second, for its vertical dimension it uses abstraction levels that can be applied very well to both organizations and projects, making it possible to state explicitly the contents of the Project Architecture and to present examples of real-life principles and analysis and design artifact types. A simplified version of the IAF-framework is shown in Figure 2.1 on the next page.

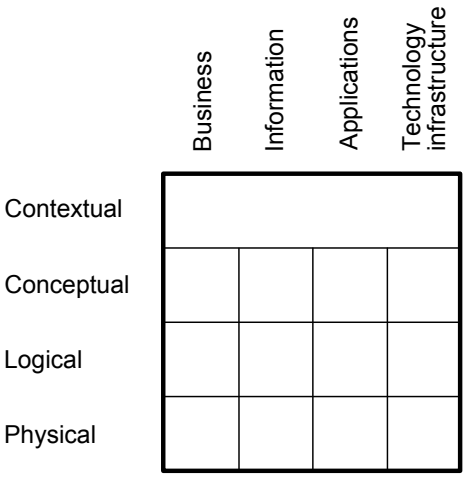


Figure 2.1. The IAF Framework for EA

Examples of content elements in the cells will be presented in subsequent sections. On the horizontal dimension a categorization of different *aspect areas* is used:

- *Business*: the business objectives and strategy, the offered products and services, the relation of the enterprise with its environment, organizational units and their relationships, the governance, the people, the key business processes and strategic projects.
- *Information*: the creation, processing, exchange, storage and use of information and knowledge. The structure of information elements and their relationships also belongs to this area.
- *Applications*: the (network of) IT-systems which offer communication and information services for the business and information areas. This includes both off-the-shelf and tailor-made systems.
- *Technology infrastructure*: the (network of) hardware devices, operating systems and middleware on which the applications run and which deliver processing, transmission and storage capabilities.

On the vertical dimension, consecutive abstraction levels detail issues identified at the levels above:

- *Contextual*: this level focuses on the context in which the organization resides, the vision and the business goals. Also, it explains why the Enterprise Architecture is created and states its scope and highest-level principles. The Contextual level is considered to stand above the aspect areas.

- *Conceptual*: the identification of all EA requirements, without detailing how they will be realized.
- *Logical*: this level focuses on designing an ideal solution. It details how the requirements can be realized, but in a way that is implementation independent.
- *Physical*: this level focuses on translating the logical ideal EA solution into an implementation specific real world version. This level, therefore, provides standards, guidelines and generic specifications for the detailed design or selection of solutions to be developed or purchased.

2.2.2 Similarities with Other Frameworks

The architecture framework presented above is similar to architecture frameworks of other groups and organizations offering EA services. For example, TOGAF (The Open Group, 2003), DYA (Wagter et al., 2005) and Microsoft Enterprise Architecture (Sousa et al., 2004).

In addition, IAF is similar to various architecture and analysis frameworks used in academic research. It can be seen, for example, as an elaboration of the influential Strategic Alignment Model of Henderson and Venkatraman (1993), which can be utilized for business/IT alignment. Furthermore, the IAF abstraction levels are similar to the design artifacts in the framework of Zachman (1987). Moreover, Pulkkinen (2006), in research on EA, also uses the four areas. Finally, a framework very similar to the IAF-framework is being used in research on information management (Maes et al., 2000; Maes, 2003).

The framework we use as a basis for this research, then, has proved its value in both practical and theoretical application and as such we consider it suitable for application in scientific research on Enterprise Architecture. What makes the framework all the more relevant here is the fact that it was used in developing the EA of the enterprise that is under empirical study here.

2.2.3 Kinds of Architectures in Working with EA

When working with EA, one can distinguish between different kinds of architectures. First, there is the *Enterprise Architecture* itself, which is the architecture residing at the level of the enterprise.

Second, if needed, one or more *Domain Architectures* (DAs) can be created. These are architectures defined on the basis of one specific group of products, services, processes or functions. A domain can be acknowledged on the level of the enterprise, for example security or a specific process step that is used throughout the organization. However, a DA can also reside below enterprise-level, for instance when creating guidelines for one specific product group.

As a third kind, *Project Start Architectures* (PSAs) can be distinguished. An architecture at the level of the enterprise or a domain does not detail the complete functional and technical design for a specific solution. This will be done in a lower level project that should conform to the general EA and/or relevant DA. Therefore, at the start of such a local project, a PSA can be created (Wagter et al., 2005). This is an architecture at the project level that inherits and translates the prescriptions from the EA, and possibly a DA, to prescriptions that are tailored to the specific project at hand. The project, subsequently, must further detail and design the proposed solution within the specified boundaries (constraints) of the PSA.

An important element of the PSA is taking into account the relationships the project has with outside elements, such as other projects, organizational units and enterprise-wide standards.

A specific project will have only one PSA. In Figure 2.2 below, the arrows demonstrate that prescriptions of an architecture affect other architectures. Note that we consider feedback loops to be important, but beyond the scope of this chapter. In section 2.3, we will zoom in on the PSA and the other constituents of the Project Architecture.

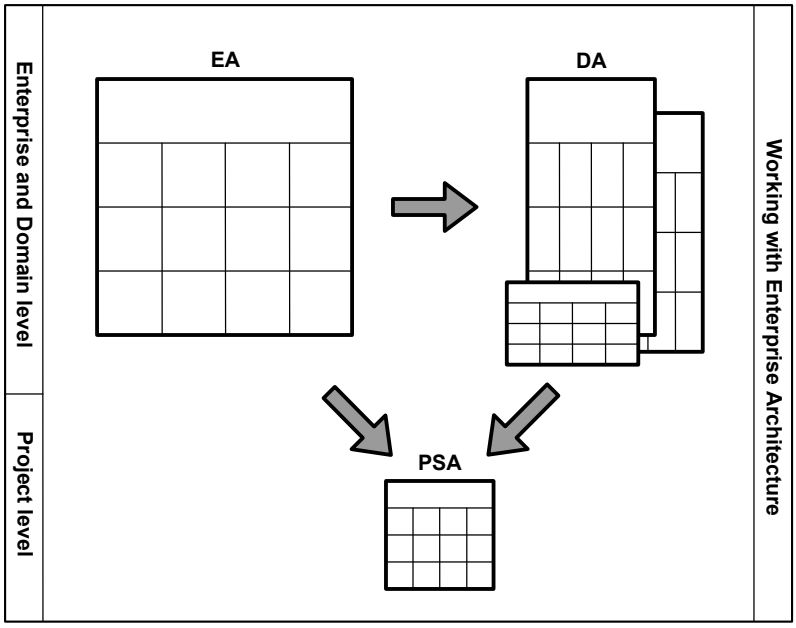


Figure 2.2. Architectures and the Flow of Prescriptions

2.2.4 The Relation between Local Projects and EA

The relationship between local projects and EA is important for two reasons. First, these projects have to use the EA, which might provide prescriptions especially for local initiatives to comply with. Second, EA is claimed to provide projects with value in a number of ways (Capgemini, 2006; Bucher et al., 2006; Wagter et al., 2005). Among the benefits mentioned are:

- *Reduced project risk and complexity*: a better understanding of the solution context and potential problems before the project is initiated should reduce project over-runs in both cost and time.
- *Improved project success*: resulting solutions are consistent with the strategic view of the business and of higher quality.
- *Reduced project costs and improved return on investment*: projects are aware of the available reusable services and components and can make use of them.
- *Project initialization*: EA models assist in specifying the PSA at the beginning of a project. As such it should remove the need to coordinate extensively with other project teams and help avoid irrelevant discussions and other redundant project activities.
- *Shorter projects*: this is the result of the decisions that are made at the beginning of the project in the PSA. The project team, then, should be able to concentrate its energy on creating the solution. There should be no need to discuss tools or techniques. In addition, reuse of knowledge and components is assured. Finally, it should be known which competencies are needed. This allows for finding compatible people for the project.

2.3 The Framework for Local Project Architecture

The PSA provides the constraints and general direction for the further elaboration of the project's fundamental design. The combination of the PSA and the remaining core design of the project constitute the Project Architecture (PA). Figure 2.3 below provides a graphical representation of the PA.

The PA consists of the essential design elements of a specific project solution and their guiding principles. In other words, a PA is the design of the fundamental elements of an IT-system and the core business processes that it will support, adhering to the relevant EA and/or DA prescriptions. The practical use of acknowledging the PA is that the analysis and design artifacts it contains can be sent to the enterprise or domain architects. This way, the actual project design can be checked on consistency with the EA and/or DA during and after the project. We will elaborate on the PA by adding to the framework a third dimension, which contains project content categories. We distinguish between two categories:

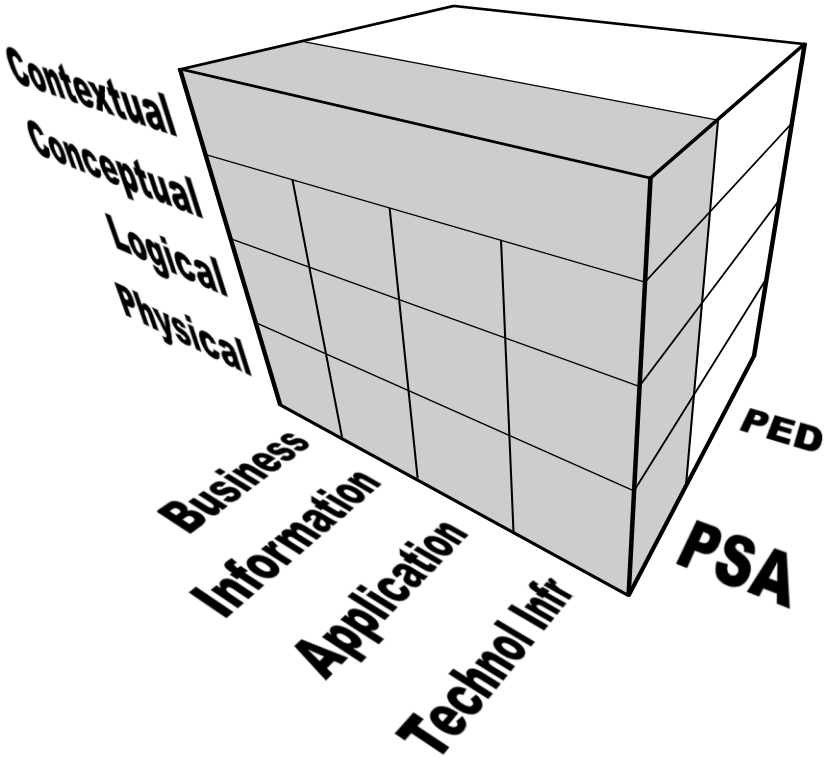


Figure 2.3. The Framework for Project Architecture

- *Project Start Architecture (PSA)*: The collection of prescriptions from an EA and/or DA that is relevant for the specific project.
- *Project Exclusive Design (PED)*: The fundamental analysis and design artifacts that are created for the specific, local project.

Figure 2.3 above shows that the PA could also be defined as the combination of the PSA and the PED. There obviously exist important relationships between these two content categories. First, one can distinguish between temporal phases in the project: the prescriptions of the PSA should be identified at the start of the project, after which the PED can be created. Second, the PED should conform to, and refine the contents of the PSA. Note that even a PA does not provide a complete view of the entire project. The PA focuses on the fundamentals, or core elements, of the project. The cube therefore contains architecture-related artifacts. Note that the PA could also be referred to as a solution architecture.

2.3.1 Dicing the Gray Slice: the PSA

The grayed category on the project content dimension represents the PSA. In this section we will elaborate further on this and present examples from a real-life PSA, which inherited text-based principles and graphical models from its EA and DA. Our definition of the Project Start Architecture is based on descriptions given by Wagter et al. (2005). A PSA is an architecture at project-level that inherits from the EA and/or DA those prescriptions that are relevant to the project and, if alteration is needed, translates them to local project prescriptions. Also, additional prescriptions can be added. A PSA should be created at the start of the project, a process in which enterprise and/or domain architects can assist. The PSA is the mechanism that links the project to the EA and/or DA. The value of a PSA should lie in ensuring that the project conforms to the EA and DA, for it sets the boundaries within which the project should operate. As such, the PSA can be seen as an agreement. In addition, it should allow for a quick start, since at the beginning of the project several fundamental decisions have already been taken and alignment with other projects has been taken care of (Wagter et al., 2005). The PSA will contain a relatively small body of content. This should make it easy to read for (new) project members, although some jargon will probably be included.

The PSA can be seen a collection of prescriptions. It is useful to clearly distinguish between prescriptions that have been taken from the EA and/or DA literally and prescriptions that have in some way been altered or added. The reason for this is that the enterprise or domain architects that have to review and maybe even approve the PSA, will definitely want to investigate the non-original prescriptions. In contrast, the prescriptions that have been taken from the EA and/or DA literally will most likely not be highly controversial. In order to make it easier for the reviewers to find specific types of prescriptions, we have developed a set of *labels*. Every prescription can have one of the labels explicitly attached to it, stating its type:

- **APL**: Directly Applicable Prescription. This prescription is inherited verbatim from the EA or DA and no major problems are expected in applying it.
- **ALT**: Altered Prescription. This is a prescription in the PSA coming from the EA or DA, but has to some degree been modified in order to fit in with the project.
- **ADD**: Added Prescription. This prescription is created specifically for the project at its initialization. Note that this renders the PSA quite extensible. Such a prescription might also be a candidate for being included in the EA or DA.
- **AMB**: Ambiguous Prescription. This is a prescription that is still subject to debate concerning its implications for or relevancy to the project. This kind

of prescription should not be present in the final version of the PSA. For a quick look-up during review sessions, however, it can be helpful to explicitly acknowledge them in earlier versions of the document.

- **ABD**: Abandoned Prescription. This is a prescription that at one point might have seemed relevant to the project, but has eventually been dropped. For documentation purposes such a prescription, and the reasons for dropping it, can be explicitly included in the PSA.

Figure 2.4 below features the aspect area and abstraction level dimensions for the PSA project content category. We have included prescriptions from a real-life case to illustrate the various cells. Prescriptions marked with [ALT] have in some way been altered from its original formulation in the EA or DA. See subsequent sections for more information about the empirical case.

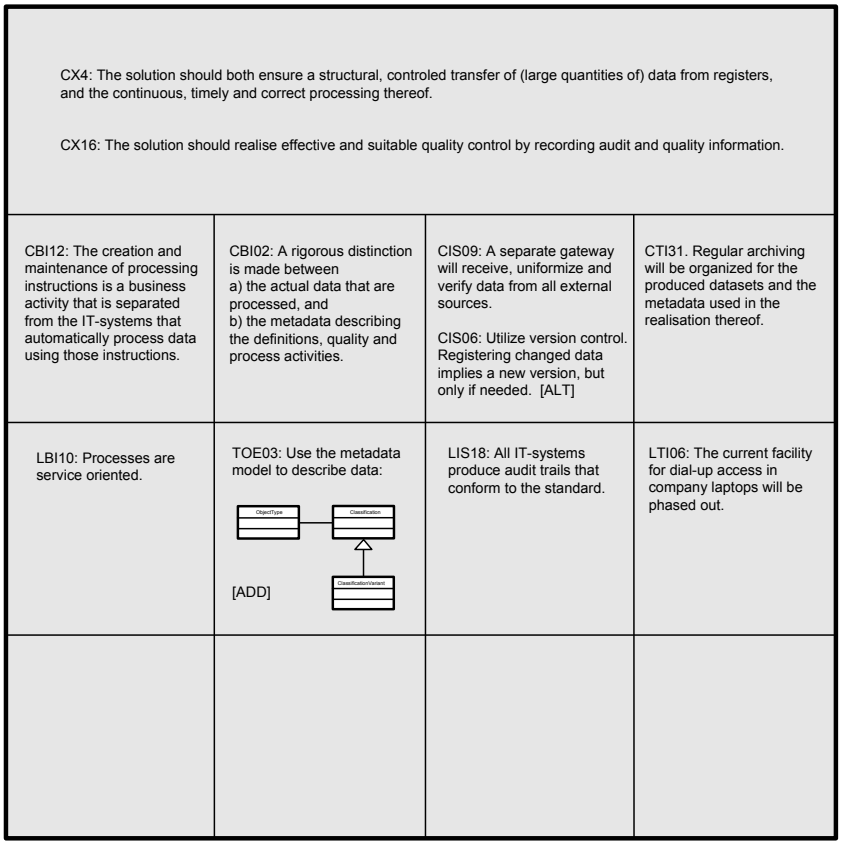


Figure 2.4. The Project Start Architecture (PSA)

2.3.2 Dicing the White Slice: the PED

In order to further clarify what can be regarded as being part of a PA, but not of a PSA, we have cut out the relevant slice in order to discuss it in more detail. The PED contains the fundamental analysis and design artifacts (deliverables) of a project that should conform to and refine the PSA, but are not included in it. Since the elements that make up this frame are entire documents and models, it is not possible to give real-life examples of elements in the cells. However, we can give examples of analysis and design artifact types of the Rational Unified Process (RUP). This is a software engineering process that provides a disciplined approach to assigning tasks and responsibilities when developing software (Kruchten, 2003; Rational, 2003). The mapping of RUP artifacts on the framework should make more tangible what constitutes the PED.

One part of the PED is the project's *Software Architecture* (SA), which is "the fundamental organization of an information system embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution". As can be seen from the Software Architecture Document (SAD) artifact in Figure 2.5, the SA is located in the four lower right cells of the Logical and Physical layers of the Application and Technology Infrastructure areas. The Software Architecture itself is a specific solution design that is not considered to be part of working with an EA, DA or PSA (although prescriptions might provide constraints and direction for its design).

The cells in the PED matrix contain examples of RUP analysis and design artifacts that are created specifically for a project. One example is the Conceptual Application cell, which deals with *what* the information system should offer its stakeholders. This concerns the functional requirements, which in RUP are described in detail in Use Case Specifications (arguably, the "features" in the Vision document could also be placed here). Another example is the Logical Information cell, which does not describe *what* information elements the business has (this is described in the list of domain entities in the cell above), but *how* these entities are structured and relate to each other. A final example is the Physical Application cell, which deals with the technical fundamentals of the information system. Examples of artifacts that make up this cell are the Implementation View of the SAD and the physical data model.

The artifacts in the PED can contain a substantial amount of content, depending on the size and complexity of the project. The PSA slice will undoubtedly contain less content. Therefore, when offering the PED to enterprise or domain architects for review or approval purposes, it would be practical to work with stakeholder-specific *views*. For instance, the project can decide to offer only the artifacts in the Application column to a technical reviewer, or only the artifacts in the Contextual layer to an information manager.

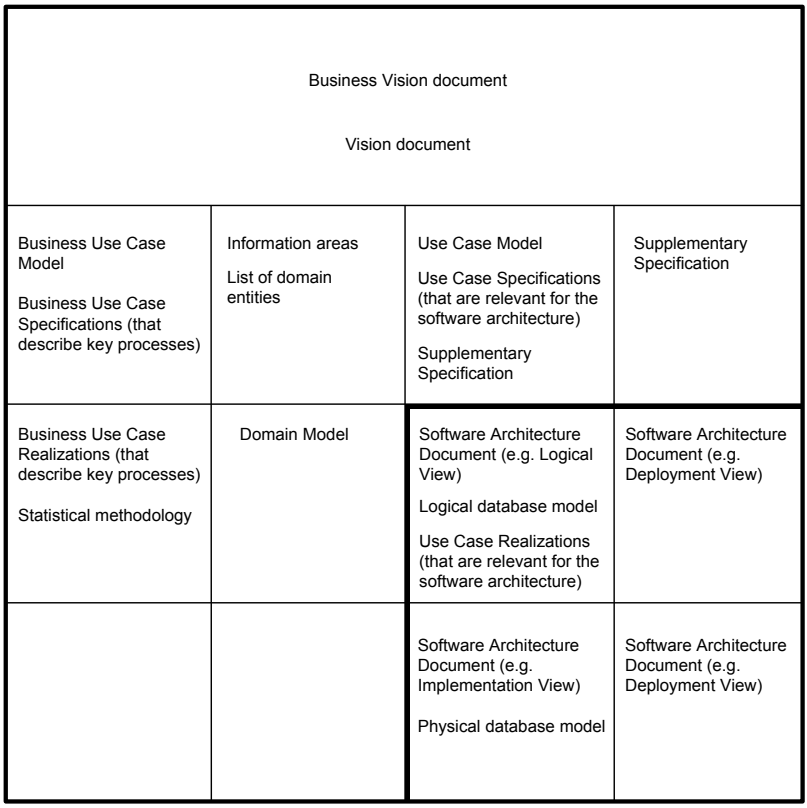


Figure 2.5. Project Exclusive Design (PED)

2.3.3 Some Remarks Regarding the Local Project Architecture

Since the PA focuses on the fundamentals of the project, the cube contains *architecture-related* content. Therefore, several artifacts that will be created in a project are still missing. For example, Use Cases that are not relevant for the SA are excluded. Also, detailed technical design of components or user interfaces is not considered to be part of the PA. The same holds true for the programming code. Furthermore, the PA does not include the end-products, e.g. the executables, databases and manuals. An interesting aspect of the Project Architecture framework is that it brings together two different types of architecture. First, the high-level *Enterprise* and *Domain Architecture* (in the PSA) and second the *Software Architecture* (in the PED). The SA is a totally different type of architecture, not covering all the cells of the IAF-framework and being valid only in the specific project.

2.4 Empirical Case

A PSA for a real-life project was created by the principal researcher to test whether the framework could be applied in practice. An Action Research (AR) approach was applied to carry out this field research. Since AR allows for studying technology in its human context (Baskerville et al., 1996), it was ideally suited to verify whether the PSA-part of our theoretical framework could be applied in a practical situation. To ensure relevance and scientific rigor, we consistently applied the five principles of Canonical Action Research (CAR), as formulated in Davison et al. (2004). Below, we will briefly discuss these principles.

- *The Principle of the Researcher-Client Agreement (RCA)*: A Researcher-Client Agreement should be created to build trust among the involved parties and to guarantee behavior.
- *The Principle of Theory*: Action researchers need to rely on theory to guide and focus their activities. This helps to position the research within the academic body of knowledge and should also help to avoid doing an irrelevant study.
- *The Principle of the Cyclical Process Model (CPM)*: The researcher progresses through five stages in a sequential fashion, ensuring systematic rigor: diagnosis, action planning, action taking, evaluation and reflection. Depending on the result, multiple cycles might be required.
- *The Principle of Change through Action*: The essence of AR is for the researcher to participate in a social setting to take actions in order to help reach more satisfying conditions for the respective stakeholders.
- *The Principle of Learning through Reflection*: Reflection and learning are needed to formulate implications for both practice (the client) and the advancement of knowledge (the scientific community).

2.4.1 Research Setting

We carried out our research in Statistics Netherlands (CBS), a large governmental organization located in two cities in the Netherlands, employing about 2000 people. Its mission is to produce and publish undisputed, coherent and relevant statistical information. The organization is information-intensive in nature, since both its input and output are information. Six months prior to the start of our research, the EA of the organization had been officially approved by high-level management, which meant that working with EA was relatively new to the organization. Although the organization planned to utilize the concept of the PSA, no formal methods or templates had yet been defined for this purpose.

The EA itself consists of five core documents (258 pages), containing the prescriptions, plus some supportive material. The EA focuses on providing a complete architecture, although, at the time of research, the physical layer did not contain any prescriptions yet. In total, a number of 247 text-based principles had then been formulated, which were uniquely identified by an ID code (e.g. "CX16"). In addition to the principles, 75 graphical models were included, some of which were high-level designs (e.g. of business processes), while others had a more clarifying purpose (e.g. showing the context of the organization). In addition, the EA documents contained descriptive text, for commenting on and relating the principles and models. In presenting the prescriptions, the Business and Information areas of the EA were joined into one column, the reason for which was the fact that the main input and output of this organization consisted of information. As a consequence, in creating the EA it had proven difficult to reach a widely accepted distinction between business products and information objects.

2.4.2 Research and Results

The researcher participated as a business analyst in the first phase of a project that had an expected duration of several years. The goal of the project was to redesign the business processes and IT-systems of one of the organization's key statistical products. In the business analysis, a PSA was created, in which the researcher had considerable freedom since no formal approach in working with a PSA had been introduced yet. Most of the prescriptions originated from the EA. However, at the time of drawing up the PSA, a Domain Architecture for the central storage and retrieval of metadata was being created. Although this DA was not yet finished and no principles could be inherited from it, its central metadata model was considered useful in the project since it provided a means to describe the business objects. Also, it was thought that using this model should allow for relatively easy alignment between the current project and the completed DA at a later stage.

To adhere to the first principle of CAR, an RCA was drawn up for the first project, which at that moment had not yet been formally initiated. This document contained 12 statements that made up the agreement (e.g. "The researcher shall openly discuss with the project members the research goals and the necessary actions that will be planned in the project."). The RCA document also contained a description of the research question and its goals, some information about the CAR method and a preliminary version of the theoretical framework. This was discussed with the project members, after which the project board approved the RCA.

Our study was ideally suited to adopt the Cyclical Process Model, since its goal was to create a PSA artifact. We started with an orientation phase, in which we assessed the project and the Enterprise Architecture. Based on this, we created a first version of the PSA, which led to the first iteration cycle. Three weeks and four iteration cycles were needed to create the final PSA, the format of which was based on the theoretical framework presented in this chapter. The primary researcher participated in all iterations. A standard iteration would consist of analyzing the shortcomings of the current version of the PSA, creating a new version, distributing it to the relevant people, and organizing a review session. The final PSA, counting 21 pages, was accepted by the project members, the involved enterprise and domain architects and the project board. The four iterations were needed to clarify the text-based principles by adding comments, to add a requested section about the feasibility of adhering to the prescriptions, to add additional principles and to add the metadata model from the DA. In the process, discussions were held with project members, enterprise and domain architects and another business analyst. Our research data were collected by recording and/or taking minutes of discussions, keeping a daily research diary and analyzing documents (e.g. EA artifacts and presentations).

To adhere to the Principle of Theory, we started out with a preliminary model of the Project Architecture, based on the IAF framework. However, the first version of the third dimension, containing project content categories, was somewhat different from the model we finally presented (see below).

Since we were creating a PSA for a business redesign project, we were following the Principle of Change through Action. The PSA was an artifact that the organization was planning to use, but had no experience with up to that moment. Actions, like creating a new version and discussing it with stakeholders, were planned and recorded in the research diary.

Learning through Reflection was ensured because every version of the PSA was discussed and evaluated with project members. The learning that emerged during and between these sessions was specified in the daily research diary. After the research project, the principal researcher organized several sessions with project members and enterprise and domain architects to discuss the process of business analysis and the role of the PSA herein. In addition, the researcher advised the responsible organizational unit how to incorporate the PSA artifact in the process of carrying out business and ICT-projects.

The PSA featured a heavy focus on the Business and Information area since the project started out as a business redesign project. It was decided that the Application and Technology Infrastructure areas of the PSA would be supplemented with additional prescriptions from the corresponding areas of the EA when sub-projects would start to build actual IT-solutions (which could take a year). Table 2.1 on the next page features an overview of the number of text-

based principles (p) and graphical models (m) that were actually used in the PSA. The number of prescriptions in the EA is specified between square brackets.

Contextual	p: 12 [31] m: 0 [4]		
Conceptual	p: 15 + 2 ADD [19] m: 1 from EA [10]	p: 7 + 1 ALT [37] m: 0 [3]	p: 8 [52] m: 0 [10]
Logical	p: 10 + 1 ADD + 1 ALT [32] m: 1 from DA [9]	p: 3 + 1 ALT [25] m: 0 [10]	p: 3 [51] m: 0 [21]
Physical	-	-	-
	Business & Information	*Application*	*Technol Infr*

Table 2.1. Prescriptions in the PSA [and EA]

In the PSA that was created, the principles were presented in a table, with one column containing their unique IDs. A second column was used for the principle statement and its comments. A third column contained the label that the principle had been given (e.g. ADD or ALT). If the principle was inherited verbatim from an EA or DA, this column remained empty in order to focus the attention of the reviewer to the ambiguous, altered, added or abandoned principles. This was considered practical by the people involved, for in a review process these latter types are expected to be the most controversial, and therefore the most important ones to be discussed. Each cell in the PSA ended up containing several text-based principles (except for the cells at the physical level, as a result of the lack of prescriptions here). Since the Business and Information areas of the EA were combined, they were also combined in the PSA of the project. However, for illustration purposes we classified the examples in Figure 2.4 as belonging to one of these areas. At the time of completing this study, the PED was not yet completed.

Only the relevant prescriptions were added to a relatively short document. Consequently, the project members were able to read the PSA, which stimulated discussion. Discussing this PSA several times with the project members proved to have some advantages. First, it created EA-awareness in an early stage of the project. Second, discussing the prescriptions created richer and more tangible insights into the EA, and the consequences that it would have on the project.

Interestingly, a significant level of interpretation was possible, and indeed required, when discussing the meaning and implications of applying prescriptions. This was due to the fact that the EA provided abstract, generic prescriptions at enterprise level. For example, principle LBI10 in the Business and Information area stated that “processes are service oriented”. However, the EA itself did not specify what defines a service oriented business process. In

addition, the EA was partially created by external consultants, whom had left the organization at the time of creating the PSA. As a result of the interpretative nature, we used the prescriptions' comments section of the PSA extensively in order to make our interpretations and translations explicit.

Another relevant learning experience was the fact that the theoretical framework could be practically applied to a specific project when creating a PSA. The participants considered the abstraction levels, aspect areas and labels for categorizing prescriptions particularly practical instruments. The original theory did not feature the label for ambiguous (AMB) prescriptions. They were added to the framework as a result of the research, for it proved practical to be able to quickly find them during discussions and review sessions. The abandoned (ABD) prescriptions were also added to the theory as a result of discussions, although this type was not required for this particular PSA. Furthermore, the original framework featured three project content categories: Unaltered Inherited Prescriptions, Altered and/or Added Prescriptions, and the PED. Our experiences with working with a PSA in the project were sent to the lead architects, so that they would be able to use the insights for an enterprise-wide PSA template.

2.5 Conclusions and Further Research

We have presented a theoretical framework that describes different architectures. At the project level these are: Project Architecture, Project Start Architecture and Software Architecture. The PA and PSA are architectures that have to be understood in the context of the EA and DA level, and can be described using the IAF framework. Software Architecture is a different type of architecture, one that can exist without an EA. It can, however, be influenced by an EA (and/or DA). For the PSA, a set of labels is presented that can be used to explicitly state the type of a prescription. A real-life case has been presented to illustrate the framework and show that it can be used to create a PSA, based on the prescriptions from an EA and/or DA. RUP artifacts have been mapped on the framework to illustrate the PED.

Partly because of the high abstraction level of the inherited prescriptions, quite some interpretation and discussion with architects and project members turned out to be required in order to understand and link them to the project. For this reason, the comments section of the prescriptions was used extensively to make the prescriptions and their implications for the project more understandable and tangible. A useful effect of the discussions was that they created architectural awareness in the project team.

Further research is needed to study creating the PED in projects conforming to EA and to see whether using a PSA is a valuable way to increase actual compliance with EA prescriptions. More research is also needed to verify the framework in other projects and to study whether other EA-frameworks than IAF can be used to structure and describe the various architectures at project level. The reason for this is that it might very well be necessary to be able to choose between several frameworks, depending on the project specific situation. For example, in this chapter we implicitly presume there is no difference between the public and the non-public sector, which might not necessarily hold true after empirical study. EA-adherence of local projects in different types of organizations can also be studied. More in general, we hold the opinion that more research is needed on the interesting and relevant topic of utilizing Enterprise Architecture at project-level. We hope our study will stimulate further research in this area.

Chapter 3

Best Practices for Projects Conforming to EA

This chapter aims to identify best practices for projects that are required to comply with Enterprise Architecture. We focus mainly on business and systems analysis and apply two qualitative research methods to study real-life projects conforming to architecture at Statistics Netherlands. First, a Canonical Action Research approach is applied to participate in two business process redesign projects. Second, we use Focus Group interviews to elicit knowledge about carrying out projects conforming to architecture. Based on this empirical research we present seven observations and ten best practices. The best practices point to the fact that project conformance is not only the responsibility of project members, but also of enterprise architects. Considering four levels of best practices (good idea, good practice, local best practice, industry best practice), we argue that our guidelines are located at the second (good practice) level. More research is required to prove or falsify them in other settings.[1]

3.1 Introduction

Enterprise Architecture (EA) provides the organization with high-level solution directions, constraints and overall views. EA therefore focuses on the relatively stable essentials of the enterprise as a whole (Richardson et al., 1990; Lankhorst et al., 2005; Wagter et al., 2005; Op 't Land and Proper, 2007; Boh and Yellin, 2007). This should lead to various benefits (Bucher et al., 2006; The Open Group, 2003; Pulkkinen and Hirvonen, 2005; Lankhorst et al., 2005; Kozina, 2006; Wagter et al., 2005). Perhaps most important, EA enables management to pursue a coherent strategy that is optimal for the entire company, instead of

1 This work has been published as: Foorthuis, R.M., Brinkkemper, S. (2008). *Best Practices for Business and Systems Analysis in Projects Conforming to Enterprise Architecture*. In: Enterprise Modelling and Information Systems Architectures, Vol. 3, No. 1, pp. 36-47.

local optimizations. This should enable the organization to align business and IT and let its business processes and IT systems contribute to the enterprise's core business objectives in an agile fashion. Furthermore, EA should be able to facilitate the reduction of complexity, and the integration, deduplication and outsourcing of processes and systems. In order for the EA's high-level solutions and constraints to provide these benefits, business processes and IT systems should be consistent with the organization's Enterprise Architecture. Specific, local projects that design and implement these processes and systems should therefore also conform to the EA (Goedvolk et al., 1999; The Open Group, 2003; Wagter et al., 2005; Foorthuis and Brinkkemper, 2007).

In addition to the above mentioned benefits for the organization as a whole, EA is claimed to provide the projects themselves with value in a number of ways. Working with EA is said to improve project success, to reduce project risk, duration and complexity, to speed up the initialization of a project and to reduce project costs (Bucher et al., 2006; Wagter et al., 2005; Capgemini, 2007; Pulkkinen, 2006).

Several governmental and commercial organizations have developed approaches for encouraging projects to comply with EA (Lines, 2007; Florida Department of Transportation, 2006; USDA, 2007; Capgemini Academy, 2007). Important recurring elements in this respect are architectural trainings and formal reviews to assess whether proposals and project artifacts (i.e. work products or deliverables) conform to the EA. Such a review may include a dedicated "project consistency checklist" containing requirements that projects should conform to (see Florida Department of Transportation, 2006). Formal reviews are also mentioned in TOGAF as a measure to ensure compliance with EA (The Open Group, 2003). The topic of conformance is discussed in more detail in (Wagter et al., 2005), where the concept of the Project Start Architecture (PSA) – which we will discuss in section 3.2 – is introduced.

3.1.1 Research Questions and Goals

The above demonstrates that practitioners have acknowledged the need for developing ways for projects to comply with EA. However, very few scientific publications seem to discuss the topic, and those that we found only scratch the surface (see e.g. Goedvolk et al., 1999; Pulkkinen and Hirvonen, 2005; Pulkkinen, 2006). This is remarkable, as an EA cannot provide the benefits mentioned above if its high-level solutions and constraints are not being applied in the projects developing and implementing the business processes and IT systems. Alignment with strategic goals, integration and avoiding duplicate processes cannot be expected to happen automatically. Not surprisingly, therefore, the question of how projects can conform to an overall architecture has

been recently identified as an important research area (Kaisler et al., 2005; Bandara et al., 2007; Foorthuis and Brinkkemper, 2007). Therefore, the research question in this chapter is:

> *What best practices can be identified for projects that have to comply with EA?*

The goal of our research is to contribute to knowledge on how enterprises can deal practically with project conformance to EA. This is done mainly from a business and systems analysis perspective. As not much research has been done on this topic, we consider our study to be explorative by nature. Therefore, in this chapter, we shall formulate hypotheses (EA-related best practices) on the basis of empirical research. As this research is part of a larger research project, the results of this study will provide input for a theoretical model for projects conforming to EA.

The focus in this chapter is on projects that are not part of the enterprise-wide EA itself, but instead have a local scope (i.e. the 'regular' projects). These projects typically affect only a given part of an enterprise, for example delivering a software solution for a specific department. Unless specified otherwise, the "projects" mentioned in the remainder of this chapter are specific, local projects that have to conform to EA. Typically, these projects comprise both a business (re)design component and an IT component.

The remainder of section 3.1 will define core terms. Section 3.2 will present the theoretical framework that we will use to carry out and present our empirical research. Section 3.3 will state our research approach. Section 3.4 will present the research results: observations and best practices. Finally, section 3.5 contains the conclusion and suggestions for further research.

3.1.2 Best Practices

Although by no means as pretentious as the much used concept of "critical success factors", the term "best practices" can be said to imply too grandiose a claim (see also the conclusion section). We will use it here, however, because of its institutionalized character. We base our definition of best practices on that of Chevron, as stated in O'Dell and Grayson (1998). Consequently, a *best practice* is: any habit, knowledge, know-how or experience that has proven to be valuable or effective within one organization, and may have applicability to other organizations. As Wagner et al. (2006) state, the term best practice is widely used in the discourse of business and Information Systems (IS) professionals. At the same time, however, they find that neither the proposal nor the analysis of such guidelines are a very common topic in IS literature.

Nonetheless, more scientific research seems to be warranted, since benchmarking best practices might provide significant gains in time and budget, whereas identifying and transferring them can be quite complicated (O'Dell and Grayson, 1998). Furthermore, there are indications that the best practices put forward by commercial vendors may not be the result of a thorough, investigative process, but may have been created by a relatively small, powerful interest group (Wagner et al., 2006).

We acknowledge four levels of best practices, based on the levels defined by Chevron (O'Dell and Grayson, 1998). These levels will be used to characterize the best practices that we identified in our research.

- *Good idea*: unproven practice, making a lot of sense intuitively and thus a potential candidate.
- *Good practice*: a candidate practice which has been tested in one or more projects. Further substantiation is needed. There is little or no comparative data from other organizations.
- *Local best practice*: a good practice that has been determined to be the best approach for all or part of an organization. This is based on an analysis of performance data, including some review of similar practices outside the organization where the best practice originated. Note that "local" here has a potentially broader scope than for the "local projects" mentioned above.
- *Industry best practice*: a practice that has been determined to be the best approach for all or most of the organizations in an industry. This is based on benchmarking inside and outside the original organization (including organizations outside its industry), and includes analysis of performance data. Note that the "industry" in this chapter comprises organizations applying EA.

3.1.3 Business and Systems Analysis

Inspired by IIBA (2006), we define *business analysis* as the set of tasks, knowledge and techniques required to describe the current or future problems, goals, needs, products, stakeholders, processes, organizational structure and/or other relevant aspects that add value to the business. The focus of business analysis is broad but abstract. Defining detailed solutions will be done by specialists (e.g. accountants or systems analysts).

We define *systems analysis* as the set of tasks, knowledge, and techniques required to describe an existing or desired information system in terms of its context, boundaries, constraints and functionality. This kind of analysis is therefore not concerned with technical design, but instead with specifying the requirements and functional design of the software and possibly hardware. Systems analysis takes as its input the artifacts that are the result of a business analysis.

3.2 Enterprise Architecture and Projects

Inspired by (Wagter et al., 2005; Braun and Winter, 2005; IEEE, 2000) we define *Enterprise Architecture* as the high-level set of views and prescriptions that guide the coherent design and implementation of processes, organizational structures, information provision and technology within an organization or other socio-technical system. The *views* can depict both as-is and to-be architecture, and typically provide insight into the fundamental organization of a system, its components and their relationships. *Prescriptions* focus solely on to-be architecture and thus provide generic constraints and direction for both high-level, enterprise-wide services and more detailed local initiatives. As such, they are the means by which the EA guides the local projects. Prescriptions may take various forms. For example, they can be text-based *principles* that state a generic requirement, e.g. "Every business process has to generate audit trails that conform to the standard." Prescriptions can also be graphical *models* that depict a generic process or structure which can be detailed by the projects which take them as a starting point. For example, a graphical overview of the organization's intended security zones and related user roles.

A framework is often used in creating an EA. This is a conceptual structure to analyze an enterprise and to structure both an EA and its design process. Such a framework often takes the shape of a two-dimensional matrix (Greefhorst et al., 2006). The cells in the matrix describe the content elements of the EA and their relationships. This provides an overview and helps to identify required analysis or design artifacts, such as information models or documents containing principles. Several architecture frameworks exist (Greefhorst et al., 2006).

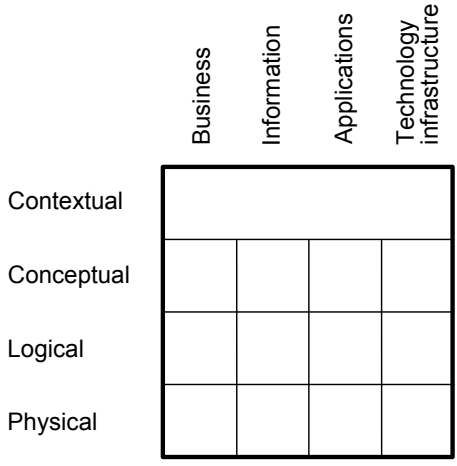


Figure 3.1. The IAF Framework for EA

Figure 3.1 shows a simplified variant of the Integrated Architecture Framework, or IAF, which can also be used on project level (Goedvolk et al., 1999; Capgemini, 2007; Foorthuis and Brinkkemper, 2007). IAF uses a categorization of aspect areas that is widely accepted (cf. Pulkkinen, 2006; Greefhorst et al., 2006; The Open Group, 2003):

- *Business*: the business objectives and strategy, products and services, organizational structure, people, key business processes and governance.
- *Information*: the creation, processing, exchange, storage and use of information and knowledge.
- *Applications*: the (network of) IT systems that offer communication and information services to the business and information areas.
- *Technology Infrastructure*: the (network of) hardware devices, operating systems and middleware on which the information systems run.

On the vertical dimension, four abstraction levels are used to detail issues identified at higher levels. As we will refer mainly to the aspect areas in this chapter, the reader is referred to the literature for more information about this dimension.

3.2.1 The project conformance framework

When working with EA, one can distinguish between different kinds of architectures. The first architecture is the *Enterprise Architecture* itself, which is the architecture residing at the level of the enterprise. Second, one or more *Domain Architectures* (DAs) may be created, if needed. These are architectures defined on the basis of one specific group of products, services, processes or functions. A domain can be acknowledged at the level of the enterprise, for example when considering enterprise-wide security. However, a DA can also reside below enterprise-level, for instance when creating guidelines for one specific product group. Third, at the project level, *Project Architectures* can be distinguished. To state the relationships between the different architectures, we use the theoretical framework for Project Architecture in the context of EA described in chapter 2. This framework is shown in Figure 3.2, condensed into one diagram. The original framework is mostly concerned with the *structure* and *relationships* of the various architectures. However, this study focuses on the *process* of carrying out business and systems analysis, which is the reason we have included feedback loops.

The Project Architecture consists of two parts. The *Project Start Architecture* (PSA) is the collection of prescriptions from an EA and/or DA that is relevant for the current project, and the early translation of these prescriptions to the specific situation (see also Wagter et al., 2005). As a result, the PSA specifies

the project's direction and boundaries at the start of that project. Therefore, the fundamental analysis and design artifacts (deliverables), which describe the specific solution that will be created in the project, will have to be compliant with the prescriptions in the PSA. This collection of fundamental artifacts is called the *Project Exclusive Design* (PED). The PED can contain artifacts such as those found in the Rational Unified Process (Kruchten, 2003), e.g. the Vision document, Use Cases, Domain Model and Software Architecture Document. See Foorthuis and Brinkkemper (2007) for an overview. During or after the creation of the Project Architecture, the project members can provide the Enterprise and Domain architects with feedback on the EA and DAs. With these comments the EA and DAs can be further modified and refined.

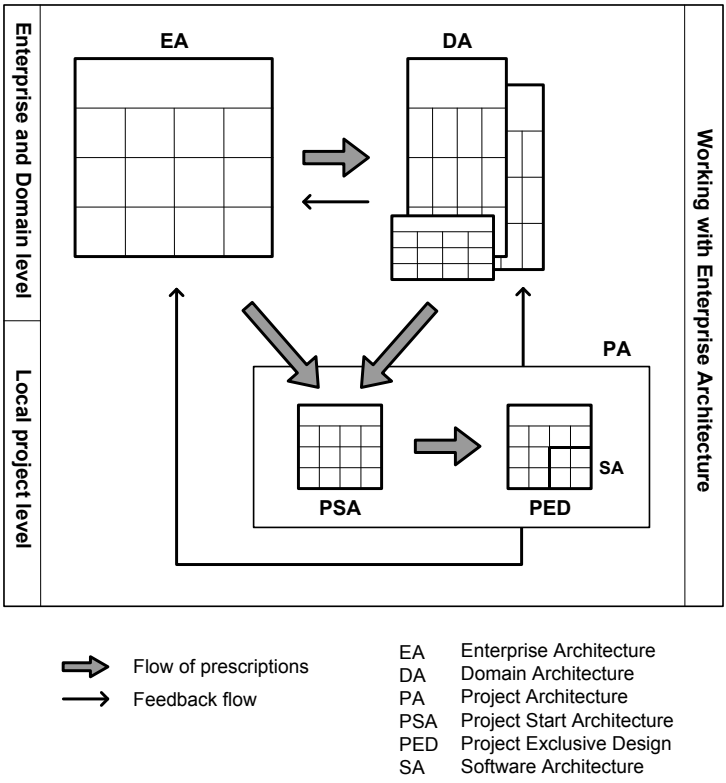


Figure 3.2. The Framework for Project and Enterprise Architecture

For the reader's convenience, when we mention "Enterprise Architecture" or "EA" in the remainder of this chapter, this actually refers to "Enterprise and/or Domain Architecture".

3.3 Research Approach

Because not much research has been done on the topic of projects conforming to EA, we consider our study to be explorative by nature. We shall develop hypotheses on the basis of empirical research. A qualitative approach is a highly relevant research strategy in this stage of scientific study (Miles and Huberman, 1994). We use a multi-method approach for discovering and experimenting with relevant best practices. The methods used are Canonical Action Research (CAR) and focus groups (FG).

3.3.1 Research setting

Both the action research and the focus group interviews have been carried out within Statistics Netherlands (SN), a large governmental organization located in two cities in the Netherlands (The Hague and Heerlen), employing over 2000 people. Its mission is to produce and publish undisputed, consistent and relevant statistical information. The organization is information-intensive by nature, as both its input and output consist of information. Six months prior to the start of our research project (late 2006), the EA of the organization had been officially approved by its top management, which meant that working with EA, DAs and PSAs was relatively new to the organization.

The EA, created using IAF, aimed to provide a complete architecture, although some parts were to be created by Domain Architectures. At the time of research, the architecture consisted of five central documents (258 pages), containing the prescriptions, plus some supporting material. The EA included 247 text-based principles, 75 graphical models (e.g. generic processes and security zones), and a substantive amount of descriptive text for explaining the principles and models.

3.3.2 Canonical Action Research

In action research, the researcher actively participates in a real-world situation to help solve an immediate problem situation while carefully informing theory (Baskerville, 1999; Vries, 2007). Canonical Action Research has been developed to ensure maximum relevance and scientific rigor by formalizing the approach using five principles (Davison et al., 2004). Participating in a project allowed us not only to discover best practices, but also to experiment with them. This was done in two business process redesign projects with an IT component: the Consumer Price Index (CPI) and the Energy statistics. The CPI, arguably Statistics Netherlands' most important publication, calculates the average price change of consumer goods and services purchased by Dutch households, and as such influences amongst others salaries, pensions and rent levels. The Energy

statistics provide information about physical energy flows in relation to energy commodities (e.g. oil and electricity) and energy producers and consumers. In both projects, the principal researcher participated as a business and systems analyst. In these projects the business processes, statistical methods and supporting IT-systems were being redesigned. Research data were collected by keeping a daily research diary, recording audio, taking minutes of discussions, and analyzing documents (e.g. EA artifacts and presentations). Below, we will describe how we applied the five principles of CAR as described by Davison et al. (2004).

- *Principle of the Researcher-Client Agreement (RCA)*: To build trust and guarantee behavior, an RCA was drawn up for each CAR project, containing twelve (mostly behavioral) statements, a description of the research question and its goals, information about the CAR method and a preliminary version of the framework presented in section 3.2.1. This was discussed with the project members, after which both project boards approved the RCA.
- *Principle of Theory*: Before participating, an early version of the framework of section 3.2.1 was discussed with the project members. No best practices were formulated before the research, since it was our intention to discover and develop them during the empirical study.
- *Principle of the Cyclical Process Model*: CAR uses a cyclical process model in order to ensure systematic rigor. Since the research focused on carrying out business and systems analysis, the action involved creating several analysis and design artifacts. As a consequence, the research featured a large number of small cycles, as every artifact needed several iterations. A standard cycle would consist of creating a new version of the artifact, distributing it to the relevant stakeholders, organizing and holding a review session, and analyzing the shortcomings of the current version. If the artifact was not yet of satisfactory quality, another run of the cycle would begin.
- *Principle of Change through Action*: Actions are a central part of CAR, as they can be used for experimenting and have to be taken in order to achieve more satisfying conditions for the stakeholders. Actions here were e.g. creating a new version of an artifact and holding a review.
- *Principle of Learning through Reflection*: Reflection and learning are needed to formulate implications for both practice and the advancement of scientific knowledge. Reflection and learning took place at several levels: the review sessions in which the artifacts were discussed, the focus group sessions (in which we presented our CAR findings), keeping the diary and refining the best practices during the projects. Learning for the organization was also specified in feedback to the EA architects and a best practices document. For more on reflection, see the data analysis paragraph in section 3.3.3.

To improve validity, both CAR projects reviewed this chapter after it had been completed. In addition, a formal peer review of this chapter was conducted (the peers being two business analysts).

3.3.3 Focus groups

According to Morgan (1996), focus groups are "a research technique that collects data through group interaction on a topic determined by the researcher." The interaction in focus groups lets participants both query each other and explain themselves, thus providing articulations on normally unarticulated assumptions. Therefore, according to Bloor et al. (2001), focus groups can yield data on the meanings that lie behind group assessments and the group processes that lead to these assessments.

FG interviews, when adjunctive to other methods, can be used in valuable ways (Bloor et al., 2001). First, as an extension to CAR, focus groups help us gain insights that were missed by the first method. Second, by discussing best practices in focus groups we have an opportunity to deepen our existing knowledge, for example by obtaining practitioner feedback on our explicitly presented CAR findings. In short, our goal of the focus groups is to extend (obtain new data) and enrich (get feedback on) our CAR findings. The following description of our research is based on the design issues (see italics) mentioned by Morgan (1996).

Starting with *sampling* and *group size*, all participants were employees of SN. We used three focus groups, depending on the role that participants had in projects in SN. Group 1 (n=6) consisted of business analysts and enterprise architects from both office locations. Group 2 (n=4) comprised systems analysts from The Hague. Finally, group 3 (n=6) included statistical methodologists, also from this location. The meetings were held in the office building during working hours. So-called *focusing exercises* (Bloor et al., 2001) were used to concentrate the group's attention and interaction on the study's topic. This means that participants were asked a week in advance to prepare a short presentation about their own best practices when doing analyses in projects. During the focus group meetings, each presentation was followed by a discussion about the practices presented. At the end of the session, another, more general discussion was held. The end of the FG session was also used by the principal researcher to present the CAR fieldwork findings and to obtain feedback on them. The *level of moderator involvement* was relatively low. Discussions were structured only to make sure the participants could present their contributions and that there was ample time for discussion. Finally, several aspects concerning *data gathering and analysis* deserve attention. In order to utilize the richness of the data and to avoid selective and superficial analysis,

the discussions in the focus groups were audio recorded and transcribed verbatim. This was done using the notation given by (Bloor et al., 2001). The transcribed recordings were coded (indexed) and further analyzed using QSR NVivo, a tool for organizing and analyzing unstructured data. Hypotheses (viz. best practices) were formulated early on in the CAR projects and, akin to Znaniecki's method of *analytic induction* (see e.g. Patton, 2002), refined and made dependent on conditions as more FG and CAR data were collected.

3.4 Research Results

3.4.1 Observations

This section presents the opportunities and problems we observed using CAR and FG, and that have led to the formulation of best practices.

1. Ambiguity of prescriptions. Because of the inherently abstract and generic nature of architectural prescriptions, the EA (and consequently the PSAs of projects) might contain quite a number of principles and models that are difficult to grasp. As a result, prescriptions might not be interpreted as originally intended by the architects. This holds true at different levels. First, the prescription content that is present may simply be ambiguous. Second, on several occasions we found that information about the level at which to apply them was missing. This means that it was not immediately clear whether these EA prescriptions described elements of the EA-level itself (e.g. enterprise-wide services that need to be delivered and which every project can then use) or were prescriptions that projects should adhere to (e.g. "Every information object has exactly one owner, who is accountable for its quality").

In our CAR projects, for example, one EA principle stated that there should be regular archiving functionality for statistical datasets. At the start of the CPI project, we interpreted this principle as a requirement for our project (i.e. our project should deliver archiving functionality to ensure that the CPI data are stored safely for reproducibility purposes). However, during the project, our interpretation shifted towards it being a requirement for a future enterprise-wide archiving service that an EA-related program was going to deliver, and which projects were expected to utilize.

2. Additional project complexity. Demanding that a project conforms to EA prescriptions may introduce considerable complexity to the project. In our study, we observed several reasons for this. First, the high-level architecture defined an ideal solution, without considering practical problems. This led to a large number of requirements for projects to conform to. Second, project

members had to learn and understand the EA that had to be adhered to. Third, the ideal and generic EA prescriptions had to be translated to the specific project situation. All of the above took time and effort. For example, the EA in our empirical study demanded that business rules be separated from the software. This should lead to more flexible systems, whose business rules can be changed quickly by the user department without requiring IT specialists. However, during the Energy statistics project it became clear that this would require quite some additional IT expertise in the user department (mainly specifying requirements, 'programming' rules and testing). This required the project to determine a governance strategy for how the user department could deal with changing its systems itself in a way that minimized risk.

3. Projects are test cases. Both in the PSA and the PED, projects have to make important decisions concerning the application of prescriptions. One reason for this is the fact that generic prescriptions are often ambiguous; another is that a project has to translate such prescriptions to its specific situation. As a consequence, early projects can be seen as important test cases for applying EA prescriptions.

4. High-level EA models. An EA might feature high-level models in order to make generic structures, processes or locations explicit. At Statistics Netherlands, for example, a distinction is made between four stage-dependent storage bases. These are the Inputbase for collected raw microdata, the Microbase for corrected microdata, the Statbase for aggregated data and the Outputbase for published data. In both our CAR projects this concept helped us to critically reflect on our own situation and provided us with the high-level design for our storage architecture in which we could fill in our project-specific data sets. See Figures 3.4 and 3.5 in section 3.4.2 for an example from one CAR project.

5. PSA similarity. PSAs of several projects were very similar in terms of the content of the architectural prescriptions that were included. The reason for this was the fact that the PSA collected the prescriptions from the EA that were relevant for projects. As might be expected, the abstract and generic nature of these prescriptions made them relevant for most statistical redesign projects. This was demonstrated in our CAR projects, of which the PSAs were created by the participating researcher shortly after each other. The second PSA, that of the Energy project, could be created far more quickly, as the selection of prescriptions and commenting on them proved to be quite similar to that of the CPI project. To a certain extent this is not surprising, as we have seen that the EA should focus on the enterprise's relatively stable essentials. For SN, one example of these essentials is the set of four stage-dependent storage bases, which can be identified in nearly every statistical process.

6. Awareness stimulating role of the PSA. The research findings seem to indicate that the PSA was mainly read at the start of the project, but was not used as a 'holy book' or rigid set of instructions during the project. These results can be explained by the fact that a PSA is created at the start of a project. Therefore, especially in complex projects, a PSA might not be sufficient to satisfactorily stimulate project conformance to architectural prescriptions. After all, the PSA is not updated during the project because other, more suitable artifacts are used (e.g. the Vision and Software Architecture Document). Furthermore, albeit cited as one of the functions of a PSA (Wagter et al., 2005), it proved to be difficult or impossible to make definite fundamental choices at the start of our CAR projects. This was a consequence of the fact that at the beginning of these complex projects not much was known in terms of requirements and domain knowledge, which severely hampered the translation of generic prescriptions to the project situation. However, we found that creating and reviewing the PSA in our CAR-projects did stimulate positive discussions about the EA and the fundamental elements of the project. This led to a richer and more tangible understanding of the EA and the possible consequences for the project.

7. Aspect area orientation. In principle, business analysis and systems analysis each have their own architectural prescriptions. *Business analysis* focuses mainly on the prescriptions in the Business and Information (B&I) aspect areas. For example, during our CAR projects, Statistics Netherlands was developing a domain architecture for storing (meta)data. One important principle in this context was "Statistical products will be described according to the metadata model". This prescription was input for the business analysts, as they had to describe statistical datasets in a pre-defined way. *Systems analysis* focuses mainly on the Information Systems aspect area and, to a lesser extent, the Technology Infrastructure (IS&TI). The IS area included the principle "Every information system supports the storage bases", referring to the bases of observation 4. In our CAR projects, this was input for the systems analyst, as he had to functionally design an information system compatible with these bases.

When reflecting on these 7 observations it can be argued that they refer to the different levels mentioned in the framework in section 3.2.1. For example, the observation that prescriptions may be ambiguous refers mainly to the EA level, as this implies that the prescriptions will have to be formulated more sharply by the enterprise architects. In contrast, the observation that prescriptions have to be translated to the specific project situation refers to work done at the project level. The above would imply that problems and other observations might need best practices at both the project level and the EA level. The next section will demonstrate this explicitly, as a set of these practices is presented for both *project members* and *enterprise architects*.

3.4.2 Best practices

This section presents the best practices according to two core dimensions of the framework presented in section 3.2.1. First, the level at which they are located (the EA level versus the project level). Second, the project content category (the PSA versus the PED).

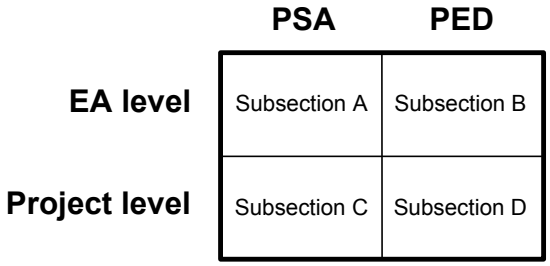


Figure 3.3. Presentation of best practices

For each best practice one or more *supporting observations* will be referenced. These are the observed opportunities and problems providing empirical support for this practice's relevance and validity.

A. The EA level – PSA

This section contains the best practices for enterprise architects creating EA prescriptions.

1. State the level of application. For every prescription in the EA, state explicitly whether it applies to an EA-level solution or service that has to be delivered, or to projects that have to adhere to it.
Comment: This makes it clear whether projects should adhere to the prescription. A local project should not implement a prescription that describes a solution or service that an EA- or DA-related initiative will implement (e.g. an enterprise-wide storage system). This practice will also make the selection of prescriptions for the PSA easier, since only the prescriptions that apply to projects are relevant (see also best practice 2).
Supporting observation: (1) Prescription ambiguity.

2. Supply PSA-template with default content. If the PSAs of various completed projects prove to contain more or less the same prescriptions, then create an enterprise-wide PSA template with a standard initial filling of prescriptions.
Comment: This will save the members of future projects considerable time, as they do not have to select the relevant principles from the large pool of EA

prescriptions themselves. Drafting the PSA in a specific project then consists mainly of tailoring it to the project circumstances (e.g. giving domain-specific translations, explanations and project-level examples of the application of the prescriptions). It is possible to create several pre-filled templates, depending on the type of project. At SN, for example, two types of these PSA templates are relevant. The template for non-statistical (re)design projects (e.g. implementing a CRM system) features all the prescriptions. A future template for statistical (re)design projects will contain only prescriptions that are relevant specifically for this project type.
Supporting observation: (5) PSA similarity.

3. Counterpart prescriptions. IT prescriptions with implications for the business should lead to counterpart prescriptions in the Business and Information areas. Analogous, Business or Information prescriptions with IT implications should lead to counterpart prescriptions in the Information Systems and Technology Infrastructure areas.
Comment: The EA should align the business and IT prescriptions, at least at a high level. Therefore, avoid that prescriptions with IT implications are present only in the B&I areas. In addition, avoid that prescriptions with business implications are present only in the IS&TI areas. There are several reasons for this. First, alignment implies tight integration between business and IT. For example, high-level design choices in the IS&TI aspect areas may impose restrictions for doing business analysis. An IT principle stating that off-the-shelf packages or data warehouse technology should be used is very likely to have an impact on (the freedom in) the design of the business process and the subsequent elicitation of IT-requirements. Therefore, IS&TI prescriptions that have an impact on the business should have related prescriptions in the Business and/or Information areas. Second, it helps to reduce complexity when creating the PSA and applying EA prescriptions in projects at a later stage. While some knowledge of prescriptions in other areas might be helpful, the business analysts should not spend their time understanding irrelevant IT prescriptions. Conversely, systems analysts should not spend their time understanding irrelevant business prescriptions. For example, in SN the IS aspect area featured the principle "Authorization is dependent on the user's role." Therefore, when we carried out the business analysis in the CAR projects, we defined roles and related them to the processes. We only did this because we had also studied the IS principles. The risk of business analysts not adhering to this principle can be minimized if the Business aspect area had featured a counterpart prescription, e.g. "Descriptions of business processes should be related to the relevant business actors."
Supporting observation: (7) Aspect area orientation.

4. Example prescriptions. Every prescription in the EA that pertains to projects should feature a comments section containing a clear *explanation* (explicating the rationale and implications) and *illustration* (giving a simple example of implementation in a specific project).
Comment: The Open Group (2003) suggests adding the rationale and implication for principles. In addition, we suggest providing examples in order to reduce the margin for interpretation. This should help in making important elements of the architecture clear. In the FG discussions, for example, it became clear that members of different projects had a fundamentally different interpretation of the four stage-dependent storage bases mentioned in observation 4, even though they are a core element of the EA. In the CPI project we could reach a shared understanding of these bases by not only stating their properties but also illustrating them with specific datasets that were familiar to the domain's stakeholders.
Supporting observation: (1) Prescription ambiguity.

B. The EA level – PED

This section contains best practices for enterprise architects regarding the PED.

5. Conformance through templates. Make enterprise-wide document templates available to projects in order to stimulate substantive project adherence to EA prescriptions.
Comment: The pre-defined template can thus give concrete specifications both for what content should be included in local analyses and how it should be filled in (i.e. specifying formats and giving the project members instructions). This way, a template is not merely a style sheet ensuring the same visual style across projects, but an effective way to influence the what and how of project content.
At Statistics Netherlands, an enterprise-wide template was created for designing logical information models in projects, describing the metadata of statistical datasets. This template forced authors to think about which of the four storage bases a specific dataset belongs to and requires the datasets to be described using a pre-specified format. Helpful comments for the future author were provided using blue text between brackets (e.g. *[Describe the object types and populations. See principle CBI03 for more information.]*). The comments can direct the author to relevant EA prescriptions or additional background information. Alternatively, they can provide guidance themselves and present the author with examples of applying the prescriptions.
Supporting observation: (6) Role of the PSA.

6. Architect involvement. An enterprise architect should either participate in projects or be available to be consulted.

Comment: This helps to stimulate conformance and to avoid deviant project interpretations of prescriptions. In our CAR projects we found that access to enterprise architects helped us to understand what was meant by certain prescriptions. Furthermore, several focus group participants indicated that they missed architect involvement in their own projects. Architect involvement is also mentioned in TOGAF as a way of ensuring compliance (The Open Group, 2003).
Supporting observation: (1) Prescription ambiguity.

C. The project level – PSA

This section contains the best practices for project members creating the PSA.

7. Phase-dependent PSA. Make the creation of the PSA artifact dependent on the project phase.
Comment: Especially if the project is complex – and thus starts with a comprehensive business analysis phase – it is recommended that two versions of the PSA be used. This helps reduce unnecessary complexity. The widely accepted distinction of the four aspect areas offers a natural way to implement this practice. The first PSA should cover only the Business and Information areas. The business analysis and design, then, should adhere to this relatively small version of the PSA. Initially focusing solely on the B&I areas keeps the PSA relatively simple, and makes it easier and more accessible for project members to read and understand this artifact. As soon as the project starts specifying IT requirements and buying or creating software, a second version of the PSA can also cover the Information Systems and Technology Infrastructure areas. This IT project phase should conform to this second version of the PSA. In our CAR projects we chose to split the PSA in two versions, as there were many prescriptions and this allowed us to speed up the initiation of the (business) project.
Supporting observations: (2) Additional project complexity; (7) Aspect area orientation.

8. Stimulate architectural awareness and knowledge. Use the PSA at the start of a project for increasing architectural awareness and knowledge. Subsequently, use templates for actually stimulating a project to conform to EA prescriptions when creating the PED.
Comment: Especially in a complex project, the PSA might be less suitable to stimulate compliance with EA when creating the PED. However, at the start of the project – which is when the PSA is drawn up – creating the PSA and reviewing it with stakeholders can stimulate discussion about the EA and the

fundamental elements of the project. This creates awareness and knowledge of the enterprise architecture among project members, managers and users.
Supporting observation: (6) Role of the PSA.

D. The project level – PED

This section contains the best practices for project members creating the PED.

9. Project instantiation. Use the project instantiation technique to provide a mapping between the general EA and the project.
Comment: In the project, the EA model can be 'copied' and filled-in in detail for the specific project situation. Thus, the EA offers the project a generic design framework onto which specific concepts can be projected, resulting in a project-specific instantiation. In our CAR projects, for example, we used the framework of the four generic storage bases (Figure 3.4) to structure our own storage bases (see Figure 3.5 for a simplified example from the CPI project). Project instantiation has several advantages. The explicit mapping stimulates the project architecture to conform to the EA. Also, the project instantiation diagram can act as a powerful means of communication to the enterprise architects and other stakeholders, to indicate that the project conforms to the Enterprise Architecture.
Supporting observation: (4) High-level models.

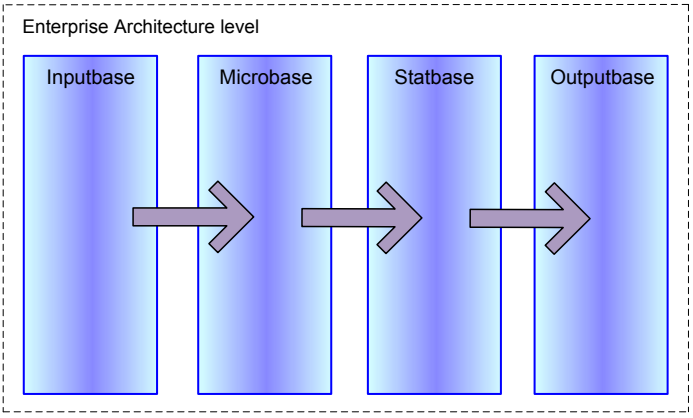


Figure 3.4. SN's generic EA model of four bases

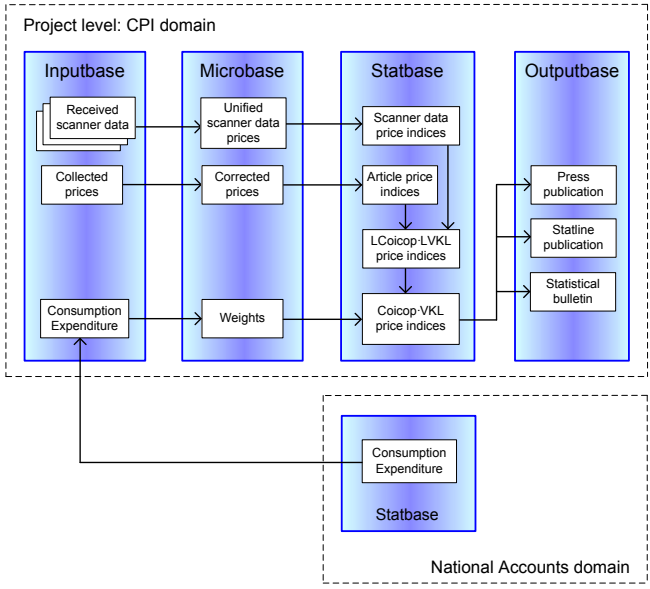


Figure 3.5. The project instantiation for the CPI

10. Provide feedback. Provide the enterprise architects with feedback regarding the application of the architectural principles and models.
Comment: Feedback should be used to improve the quality of the EA, which is especially important if such an architecture is relatively new. Looking back at the PSA, which was created at the start of the project, may provide valuable information. Prescriptions in the PSA which are labeled ADD (added), ALT (altered), AMB (ambiguous) or ABD (abandoned) might be candidates for additions, changes and deletions of prescriptions in the EA. (See chapter 2 for a more detailed description of the PSA labels.) Furthermore, when creating the PED, project interpretations of, deviations from and suggestions for improving the generic prescriptions should all be noted. Once the project is completed, these findings can be sent to the enterprise architects, who might be able to use this feedback for a revision of the EA. Based upon the experiences in the CAR projects, the participating researcher indicated several times that there were too many prescriptions to conform to. This was used by the enterprise architects to reduce the number of prescriptions down significantly. The notion of feedback is also mentioned by Pulkkinen (2006), flowing from the systems level to the domain and enterprise level. However, it is not stated explicitly here if this concerns systems actually conforming to EA, or a generic systems architecture for projects to be adhered to.
Supporting observation: (3) Projects as test cases.

In Statistics Netherlands, several of these best practices are either implemented or are in the process of being implemented for the entire organization (2, 3, 5, 6, 7, 8, 9). The other best practices are included as proposals in a document that the researcher created specifically for carrying out statistical (re)design projects that have to conform to the higher-level architectures of SN.

3.4.3 Discussion of best practices

Looking at the 10 best practices listed above, we see several themes emerging. As could be expected, several practices aim to directly *stimulate project compliance* with higher-level architectures (5, 6, 9). See chapter 7 for more. Another theme is to *reduce the complexity* that is added to the project by demanding conformance to EA (2, 3, 7). Our observation of increased project complexity is interesting, as it contradicts the claim of EA as an instrument for managing and reducing complexity (Winter and Fischer, 2007; Capgemini, 2007; Kozina, 2006). Justification for this claim usually lies in the fact that EA frameworks facilitate breaking down complexity using aspect areas, abstraction levels and views. An interesting hypothesis is that this might actually *cause* (project) complexity to increase. Modeling at the EA level provides a relatively simple overview, detecting processes and systems that should be integrated or deduplicated. Consequently, a result may be quite ambitious and complex projects that cannot focus solely on their own relatively simple silo anymore. Instead, they now need to take into account a larger environment and additional requirements (i.e. EA prescriptions). Further research is required to test whether this hypothesis can be supported by empirical evidence. This will be picked up in chapter 7.

As a third theme, we observe that several practices are meant to *avoid project level interpretations* of prescriptions that deviate from what was intended by the original enterprise architects (1, 4, 6). Related to this theme, ambiguous principles are already a research topic that has been studied recently. In this context, several publications have focused on criteria for the formulation of less ambiguous or even formalized principle statements (see e.g. The Open Group, 2003; Bommel et al., 2006; Lindström, 2006; Op 't Land and Proper, 2007). The formalization of principles still has to prove its value, however, as several problems might surface. First, formal principles might be unambiguous for automated compilers, but difficult to read for humans (who actually have to work with them). Second, even formal EA principles cannot be very specific, as they are inherently generic. Because of these reasons, we have chosen in our research to experiment with *examples* of prescriptions (best practice 4).

An interesting aspect is that best practices for project conformance are not only found at the level of the project, but also at the EA level. Therefore, project conformance is not only the responsibility of *project members*. It is also

desirable that the *enterprise architects* themselves take action to assist projects to comply with EA. According to the best practices, active tuning between the two levels is advised, for example by providing feedback and involving enterprise architects in projects.

In this context it is interesting to consider tool support, as tools might assist in aligning the EA and project level. Enterprise architects could initially use the tool to create prescriptions, mark them (ir)relevant for projects, and store them in a central repository. Subsequently, projects could use the same tool to select the relevant prescriptions from this repository and tailor them to generate the PSA artifact. The tool could also be part of a larger integrated environment, facilitating more types of communication between EA and projects (e.g. news, FAQs, new templates, new example prescriptions).

3.5 Conclusion

We set out to identify best practices for performing business and systems analysis in projects that have to conform to EA. We presented seven observations and ten best practices based on CAR experimenting and focus group interviews. Not all best practices we found are guidelines for project members. Several of these are practices for enterprise architects, as they can play a role in stimulating project conformance and avoiding deviating project level interpretations of prescriptions. In other words, EA architects have an indirect but important role to play in business and systems analysis in projects conforming to EA. It would be too simplistic to consider it solely a responsibility for project members.

In terms of the four levels of best practices mentioned in section 3.1.2, the best practices we identified are at the second level, i.e. the *good practice* level. As we based our explorative research on an in-depth qualitative study of only one enterprise, some modesty is in order. Additional research should be done in other settings, where different and entirely new best practices might be found. Furthermore, we concur with Green (2001) that best practice research should not only be concerned with internal validity, but also with external validity, i.e. the extent to which the findings can be generalized to other settings and populations. We view our research results as being grounded hypotheses (i.e. based on empirical study) which require further research to test and refine them with other (perhaps more positivist) methods. Being practices at the *good practice* level, more research is also needed to validate them in alternative settings in real-life projects before they may possibly be promoted to the *local* and *industry best practice* levels. The validation of best practices will be picked up in chapter 7, whereas the promotion issue will be discussed in chapter 9.

Despite the above, the difference between the best practice levels – and their value in practical situations – should not be overestimated. In our opinion even the practices at the highest level, which have been tested in many different situations, cannot be adopted blindly by an organization, but should merely be seen as guidelines or behavioral patterns. We agree with Green (2001) that, when facing social and behavioral aspects, best practices are contingent upon the specific situation. Consequently, best practices will never be a "silver bullet". In our view, therefore, even industry best practices should always be checked for validity in a specific situation, and possibly be tailored to its idiosyncratic needs. This also means that the best practices presented here could already be applied in practice, although a more critical evaluation of their validity in the situation might be justified than for industry best practices.

Another recommendation for future research would be to study how applying the guidelines presented in this chapter affects project risks and costs. Finally, perhaps the most important next step will be to take these relatively independent best practices as a basis for a coherent model for projects conforming to EA. Such a model would have to take into explicit account both the EA level and the project level. This will be the topic of the next chapter.

Chapter 4

An Artifact Model for Projects Conforming to EA

This chapter presents a model for projects that have to adhere to Enterprise Architecture (EA) in order for their results to be aligned with the broader organization. The model features project artifacts (i.e. deliverables such as Software Architecture Documents), their mutual relationships, their relationship with EA, and the processes in which they are created and tested on conformance. We start with applying Activity Theory to show the crucial mediating role that artifacts have in projects and to identify and justify the new EA-related artifacts we introduce. We subsequently incorporate these findings and existing best practices in a standard systems development approach in order to create a practical model that projects can apply for EA conformance. This model features both new, dedicated EA artifacts, and well-known existing artifacts of which we describe the way they should conform to EA. Finally, two action research studies are used to empirically support the model.[1]

4.1 Introduction

Recent years have yielded a wide array of publications on Enterprise Architecture (EA). However, the topic of projects that have to apply and conform to the high-level constraints and solution guidelines provided by an EA has received little attention in this research area. Nonetheless, project conformance is a highly relevant topic, as EA aims to align projects (and the processes and systems they implement) with the broader organization. Various

1 This work has been published as: Foorthuis, R.M., Brinkkemper, S., Bos, R. (2008). *An Artifact Model for Projects Conforming to Enterprise Architecture*. In: Stirna, J., Persson, A. (Eds.). The Practice of Enterprise Modeling. Proceedings of PoEM 2008, IFIP WG 8.1 Working Conference, LNBIP 15, pp. 30-46. Berlin: Springer. www.springerlink.com

benefits are claimed as a result of EA (Bucher et al., 2006; The Open Group, 2003; Lankhorst et al., 2005; Pulkkinen and Hirvonen, 2005; Wagter et al., 2005). EA should enable local initiatives to contribute to the enterprise's core business objectives in an agile fashion, and facilitate the integration, deduplication and outsourcing of processes and systems. In addition to these benefits for the organization as a whole, EA is claimed to provide projects themselves with value in a number of ways (Bucher et al., 2006; Wagter et al., 2005; Capgemini, 2007; Pulkkinen, 2006). In this respect, EA is said to improve project success, to reduce project risk, duration and complexity, to speed up project initialization and to reduce their costs. Regardless of whether these claims are valid, the question of how local projects can conform to an overall architecture has recently been identified as an important research area (Kaisler et al., 2005; Bandara et al., 2007; Foorthuis and Brinkkemper, 2007).

In chapter 2 we identified key architectural project artifacts (i.e. deliverables or working products, such as the Software Architecture Document). In chapter 3 we identified best practices for this type of project, and presented them relatively independent from each other. A next step is to take these artifacts and practices to formulate a coherent model for deliverables in projects applying EA prescriptions. Therefore, the research question of this chapter is:

> *What artifacts are relevant for projects conforming to EA, how are they related to EA, and how are they created and tested on conformance?*

The goal of this research is twofold. First, our model of the EA-related artifacts, processes and roles provides organizations with a (semi-)structured approach to carry out projects conforming to higher level architectures. Second, by adopting an Activity Theory perspective in order to understand, identify and justify relevant new project artifacts, we learn more about the nature of projects conforming to EA.

The *projects* referred to in the remainder of this chapter are projects containing both a business (re)design component and an IT component. Central to this study is that they are specific, local projects that have to adhere to Enterprise Architecture. Therefore, we do not consider initiatives to implement e.g. enterprise-wide services to be projects here, since these may be seen as part of (or directly related to) the EA itself and are therefore located at another level. See section 4.2 for more information.

The chapter will proceed as follows. In section 4.2 we will briefly present a framework demonstrating our view on EA and projects. In section 4.3 we will apply Activity Theory to specify the role of project artifacts, understand projects conforming to EA, and thereby identify and justify important artifact types for this kind of project. In section 4.4 we present our artifact model. Section 4.5

describes our empirical research strategy and the results from this participative approach in a national statistical agency. Section 4.6 is for conclusions and further research.

4.2 Enterprise Architecture and Project Conformance

We define *Enterprise Architecture* as the high-level set of views and prescriptions that guide the coherent design and implementation of processes, organizational structures, information provision and technology within an organization or other socio-technical system (Foorthuis and Brinkkemper, 2008). The views typically provide insight into the context and meaning of a system, and its fundamental organization, its components and their interrelationships. As such, views can depict both the as-is and the to-be situation. *Prescriptions* can be principles, models or policy statements. They focus solely on the to-be situation and thus provide generic constraints and directions for both high-level, enterprise-wide endeavors and more detailed local initiatives. As such, they are the means by which the EA guides projects.

Figure 4.1, adapted from chapters 2 and 3, shows the conformance relationship between projects and Enterprise Architecture. The Project Architecture consists of two parts. The *Project Start Architecture* (PSA) is the collection of prescriptions from an EA that is relevant for the current project, and the early translation of these prescriptions to the specific situation (see also Wagter et al., 2005). As a result, the PSA specifies the project's direction and boundaries at the start of the project, and as such increases EA awareness amongst project members (Foorthuis and Brinkkemper, 2008). Consequently, the fundamental analysis and design artifacts that describe the specific solution that will be created in the project will have to be compliant with the prescriptions in the PSA. This collection of fundamental artifacts is called the *Project Exclusive Design* (PED). The PED can contain artifacts such as a (Business) Vision document, a Domain Model, architecturally significant Use Cases and a Software Architecture Document. The PSA and the artifacts of the PED will be incorporated in our model in section 4.4.

During or after the creation of the Project Architecture, the project members can provide the enterprise architects with feedback on the EA. With these comments on the prescriptions and views, the EA can be further refined.

Although governmental and commercial organizations have developed approaches for encouraging projects to conform to EA, not much academic research has been conducted on the topic (Foorthuis and Brinkkemper, 2008). Important lessons learned so far include: use a PSA for a first translation of EA prescriptions and to create architectural awareness; review artifacts on EA con-

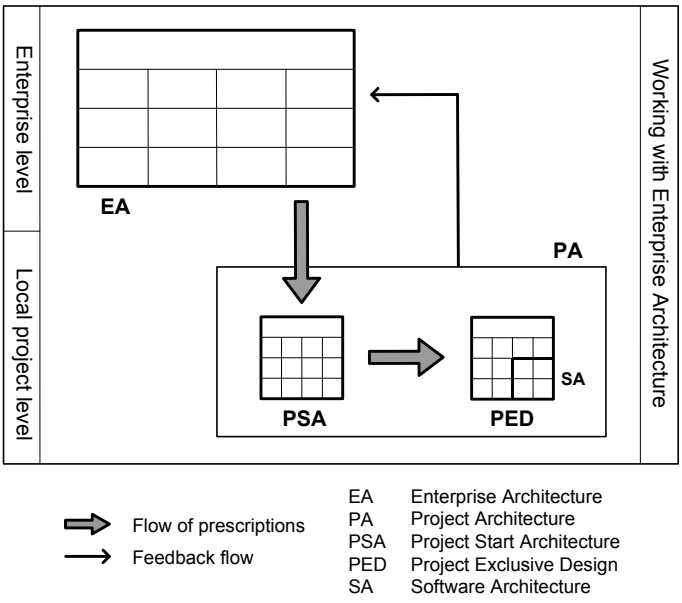


Figure 4.1. The Framework for Project and Enterprise Architecture (simplified)

formance; use artifact templates to stimulate EA conformance; use one PSA version for the business analysis phase and another for the IT development phase; involve EA architects in the project; provide feedback to the EA architects to refine the EA (The Open Group, 2003; Wagter et al., 2005; Foorthuis and Brinkkemper, 2008; Pulkkinen, 2006). We have incorporated this knowledge into our model in section 4.4.

4.3 Applying Activity Theory to Projects Conforming to EA

This section will discuss Activity Theory (AT) and apply it to projects conforming to EA. See Engeström (1987) for a general treatment of AT and Kuutti (1995), Bardram (1998) and Barthelmess and Anderson (2002) for an overview in the context of IS. AT is used in IS research mainly in the fields of Computer Supported Cooperative Work and Human-Computer Interaction. Activity Theory is relevant here for two reasons. First, it demonstrates the meaning and importance of artifacts in a project. This is relevant here, as they form the core element of our artifact model. Second, applying AT helps to identify and theoretically justify the new EA-related artifacts that we will incorporate in our model. Section 4.3.1 describes important elements of Activity Theory. Section 4.3.2 applies these elements to projects conforming to EA.

4.3.1 The Elements of Activity Theory

According to Merriam-Webster's Online Dictionary, an artifact is "something created by humans usually for a practical purpose." Consequently, an artifact can be almost anything, such as a surgical instrument, a chair, a book or even the knowledge in a book. This broad definition is also used in Activity Theory, a theoretical approach in which artifacts have a very important function in *mediating* human activities. Artifacts are seen as tools, rules or the way that labor is divided (Barthelmess and Anderson, 2002; Kuutti, 1991). According to Engeström (1987) and Kuutti (1995), artifacts mediate between the elements of activities: active *subjects* (actors), *objects* (that need to be transformed to the desired outcome) and the *community* (those who share the object). An artifact can mediate not only between a subject and other elements, but also helps both explicitly and implicitly in tuning the actors involved. Figure 4.2 shows the structure of an activity. A continuous line represents mediation between an activity's elements (which are represented by rectangles), whereas a broken line denotes the relation that is being mediated by artifacts (which are represented by ellipses).

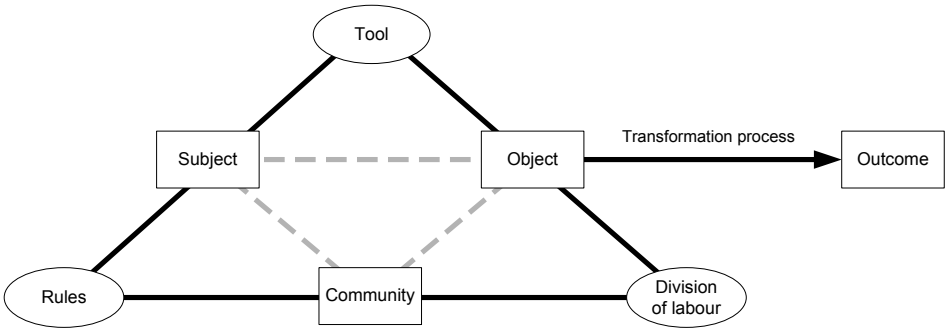


Figure 4.2. Mediation between elements of an activity (from Kuutti, 1995)

Over the years, the artifacts have often been adopted and developed in such a way that they can mediate activities within a community (Bardram, 1998). In a hospital, for example, a surgical instrument (tool) that is used within an operating room can be seen as a mediator between the surgeon (subject) and the patient being operated (object). This activity hopefully results in a cured patient (outcome). Kuutti (1995) describes the artifact as being both *enabling* (as it embeds the historically collected experience and skills) and *limiting* (as one specific tool does not allow all possible actions). In this example, the artifact is a physical tool. However, artifacts can also be seen as being less tangible, even cognitive in nature. For example, the heuristics, experiences, concepts, methods,

roles and also the language and signs used in carrying out a task. However, we will take an even narrower view of artifacts, as we focus on the deliverables or work products. Inspired by Rational (2003), we define an *artifact* as an intermediate work product that is produced and used during a project, and has the function to capture and convey project information. This can be both information about the desired outcome (specialist artifacts) and about the project itself (project management artifacts). Created during projects, artifacts are subject to version control.

In this chapter artifacts are either documents (e.g. Software Architecture Documents) or models (e.g. Use Case Models). We consider the artifacts that are central to our study mainly to be *tools* (because a document such as a Use Case is an analysis and communication tool used in understanding, building and documenting the desired IT system). However, they are also closely related to AT's *rules* (because creating and using artifacts is bound to the method's rules of the game) and *division of labor* (because an artifact is usually created by a specific project role).

An activity consists of several short-term processes called *actions* (Kuutti, 1995). Actions cannot be fully understood without taking into account the broader activity, as they are all instrumental in transforming its shared object into the intended outcome.

To understand the dynamics of activities, three *levels of a collaborative activity* are acknowledged in AT (Engeström et al., 1997; Bardram, 1998). Because of their hierarchical nature, we consider these levels to be valuable in analyzing the dynamics between the EA-level and the project-level. As such, they can assist in identifying and theoretically justifying crucial EA-related artifacts, which we will incorporate into our model. The lowest level of an activity is the *co-ordinated level* of work, capturing the routine and normal flow of interaction. The actors are individually following their roles, which are embodied in a *script* coordinating the actions. Such a script supplies working instructions, which are coded in explicit rules (e.g. plans, role descriptions) or in implicit, unwritten culture. The actors involved work in isolation, focusing solely on their own actions. The actors could be seen as passive participants instead of active subjects, as the script ensures that they are working in harmony with each other and their environment. It is followed strictly and is not being discussed. Bardram (1998) gives the example of a hospital kitchen only delivering the food on the basis of standard requests, not taking into account the motives of the involved healthcare professionals.

At the *co-operative level* of work, the actors focus on a *shared object* instead of each focusing blindly and passively on performing their predetermined individual roles. They actively try to find mutually acceptable ways to

conceptualize and solve the problem. This requires the actors to go beyond their scripts, balancing their own actions with the actions of others, possibly even influencing them. Although the script itself is not rewritten, it is insufficient in the current situation and active discussion is required to determine how to go beyond it. However, the object being worked on is stable and agreed upon, enabling the participants to relate to each other in the discussion and make corrective adjustments. In the hospital example, if the kitchen staff and the ward's healthcare professionals share the same motive and object (the patient who needs to be cured) we speak of co-operation. The activities of the kitchen would then be determined both by the request and the patient's status. Therefore, if the ward orders the normal dinner for a patient with heart disease, the kitchen staff – knowing the dinner is too fat – can contact the ward to discuss the diet and correct the request.

At the *co-constructive level*, the actors focus on fundamentally reconceptualizing the nature of the interaction between the collaborating participants, and of the organization in which they are situated. Co-construction has two important aspects. First, the actors need to reach an understanding of a *shared object* (i.e. it has to be collectively constructed). This implies a joint and accepted understanding of the problem situation, of its relevance and of the nature of the solution being worked on. Second, one or more *scripts* will be created or heavily revised. Co-construction is typically located at the level of the entire organization since it fundamentally reconceptualizes both the script and the shared object. Therefore, it is a process rarely taking place in the ongoing flow of daily work actions. In the example of Bardram (1998), the hospital can decide to implement the model of the "Patient Focused Hospital", moving from a model of patient treatment with relatively independent departments to a more holistic model organized around teams of healthcare professionals.

Upward transitions between the three levels are caused by *reflections* on the script or on the object (Bardram, 1998). These reflections can be triggered by a *breakdown* or a *deliberate shift in focus*. Engeström (1991) and Engeström et al. (1997) provide two mechanisms that are involved in breakdowns, namely *disturbances* (unintentional deviations in the observable flow of interaction, resulting from an obstacle, difficulty, failure or conflict) and *ruptures* (blocks or gaps in the flow of information between participants and the shared understanding). The reflection can culminate in one or more solutions, causing a downward transition from one level to another that establishes the resolution at the lower level. For example, installing an updated procedure that now takes exceptions into account.

4.3.2 Applying Activity Theory to Projects

This first part of this section will demonstrate that AT can be meaningfully applied to projects conforming to EA. This shows the important mediating function of artifacts, and as such the relevance of our artifact model in section 4.4. The second part will use the levels of section 4.3.1 to identify and justify new EA-related project artifacts.

We consider a business (re)design and IT project that conforms to EA to be a collaborative activity involving both project members and enterprise architects. Figure 4.3 shows the activity triangle applied to projects. The *subjects* are the project members. In AT this may be an individual, but also a collective (Barthelmess and Anderson, 2002; Kuutti, 1991). In a project this will depend on whether an artifact is created by one or by more project members. The *object* is the solution that is being worked on (e.g. programming code), and the *outcome* consists of the implemented business processes and information systems.

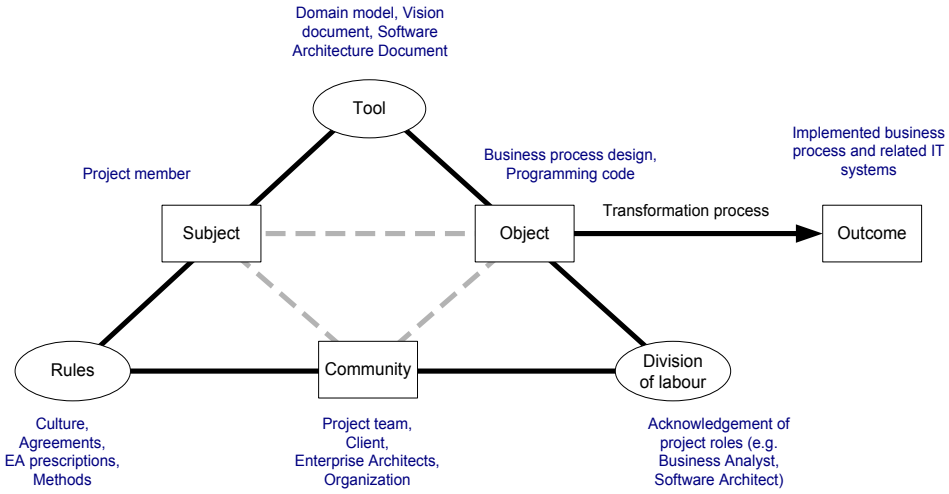


Figure 4.3. The structure of an activity applied to projects conforming to EA

Examples of *tools* are not only the applied modeling tools, programming languages, editors and compilers (Barthelmess and Anderson, 2002), but also the artifacts that are central in this chapter (deliverables such as Vision and Software Architecture Documents). Examples of *rules* are systems development methods and formal and informal agreements with project members. Moreover,

the Enterprise Architecture is an important provider of rules (i.e. prescriptions). Examples of the *division of labor* are the roles that individuals play, such as the system analyst, software architect and project manager.

The project here is an *activity* consisting of several *actions*. For example, an action may be the process of creating a Use Case artifact. Such an action cannot be fully understood without the frame of reference of the overall activity and its object and motive (Kuutti, 1995) – creating and delivering a business process and information system.

To fully understand an artifact such as the Software Architecture Document, it should be seen in the context of time in several ways. First, the concept (and template) of this document has been developed over years, eventually using the 4+1 view model of architecture (Kruchten, 2003). Second, the artifact itself (or rather, an instantiation of it) is created each time in the course of a project, in several versions. Such a dynamic artifact is different from a stable artifact that does not change during the activity, such as a surgical instrument.

Although we emphasize a limited view on artifacts here (viz. documents and models), we still acknowledge the crucial mediating role they have in projects. This holds at different mediation levels. First, mediation occurs *between the project and the environment*. Considering the immediate environment, requirement artifacts like Vision documents and Use Cases can be used to create a shared understanding among the client, future end users and enterprise architects. Furthermore, the more distant colleagues in the organization and even entire industry contribute knowledge such as artifact templates, best practices, text books and white papers. They do not share the immediate object, but they do share an abstraction of it. Second, artifacts help mediate *between the actions of project members*. Inside the project, individual project members partly communicate by the artifacts they create and share. A project manager communicates what needs to be done in what project phase by his project plan. A system analyst communicates to the software architect what the high-level requirements for the system are by his Vision document. Third, artifacts also help mediate *the actions of an individual project member*. An artifact's template not only provides structure for the artifact itself, but it also identifies and structures the actions that need to be carried out by its creator. For example, a Vision document contains a Product Position Statement and a features section. These imply two distinct analytical actions for the system analyst to perform, albeit that the results of these actions should be consistent. Furthermore, a template can contain advice for the author, guiding his or her actions.

Below, we will apply the three levels of a collaborative activity to projects conforming to EA in order to identify important areas for EA-related mediation and, as a consequence, for artifacts. In the context of EA, *co-construction*

typically implies creating or updating the Enterprise Architecture and its architectural prescriptions. Co-construction is therefore located at the level of the EA, where (an abstraction of) the object is being reconceptualized. In the case of this study's statistical agency (see section 4.5) it may be the statistical product (publication) that needs to be created, or the information system that generates this statistical product. In addition to the reconceptualization of the object, one or more written scripts are being created in the form of enterprise-wide high-level design choices and constraints (prescriptions) regarding this object. This can take the form of models or architectural principles such as "Software will be developed in conformance to the organization's programming standards" and "If feasible, statistical products will be created using existing register data instead of self-developed surveys". Consistent with AT, creating an EA is a reflective activity rarely taking place in the ongoing flow of daily project actions. Therefore, to be able to communicate the prescriptions to projects, the EA needs to be captured in one or more artifacts (which we will call the Full EA Documentation in the next section).

Co-operation means actively discussing the script in relation to the shared object, and going beyond the script without fundamentally questioning or reconceptualizing it (Engeström et al., 1997). From the perspective of this study, this is the level where project members and enterprise architects meet. In order for project members to correctly apply the EA, they may need to consult the enterprise architects and discuss the prescriptions' meaning, relevance and application in the project context. This may therefore result in an artifact in which the enterprise architects can capture their advice (we will call this the EA Consultancy Report). Even if discussions with enterprise architects are not deemed necessary, project members may well be faced with prescriptions that impact the project so profoundly that they need to be actively discussed inside the project (e.g. the principle prescribing that a statistical product should be created using register data). Having such a fundamental impact, relevant EA prescriptions should be discussed at the beginning of the project, and their initial, intended application and tailoring should be recorded. The resulting set of prescriptions (we will call this the Project Start Architecture) will then function as boundary-setting and direction-providing for the remainder of the project. More discussions are likely to occur when these prescriptions are actually being applied during the project's remaining phases. It is necessary to inform the enterprise architects about the project members' experience with these prescriptions-in-action (we will call this the EA Feedback Report). The feedback can be used to update the EA. Or, to put it in terms of AT, this allows for the activity system to reconstruct itself (Engeström, 1991) and may trigger a transition to co-construction. In short, the co-operative discussions lead to communication both up to the enterprise architects and down to the project members.

Co-ordination only takes place at the project-level, as enterprise architects are not actively involved at this level. In fact, there is no discussion at all, as project members perform their EA-compliant actions in isolation. The project is able to adhere to architectural prescriptions by individually applying them. Therefore, discussing the script in relation to the shared object is not necessary, neither with the enterprise architects nor with fellow project members. An example at this level is adherence to the architectural principle "Software will be developed in conformance to the organization's programming standards." One such standard might be to apply the UpperCamelCasing naming convention to variable names. It is not difficult to see that project-wide and even organization-wide compliance is possible by individual developers independently following the script – in this case the principle and the standards it refers to. Although enterprise architects are not actively involved in performing EA-compliant actions at the co-ordinated level, they can get indirectly involved. As a script is *prescriptive* and therefore implies conformance, the extent to which the project complies with EA prescriptions will have to be checked and communicated (resulting in what we will call the EA Conformance Report). Note that testing on EA conformance is not only relevant for co-ordination, but also for co-operation, as both levels apply EA prescriptions.

There are several mechanisms that can trigger the transition to a higher level. A *breakdown* can occur because of a poorly formulated EA prescription (a rupture) or a non-effective EA prescription (a disturbance). An example of a *deliberate shift in focus* is an idea for a new, improved or extended prescription, originating in a project and communicated via the EA Feedback Report. Enterprise architects have to know if any such transition occurs – yet another indication of how important the EA Feedback Report mentioned above is.

A co-constructive effort might seem removed from the actual task itself (in this case carrying out a project). However, as Bardram (1998) points out, it is essential to view it as a part of the same activity because it helps to improve performing the task. This is especially apparent at the co-operated level, which implies that EA architects should be actively involved in projects, providing advice and also testing on EA conformance. Furthermore, note that our application of the three levels describes the collaborative activity of *carrying out projects conforming to EA*, not the activity of *creating the EA* (there would be some overlap, but in the latter case the focus of the lowest levels would shift from the project members to the enterprise architects).

Concluding this section we observe that Activity Theory demonstrates the crucial role of artifacts in mediating between processes and helps in identifying and justifying the relevant artifacts for projects conforming to Enterprise Architecture.

4.4 The Artifact Model

Based on the findings of the previous section, we will present the model for projects conforming to EA here. This model features EA-related artifacts used in or created by projects, the relationships of these artifacts with EA, and the actions in which they are created and tested on conformance.

We will use the Rational Unified Process (RUP) as a base model to extend. RUP is a software engineering process that provides a disciplined approach to assigning tasks and responsibilities in software development, featuring e.g. business modeling, requirements elicitation and technical systems design (Kruchten, 2003; Rational, 2003). We will use RUP for several reasons. First, RUP is the *de facto* standard for software engineering (Ambler et al., 2005). Consequently, we can take for granted the existing RUP artifacts, and only need to justify the new EA-related artifacts. Second, being a "unified" approach, it features artifacts and techniques also present in other approaches (such as the Vision document, Use Cases and UML). This makes our model relevant for other software engineering approaches as well. Third, RUP is also used in the organization in which we did our empirical research, making it possible to experiment with it.

The model is presented visually in Figure 4.4. In order to present an orderly and understandable diagram, we have included only the fundamental analysis and design artifacts (as contained in the Project Architecture of section 4.2) and an occasional project management artifact. See also chapter 2 for the artifacts in the Project Architecture. See tables 4.1 and 4.2 for a description of the artifacts.

In terms of Activity Theory, the diagram shows the *(sub-)actions* and the *artifacts* used and generated therein. The *subjects* and *division of labor* are also present in the form of the roles that perform the *(sub-)actions*. In terms of the *community*, the diagram features not only the actions of project members, but also those of the project's environment. These external actions and roles are printed in bold text. The flow of time is implicitly included by reading from left to right, but it should be noted that the length or surface area of the actions is not necessarily indicative of the relative duration or amount of work.

The interaction between actions – and therefore between actors – is specified in terms of artifacts, explicitly representing their mediating function at two of the mediation levels of section 4.3.2. First, *between the project and the environment*: PSA templates, actual PSAs, EA Consultancy Reports and EA Conformance Reports are used to align the project with the EA and other projects. Also, EA Feedback Reports are used for input to update the EA with knowledge from real-life situations. Finally, several existing RUP artifacts are used here. Second, the mediation *between the actions of project members* is represented: the (Business) PSA communicates to which prescriptions the indivi-

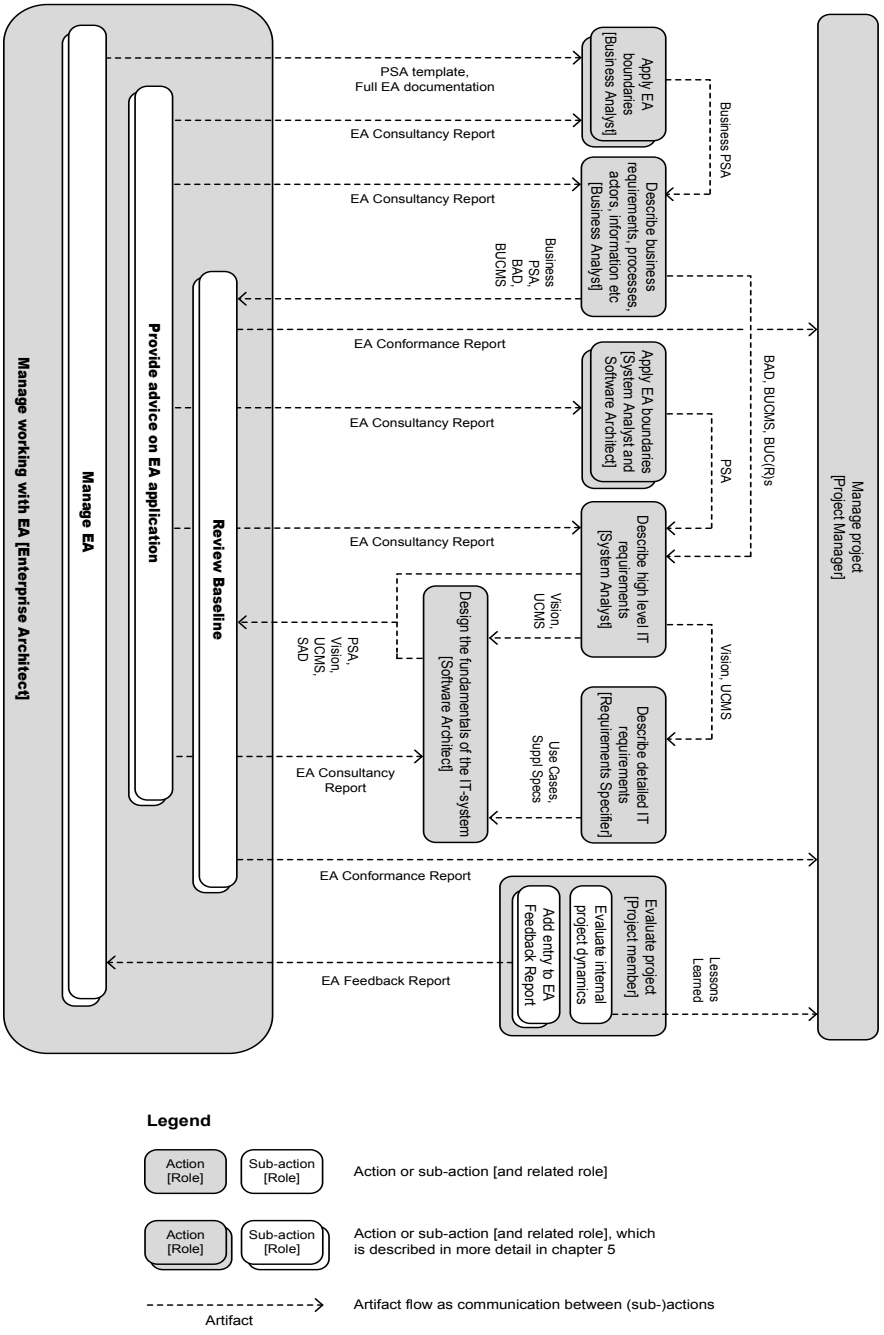


Figure 4.4. The artifact model: artifacts and the actions that create and use them in projects

dual project members and their artifacts should adhere. Other artifacts describe e.g. requirements. The third level, *actions of an individual project member*, can be found in chapter 5.

The artifacts created by projects are described in more detail below. Existing RUP artifacts are defined according to Kruchten (2003) and Rational (2003). For these existing, well-known project artifacts the table features a "Relation to EA" section, specifying in what way they will have to conform to EA. Artifacts that are new and exclusive to working with EA are displayed underlined.

Business PSA: The collection of business prescriptions from the EA that is relevant for the specific project, and their initial translation to the project situation. This artifact specifies the boundaries for the business analysis phase of the project, and can be seen as a preliminary version of the PSA artifact (see below). Can also contain a sketch of the intended situation.
PSA: The collection of business and IT prescriptions from the EA that is relevant for the specific project, and their initial translation to the project situation. This artifact specifies the boundaries for both the business and the IT phases of the project. The PSA includes the Business PSA.
BAD: The Business Analysis Document contains the Business Vision document and the Business Architecture Document. The Business Vision describes the business goals and requirements of the project. The Business Architecture Document describes the fundamental aspects of the business from a number of perspectives (e.g. key business processes, organizational structure, delivered products and services, business domain and market). *Relation to EA*: The Business Vision should explicitly state that the future business setting will be consistent with the EA. This can be done in the *Constraints* and *Applicable Standards* sections.
BUCMS: The Business Use Case Model Survey is a model of the business goals and intended functions that identify roles and business deliverables in the production situation. *Relation to EA*: This artifact is well-suited to specify the utilization of the enterprise-wide services delivered (or defined) by the EA, using secondary actors representing these EA services.
BUC(R): A Business Use Case (BUC) is a description of a business process from an external (e.g. customer), value-added point of view. A Business Use Case Realization (BUCR) can be used to describe the business process from an inside (e.g. business worker) perspective. *Relation to EA*: The content should be consistent with PSA (and therefore EA) prescriptions. The way in which EA business services will be used should be (non-technically) described in detail.
Vision: The Vision document is a description of the high-level requirements of the IT system. It captures the essence of the product in terms of needs, features and design constraints. *Relation to EA*: The Vision should explicitly state that the IT system will be consistent with the EA. This can be done, for example, in the *Applicable Standards* and *Assumptions and Dependencies* sections. Also, the role of the Enterprise Architect should be included in the *Stakeholders* section. Finally, the features, which describe the system, should be consistent with the EA.
UCMS: The Use Case Model Survey provides a model of the system's intended functions and its environment. Contains all Use Cases that describe the system and the actors that interact with it. *Relation to EA*: This artifact is well-suited to specify the utilization of the enterprise-wide IT services delivered (or defined) by the EA, using secondary actors representing these EA services.

Use Case: Use Cases describe the detailed functionality of the IT system as tasks that can be carried out with the system. This takes the form of a sequence of actions that the system performs, yielding an observable result of value to the actor initiating the Use Case. *Relation to EA*: The content should be consistent with the EA and PSA. The way in which EA IT services will be used should be (non-technically) described in detail.
Suppl Specs: The Supplementary Specifications artifact describes the requirements of the IT system that can not be easily captured in one specific Use Case. *Relation to EA*: The content should be consistent with PSA (and therefore EA) prescriptions.
SAD: The Software Architecture Document provides a comprehensive architectural overview of the system, describing several software-architectural views, such as the *deployment view*. *Relation to EA*: The content should be consistent with the EA and PSA. The way that the EA's IT services will be used should be technically described.
Lessons Learned: This artifact collects and explicitly states improved practices for future projects (excluding feedback regarding the EA).
EA Feedback Report: This artifact, which does not need to be a lengthy report, provides feedback to the Enterprise Architect about applying the architectural principles, and, for example, using enterprise-wide services delivered by the EA. Any project member who has to adhere to EA while carrying out actions can add entries to this report. The feedback can result in EA prescriptions and views being changed, added, removed, grouped or stated more clearly in the EA.

Table 4.1. The artifacts created by the project

The table below describes the artifacts delivered by the Enterprise Architect.

PSA template: The template that assists the authors in creating the Business PSA and the PSA.
Full EA documentation: The full and official artifacts, which describe the EA in detail.
EA Conformance Report: A report created by the Enterprise Architect in which an artifact baseline of the project is judged against the EA per prescription. (A *baseline* is a set of artifacts which the project pretends is complete and accorded by its immediate stakeholders.) The report can be formal or informal and contains a final judgment and suggested actions for the project.
EA Consultancy Report: A report created by the Enterprise Architect in which the project is given tailor-made advice on the application of EA prescriptions. May or may not be on request.

Table 4.2. The artifacts created by the Enterprise Architect role

Several remarks should be made. First, the Enterprise Architect supplies the PSA template and Full EA documentation only to the Business Analyst. However, this does not imply that other project members do not have access to this material, as we assume the Business Analyst will distribute it. Second, it is important to understand that in a real-life project an artifact can be a formal, elegantly written document, but that it can also be a simple e-mail. Moreover, in some cases a written or drawn artifact may not be the only or most effective

way of communication. For example, a face-to-face dialogue may sometimes be a better way to communicate advice than an EA Consultancy Report. However, it is often still advisable to also create a physical artifact, as it persists what has been said and may prevent unnecessary discussion afterwards.

Third, in our model we differentiate between the EA itself (the Full EA documentation) and the artifacts based on it. A generic PSA template could be created, however, already containing the EA prescriptions that are relevant for projects (see also chapter 3). This is interesting, as it blurs the distinction between EA and project template. However, as an EA also comprises prescriptions that are not relevant for projects, we still see the EA as a separate entity.

4.5 Empirical Support

In Action Research (AR) the researcher participates in a real-world situation to help solve an immediate problem situation while carefully informing theory (Baskerville, 1999). To ensure maximum relevance and scientific rigor, we followed the formalized Canonical Action Research (CAR) approach and applied its five principles, as described in Davison et al. (2004). Participating in a project allowed us not only to discover best practices, but also to experiment with them. The CAR was carried out in Statistics Netherlands (SN), the Dutch government agency responsible for producing and publishing undisputed, consistent and relevant statistical information. Late 2006, the EA had been officially approved by SN's top management. None of the authors was actively involved in creating the Enterprise Architecture. See chapter 3 for more information about SN and its EA. The principal researcher participated in two business process redesign projects with an IS component: the CPI (consumer price index) and the Energy statistics. The CPI calculates the average price change of consumer goods and services purchased by Dutch households, and as such influences salaries, pensions and rent levels. The Energy statistics provide information about physical energy flows in relation to energy commodities (e.g. oil and electricity) and energy producers and consumers. In both projects, the principal researcher participated as a business and system analyst. In these projects the business processes, statistical methods and supporting IT systems were being redesigned. Research data were collected by keeping a daily research diary, recording audio and/or taking minutes of discussions and analyzing documents (e.g. EA artifacts and presentations).

During the research we adhered to the five principles of CAR (Davison et al., 2004): the Researcher-Client Agreement, the Principle of Theory, the Cyclical Process Model (see below), Change through Action and Learning through Reflection. As artifacts are central to this chapter and we have already described the

application of these five principles in our projects in chapter 3, we shall focus here on how the cyclical process model was applied to create project artifacts. The cyclical process model is used in CAR in order to ensure systematic rigor.

As artifacts are central in our study and SN needed a practical approach for creating them when conforming to EA, the action in our CAR consisted of creating several project artifacts. The research therefore featured a large number of small cycles, as every project artifact required several versions. Below, we will describe the five stages of the cyclical process model (Baskerville, 1999; Davison et al., 2004) and the way we applied them.

- *Diagnosing*: Diagnosing refers to the definition of the organization and its problems by the researcher, which directly informs the planning of actions. Therefore, this action is not only performed at the start of the research project, but also as a regular part of each subsequent cycle. In our study, the participating researcher started with an orientation phase, in which the EA was assessed independently. Each CAR project also had an orientation phase in which the domains and its problems were explored by reading documents and interviewing key people. In each subsequent stage the current state of the project was analyzed in order to be able to determine what (aspects of the) artifacts had the highest priority.
- *Action Planning*: In action planning, the actions that should solve or improve the problems are specified using a theoretical framework. At the start of our study this was the framework as described in chapter 2. In later cycles the (preliminary version of the) artifact model was used for planning. Two main actions that required planning were creating a new version of a specific artifact and a review session to discuss it.
- *Action Taking*: The researcher and practitioners work together to intervene in the organization, causing change in the setting. In the case of our study, action taking meant analyzing input information (such as statistical methodology documents), interviewing stakeholders and writing or visually modeling the artifact. Finally, the artifact had to be distributed to the relevant stakeholders. In the creation process, it was sometimes necessary to (re)define artifacts when no relevant predefined artifacts existed in Statistics Netherlands. For example, neither the PSA nor a specific format (template) for a business analysis artifact existed.
- *Evaluating*: After the action is taken, the researchers and practitioners evaluate the outcome. In our study, therefore, after a new version of an artifact was created it was reviewed by project members, future users or other stakeholders. If all involved agreed that the artifact was finished, it was approved. If not, the shortcomings were captured in the review history, and another cycle would be required.

- *Reflecting*: Specifying learning is usually an ongoing process, as it was in our study. Interesting findings were recorded in the daily research diary and, if needed, changes were made to the current artifact model. Also, an artifact model was tailored specifically for SN (e.g. including statistical method artifacts) and interesting findings were collected in a document to share with the practitioners.

In addition to the projects, the participating researcher was involved in several sessions that Statistics Netherlands organized in order to invent a way in which projects conforming to EA can be carried out. The sessions included enterprise architects, business analysts, system analysts and information managers. As a result, the researcher created a preliminary version of the artifact model for SN, which was discussed and after several iterations included in the official documentation. The model presented in this chapter evolved from the model in this documentation, based on the subsequent experiences in the AR projects.

Therefore, it is not the case that Activity Theory and the best practices of chapter 3 were the input for the model of section 4.4, and that the empirical research has the function of testing it. Rather, in the research these three elements were all input for the model simultaneously. In other words, the model resulted from the CAR, instead of being tested by it. Testing the model is therefore a suggestion for further research. The table below presents an overview of the artifacts created in the Energy project.

Artifact	#Instances	#Cycles (#Versions)	Format	Assisted by Enterpr Architect	Reviewed by Enterpr Architect	(Co-) written by researcher	Roles
PID	1	2 (3)	Document				Proj Man
Bus PSA	1	1 (3)	Document			✓	Business Analyst
BAD	1	6 (10)	Document		✓	✓	
LIM	1	6 (18)	Document		✓	✓	
Stat Method	1	4 (10)	Document				*Statistician*
PSA	1	2 (6)	Document		✓	✓	Syst Anal Softw Arch
Vision	1	3 (9)	Document				Syst Anal
UCMS	1	4 (9)	Document			✓	
Key UCs	3	UC06: 2 (4) UC07: 3 (8) UC12: 1 (5)	Document				Req Spec
SAD	1	1 (18)	Document	✓	✓		Softw Arch
EA Feedbk	1	1 (1)	E-mail		✓	✓	All
EA Conformance Rep	1	1 (1)	E-mail	n.a.	n.a.		Enterpr Architect

Table 4.3. Creation of project artifacts for the Energy project

The number of cycles is operationalized by the number of review sessions related to a unique artifact version (e.g. two review sessions discussing the same version of an artifact counts as one cycle). The number of instances of "Key UCs" is the number of architecturally significant Use Cases identified in the Use Case View section of the SAD. The CPI project was very similar, the main difference being that the researcher also created a Vision document and a key Use Case.

Experimenting with the artifacts in real-life projects also provided us with the knowledge of how to make their contents consistent with the organization's EA. This knowledge was input for the "Relation to EA" sections in the tables of section 4.4.

As the table's *italics* show, the statistical project featured artifacts not present in the artifact model of figure 4.4: the Statistical Method document and the LIM (Logical Information Model describing statistical datasets). This indicates that our artifact model should be seen as heuristic by nature: it provides guidance, but the model should be checked for validity and possibly be tailored to the specific organization or project situation. One can especially wonder if all of the artifacts in the model are mandatory. In our opinion artifacts should be delivered only if relevant to the situation. This can also be seen from table 4.3, as the Energy project did not produce any Business Use Cases.

The table also shows that an enterprise architect was involved in creating the Software Architecture Document, but no architect actively assisted in creating the business-oriented artifacts. This was due to the fact that the decision to involve enterprise architects more closely in projects was taken by SN's management at a moment that the business analysis phase of the Energy project had already been completed. More recent projects, depending on their importance, also had an enterprise architect attached to them that was specialized in the business aspects of the EA.

4.6 Conclusion

Focusing on the real-life application of Enterprise Architecture, this chapter features several contributions. First, we have demonstrated that Activity Theory can be usefully applied to projects conforming to EA. This allows us to learn more about the nature and structure of this type of project in relation to EA, and the role of artifacts therein. Second, AT's levels of a collaborative activity have helped us to identify and justify the artifact types that are relevant for projects conforming to EA. Third, this theoretical knowledge has been used to create a model for projects conforming to EA. This model – also based on RUP, best practices identified earlier and empirical action research – provides a practical

approach for carrying out projects conforming to EA, and for testing projects on conformance by enterprise architects. Finally, we presented how each individual deliverable in this model, both new and existing, should conform to Enterprise Architecture.

Further research might focus on testing the artifact model in similar and different settings. Furthermore, we have used RUP for our specific model, but, as the dedicated EA artifacts we have introduced are generic in nature, it would also be valuable to incorporate them in other systems development approaches. As we focus on artifacts, this would especially be interesting for 'document-light' agile methods, such as Extreme Programming and Lean Software Development.

As a final remark, we have focused on the artifacts that play a major role in carrying out projects conforming to EA. As a consequence, however, several aspects of carrying out projects have received little or no attention in this study. For example, leadership styles and risk analysis – see e.g. Box and Platt (2005) and Project Management Institute (2004) – which are important aspects in their own right but might also prove relevant for projects conforming to Enterprise Architecture. Where relevant to compliance these aspects will be included in the analysis of chapter 8.

Chapter 5

A Process Model for Project Members Conforming to EA

This chapter presents a model for individual project members that carry out projects conforming to Enterprise Architecture. The work is strongly related to chapters 4 and 6. Chapter 4 presents a high-level model for projects conforming to Enterprise Architecture. This artifact model focuses on creating the artifacts (deliverables or work products such as a Software Architecture Document) at two levels, viz. the project and the environment, and the interaction between project members inside the project. The process model of the current chapter focuses instead on a more detailed level, viz. the actions of an individual project member. Chapter 6 presents an approach to test projects and their project artifacts on compliance with Enterprise Architecture. As chapter 6 does not contain a detailed description of specific artifacts, this will be presented in the current chapter.[1]

5.1 Introduction

This chapter presents a model for individual project members that carry out projects conforming to Enterprise Architecture. It details the models presented in chapters 4 and 6. More precisely, chapter 4 presents a high-level model for projects conforming to Enterprise Architecture. This artifact model focuses on creating the artifacts (deliverables or work products such as a Software Architecture Document) at two levels, viz. the project and the environment, and the interaction between project members inside the project. The process model of the current chapter focuses instead on a more detailed level, viz. the actions of an individual project member. Chapter 6 presents an approach for testing

1 This work has been published as: Foorthuis, R.M., Brinkkemper, S., Hofman, F. (2008). *A Process Model for Project Members Conforming to Enterprise Architecture*. Technical Report UU-CS-2008-023, Utrecht University, ISSN 0924-3275.

projects and their project artifacts on conformance to Enterprise Architecture. As chapter 6 does not contain a detailed description of the specific artifacts which comprise the baseline, this will be presented in the current chapter. Note that this chapter cannot be fully understood without knowledge of chapter 4.

This chapter focuses on the role of project artifacts at the level of the actions of individual project members. An *artifact* is an intermediate work product that is produced and used during a project, and has the function to capture and convey project information (Foorthuis et al., 2008; Rational, 2003). In other words, artifacts are deliverables or work products such as a Software Architecture Document, a Business Analysis Document or a Use Case. Artifacts mediate between project members, and between the project and its environment by communicating through artifacts both explicitly (by its literal text) and implicitly (as boundary objects) (Foorthuis et al., 2008; Bertelsen, 2000; Star and Griesemer, 1989). However, the actions of an individual project member or role can also be mediated by an artifact, or rather by its template. A template not only breaks the artifact down in its constituent parts (which imply actions), but can also contain instructions and advice for the author. This guidance is also provided by the approach to which a particular artifact belongs (e.g. UP or RUP). Creating the artifacts by individual project members is central to this chapter's model.

5.2 The Process Model

In chapter 4 a high-level artifact model for projects conforming to EA was presented. This model features various artifacts and activities that are dedicated to EA (and project conformance to EA in particular). The following subsections will describe the processes (or actions) that create and use these artifacts at a more detailed level. To this end, the notation of the Process-Deliverable Diagram presented in Weerd and Brinkkemper (2008) will be used. This type of diagram is a combination of a UML class diagram and an activity diagram, extended with symbols to indicate abstraction levels.

The process model described in this section is not a single diagram, but rather a set of diagrams. Each diagram describes an EA-related process or action identified in chapter 4. The "Review Baseline" action is also described in more detail in chapter 6. The processes described are:

- Apply EA boundaries
- Provide advice on EA application
- Perform project action conforming to EA
- Add entry to EA Feedback Report
- Review Baseline
- Manage EA

The diagram below, which is a variation of the artifact model presented in chapter 4, shows these processes (rounded rectangles) and the interfacing project artifacts (rectangles). Dotted arrows represent artifact flows. The remainder of section 5.2 will describe each of the processes in more detail.

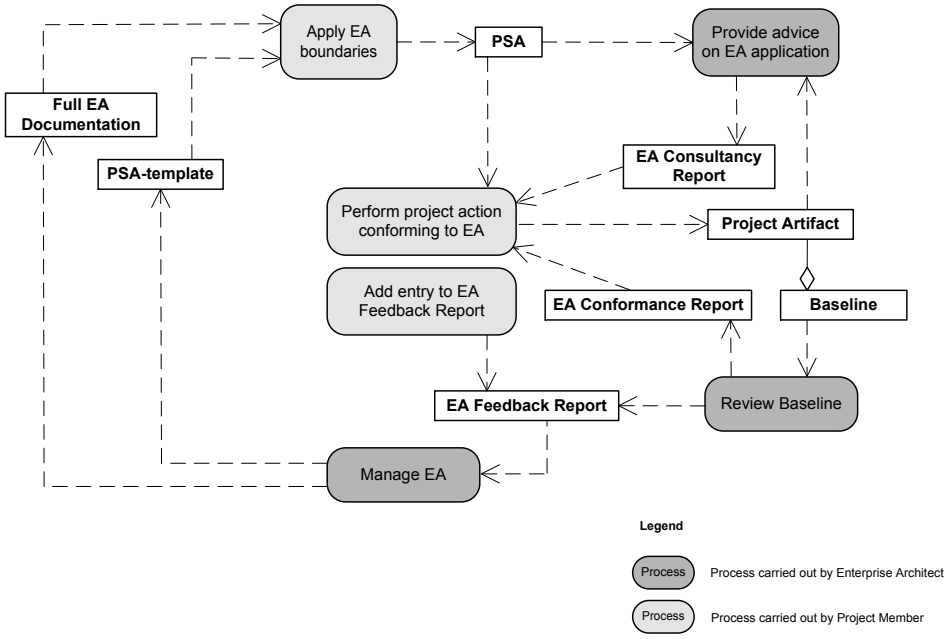


Figure 5.1. Overview of processes and artifacts in working with EA

5.2.1 Apply EA boundaries

The *Apply EA boundaries* action identifies EA prescriptions (constraints or solution guidelines) relevant to the project and, if possible, translates them to the specific project situation. During a project, this action is carried out two times. At the beginning of the business analysis phase, this results in the Business PSA artifact. At the beginning of the IT phase, this results in the PSA artifact, which specifies both the business and the IT prescriptions. The Project Member performing this action is the Business Analyst for the Business PSA version, and the System Analyst and Software Architect for the IT section of the regular PSA. Preferably, an Enterprise Architect assists in creating the PSA, as this would guarantee interpreting the EA prescriptions correctly.

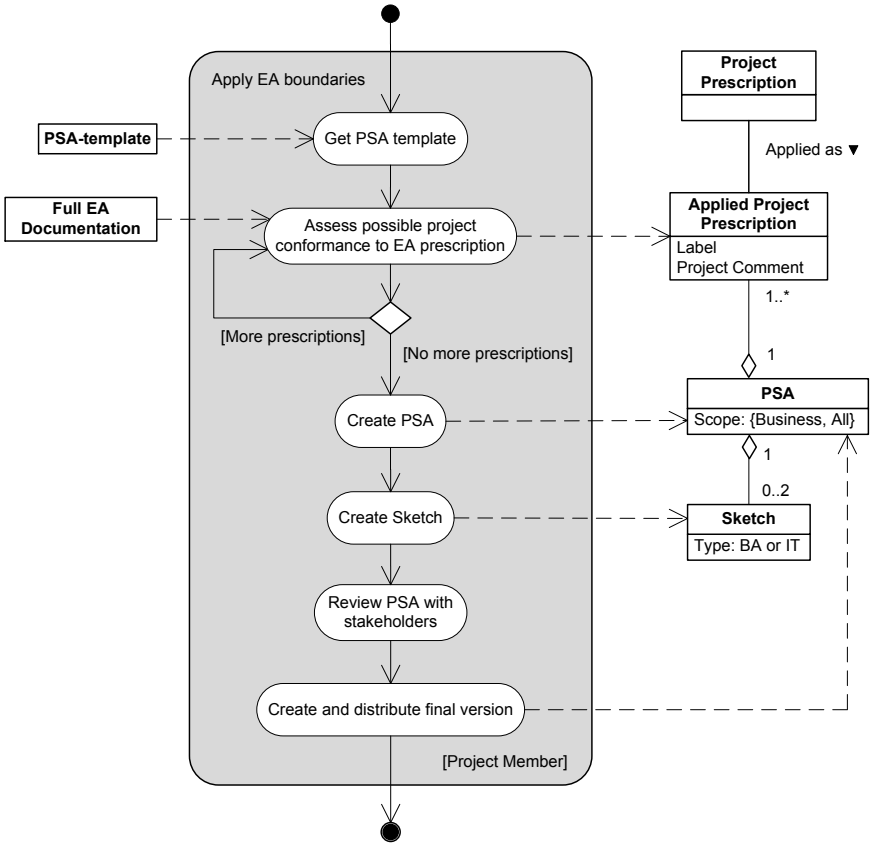


Figure 5.2. The Apply EA boundaries action

Apply EA boundaries	
Get PSA template	The Project Member obtains the PSA template. This template can already include the EA prescriptions (boundaries or constraints) that are relevant for projects. However, they still need to be tuned to the current project.
Assess possible project conformance to EA prescription	The Project Member picks a prescription in order to assess whether the project is expected to be able to conform to it. In this context, the prescription can be given a label. For example, “APL” if it is considered directly applicable, or “ALT” if it needs to be altered to project circumstances. See chapter 2 for the full set of labels. In addition to the label, the Project Member adds a comment indicating how the project expects to comply with the prescription. The result is an Applied Project Prescription, although this concerns merely the first step of a Prescription’s application. At a later stage, Prescriptions will be applied in Project Artifacts, such as the

	Software Architecture Document. See 5.2.3 for more on this. Prescriptions can be applied in Project Artifacts explicitly (citing and/or referencing prescriptions) or implicitly (being consistent with prescriptions without explicitly citing or referencing them).
Create PSA	After all the prescriptions have been assessed, the PSA can be created. Its Type indicates whether it concerns the Business PSA or the entire PSA (which also includes IT prescriptions).
Create Sketch	Optionally, a Sketch can be created, giving a preliminary vision of the envisioned business situation or a first high-level overview of the system's functional and technical requirements. This Sketch can be used to communicate fundamental ideas in an early stage with stakeholders, including the Enterprise Architect. As the Business PSA and the PSA are created early in the Business Analysis phase and IT-phase respectively, it might not be possible to create a useful Sketch at this time if the project is complex. Therefore, a Sketch can be included in the PSA or it can be distributed as a separate artifact.
Review PSA with stakeholders	The (Business) PSA needs to be reviewed with stakeholders. This has several functions. First, the Project Member can check and communicate whether he or she has understood the business and the Enterprise Architecture. Second, reviewing the (Business) PSA creates architectural awareness amongst the people inside and outside the project. Reviewing and updating the artifact may take several iterations. In order to keep the diagram simple, however, we have abstracted from this.
Create and distribute final version	The Project Member creates the final version of the (Business) PSA and distributes it to the relevant stakeholders.

5.2.2 Provide advice on EA application

The *Provide advice on EA application* action features several steps for an Enterprise Architect to take when giving advice to a project conforming to EA. The initiative for this action can come from the project or from the Enterprise Architect. This action results in an EA Consultancy Report. Although a review can result in this type of report, this is not a review or assessment action (this action type is described in section 5.2.5).

Provide advice on EA application	
Study project situation	The Enterprise Architect studies the project situation, using Project Artifacts (if present) and possibly face-to-face interviews or workshops. The Project Artifact can also be a PSA here.
Formulate advice for project	The Enterprise Architect writes down his advice in an Advice Comment, using the Full EA Documentation as a reference.

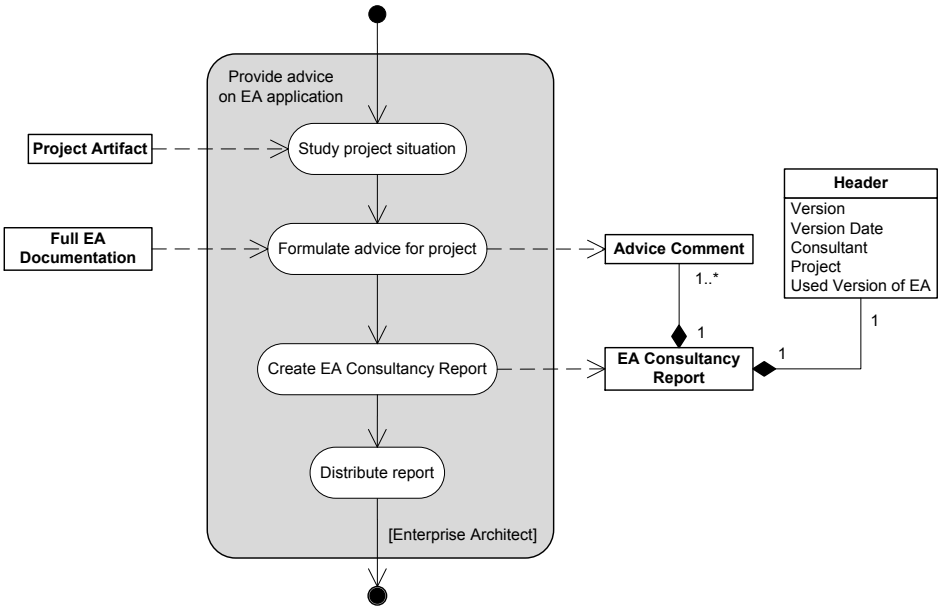


Figure 5.3. The Provide advice on EA application action

Provide advice on EA application	
Create EA Consultancy Report	The Enterprise Architect creates the final EA Consultancy Report, including its meta information in the Header.
Distribute report	The Enterprise Architect distributes the EA Consultancy Report to the relevant stakeholders.

5.2.3 Perform project action conforming to EA

Perform project action conforming to EA represents a generic process for carrying out a project action that needs to be consistent with the prescriptions of the EA.

Perform project action conforming to EA	
Analyze relevant EA prescription(s)	The Project Member studies the relevant prescription(s) in the PSA in order to know in what way he or she is constrained when performing his planned action.

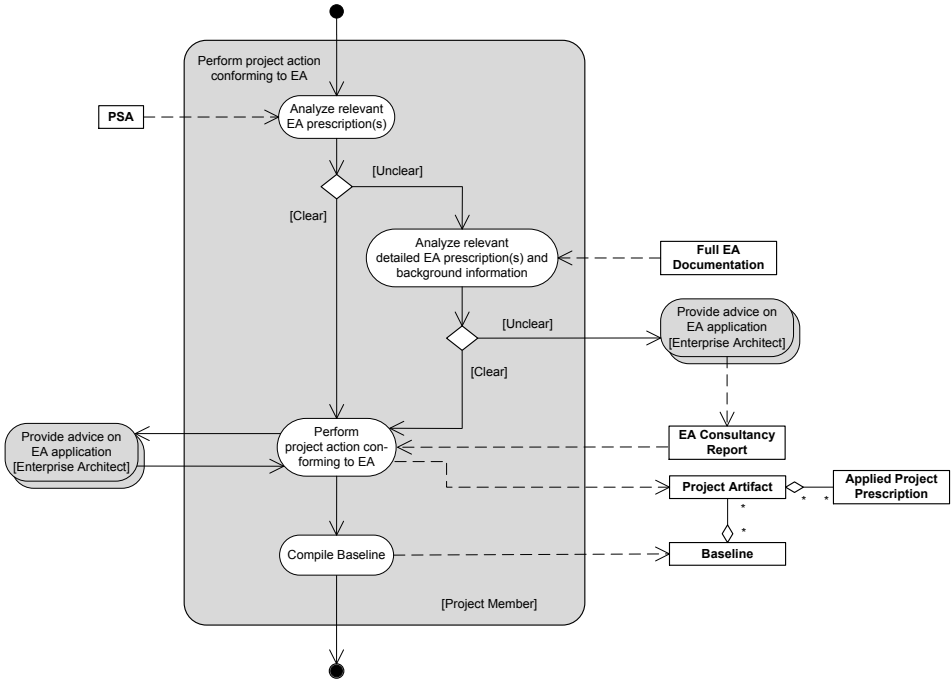


Figure 5.4. Perform project action conforming to EA

Perform project action conforming to EA	
Analyze relevant detailed EA prescription(s) and background information	If the PSA does not provide sufficient information about how to apply the prescriptions to the project situation, the Full EA Documentation might be consulted. This documentation is expected to contain more background information and comments than the PSA does.
Provide advice on EA application	If the Full EA Documentation also does not provide the required information, an Enterprise Architect can be consulted. Formally, this action is not part of the *Perform project action conforming to EA* action, but it is included here to provide context. This action is described in more detail in section 5.2.2. It results in an EA Consultancy Report, the advice of which can be used to perform the project action. Note that this report can also be a simple e-mail.
Perform project action conforming to EA	The Project Member performs the action (e.g. designing a business process), resulting in one or more Project Artifacts conforming to EA. During this action, relevant experiences can be entered into the EA Feedback Report (see 5.2.4).

5.2.4 Add entry to EA Feedback Report

The *Add entry to EA Feedback Report* action evaluates the applicability of the Enterprise Architecture from a project perspective. The action can be carried out by any project member that is constrained by architectural prescriptions.

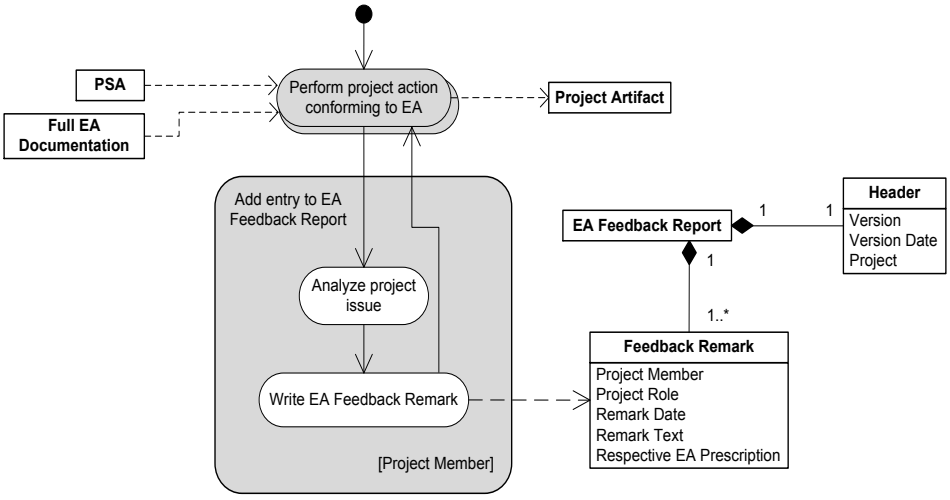


Figure 5.5. The Add entry to EA Feedback Report action

Add entry to EA Feedback Report	
Perform project action conforming to EA	The Project Member carries out his action while trying to adhere to architectural prescriptions (included in the PSA and EA documentation). Formally, this action is not part of the *Add entry to EA Feedback Report* action, but it is included here to provide context. This action is described in more detail in section 5.2.3. The *Add entry to EA Feedback Report* action can also be initiated from the *Apply EA boundaries* action described in section 5.2.1, as this too applies EA prescriptions.
Analyze project issue	If the Project Member experiences an issue in applying the architectural prescription, he or she analyzes it. An issue need not be negative per se, it can also be positive feedback.
Write Feedback Remark	The Project Member adds a Feedback Remark – including its meta information – to the EA Feedback Report.

5.2.5 Review Baseline

The *Review Baseline* action formally reviews project artifacts on EA compliance, resulting in an EA Conformance Report. This action description could in principle also be applied to an informal review, but note that it could then have any project artifact as its input and would result in an EA Consultancy Report. For reasons of visual clarity, the diagram does not show the multiplicity of the relationship between Baselines and Project Artifacts, such as the Software Architecture Document (SAD). (The multiplicity being: one (version of an) artifact can belong to multiple Baseline versions, and one Baseline version can comprise multiple artifacts). This action – and its four compliance checks – is described in more detail in chapter 6.

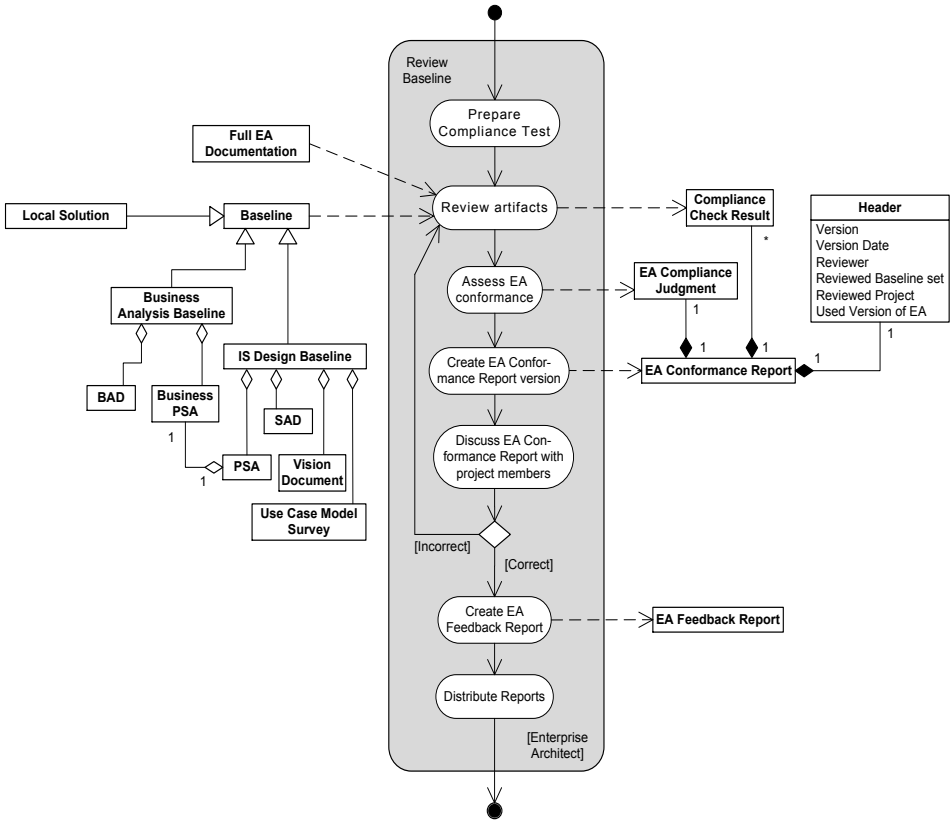


Figure 5.6. The Review Baseline action

Review Baseline	
Prepare Compliance Test	The Enterprise Architect prepares the Compliance Test for use in the specific situation. This includes collecting the Baseline and obtaining the most recent versions of the Prescriptions present in the Enterprise Architecture documentation. In addition, the involved stakeholders should agree on a time planning. See chapter 6 for more on compliance assessments.
Review artifacts	The Enterprise Architect reviews the Project Artifacts from the Baseline. Reviewing the artifacts implies using Compliance Checks for assessing the EA Prescriptions that have been implicitly or explicitly applied in the Baseline's project artifacts. The four types of Compliance Checks are the *Correctness Check*, the *Justification Check*, the *Consistency Check* and the *Completeness Check*. Applying them yields Compliance Check Results that (possibly only in the case of non-compliance) will be included in the EA Conformance Report. See chapter 6 for more information on the Compliance Checks.
Assess EA conformance	After reviewing the Project Artifacts, the Enterprise Architect passes an EA Compliance Judgment regarding the degree to which the project complies with the EA.
Create EA Conformance Report version	The Enterprise Architect creates a version of the EA Conformance Report, including its meta information in the Header.
Discuss EA Conformance Report with project members	The Enterprise Architect discusses the draft version of the EA Conformance Report with the authors of the assessed Baseline. The goal of this step is twofold. First, to clarify the report, if needed. Second, to avoid Compliance Check Results (i.e. review comments) and an EA Compliance Judgment that are invalid due to an incorrect understanding of the Baseline and its knowledge domain. If changes in the EA Conformance Report are required, the Enterprise Architect returns to the "Review artifacts" step.
Create EA Feedback Report	During the review process and the discussions with the project members, the Enterprise Architect may discover weak aspects of the EA. These can be stated in an EA Feedback Report.
Distribute Reports	The Enterprise Architect distributes the EA Conformance Report to the relevant stakeholders. The EA Feedback Report is sent to the lead Enterprise Architect.

5.2.6 Manage EA

The *Manage EA* action creates and revises the Enterprise Architecture and related artifacts, resulting in the Full EA Documentation and the PSA template. These artifacts are distributed to projects conforming to EA. The feedback that these projects send to the Enterprise Architect as a result of applying EA prescriptions can be used to update the enterprise architecture and PSA template.

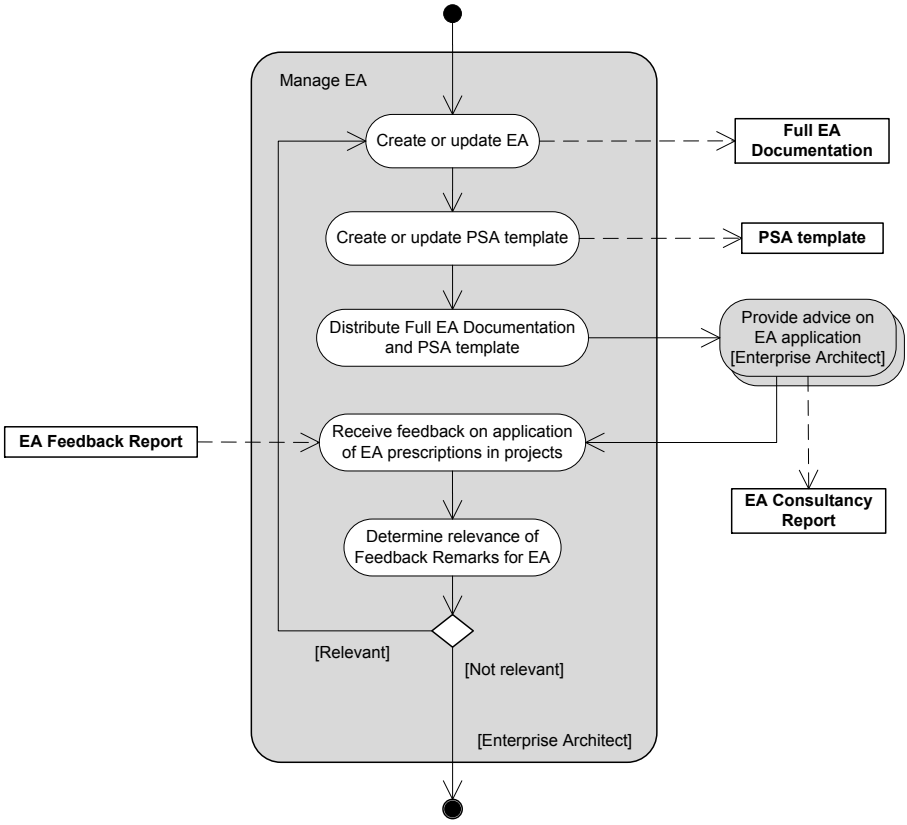


Figure 5.7. The Manage EA action

Manage EA	
Create or update EA	The Enterprise Architect creates the EA (if non-existent) or updates the EA (if relevant Feedback Remarks are received).
Create or update PSA template	The Enterprise Architect creates or updates the PSA template if the new EA demands so.
Distribute Full EA Documentation and PSA template	The Full EA Documentation and PSA template are distributed to projects that need to conform to EA.
Provide advice on EA application	The Enterprise Architect provides projects with advice on how to apply the EA prescriptions. Formally, this action is not part of the *Manage EA* action, but it should be regarded as a nested action and is also included here to show the relationship between these actions.

Receive feedback on application of EA prescriptions in projects	As projects carry out their actions conforming to EA, they collect their evaluation remarks in an EA Feedback Report. This report is sent to the Enterprise Architect.
Determine relevance of Feedback Remarks for EA	The Enterprise Architect then determines whether one or more Feedback Remarks are relevant for the current version of the EA. If so, the Full EA Documentation and/or the PSA template are revised.

Chapter 6

Compliance Assessments of Projects Adhering to EA

This chapter focuses on how to assess projects, which implement business processes and IT systems, on compliance with an Enterprise Architecture (EA) that provides them with constraints and high-level solutions. We start out with presenting the core elements of EA compliance testing. Next, we discuss the testing process and four types of compliance checks (correctness check, justification check, consistency check and completeness check). Finally, an empirical case is reported in which a real-life project has been tested on conformance, demonstrating and evaluating our approach. The results indicate that objective compliance testing cannot be taken for granted. Therefore, several suggestions are presented to decrease the subjectivity of assessments, such as operationalization of EA prescriptions.[1]

6.1 Introduction

When studying the literature, Enterprise Architecture (EA) can be said to have two major ideal type functions. One function is to provide decision-makers with a clear and comprehensive *descriptive overview* of the organization, or relevant aspects thereof. Such insights into the enterprise form the basis for making high-level management decisions (cf. Johnson et al., 2004; Riempp and Gieffers-Ankel, 2007; Gammelgård et al., 2007), determining e.g. which programs or projects to initiate. This reflective function of EA targets mainly managers as its users. The EA can be expected to demonstrate a heavy focus on depicting the

1 This work has been published as: Foorthuis, R.M., Hofman, F., Brinkkemper, S., Bos, R. (2012). *Compliance Assessments of Projects Adhering to Enterprise Architecture*. Journal of Database Management, Vol. 23, No. 2, pp. 44-71.

(problematic) as-is situation. A second ideal type function of EA is to provide a *prescriptive framework* that guides and constraints subsequent development of business and IT solutions (cf. Kaisler et al., 2005; Boh and Yellin, 2007; Op 't Land and Proper, 2007; Bommel et al., 2007; Foorthuis et al., 2008b; Hoogervorst and Dietz, 2008; Meschke and Baumoel, 2010). This normative approach, focusing strongly on the to-be situation, should ensure that both enterprise-level and local initiatives within the organization are consistent with the overall strategy, and enable a coherent and integrated development of business, information and IT. This directive function of EA targets not only managers as its users, but also business analysts, system analysts, software architects and other roles in projects (re)designing the business and its IT support. In this chapter, we focus mainly on this latter function, a prescriptive EA providing constraints and high-level solutions to which business and IT systems – and in particular the projects implementing them – should conform. Prescriptive EAs prove to be common in practice. One example is the Enterprise Architecture of a manufacturing company, which uses principles, policies and models to ensure that business and IT initiatives are consistent with the business strategy (Bruls et al., 2010). Another example is a national statistical institute's architecture, consisting of principles and models to which projects much adhere in order to save costs and increase the quality of statistical products (Foorthuis and Brinkkemper, 2008a).

An EA's norms or prescriptions are often applied in projects. Although EA typically focuses on the entire enterprise and compliance is indeed demanded at this level, in practice it is unrealistic for an entire organization to become EA-compliant at short notice. It can therefore be expected that conformance will be achieved incrementally at the local level, step by step – or rather, project by project (cf. Ross et al., 2006). However, philosophers have acknowledged for hundreds of years that, although compliance with 'contracts' might be better for the group as a whole and it might also be in an individual actor's best interest to agree to contracts, it may not be in his interest to actually comply with them. In contractarian ethics this is one of the issues of the so-called *compliance problem* (cf. Gauthier, 1991; Hartman, 1996). Because of this potential conflict of interest, it should be tested whether actors actually conform to the contract. If we consider a specific project to be the actor, then an EA could be seen as the contract that needs to be complied with. In other words, although conformance is required for obtaining EA benefits, it cannot be expected to occur automatically (Boh and Yellin, 2007). This is especially relevant here as compliance with EA norms may be in the best interest of the organization as a whole, but not optimal per se to the local projects and departments that actually have to comply. Assessments should therefore be carried out at the level at which EA is applied, viz. the project level. Testing at this level also allows for

correcting non-compliant aspects, at least if it is performed while EA is being applied. Assessing projects on conformance is crucial, as a large survey study (n=293) has shown not only that project compliance with EA is positively associated with various strategic benefits, but also that the most important determinant of conformance is in fact conducting compliance assessments of projects (Foorthuis et al., 2010).

Emmerich et al. (1999) define compliance in the context of IT projects as "the extent to which software developers have acted in accordance with the 'practices' set down in the standard." Kim (2007) defines compliance in this context as "an accordance of corporate IT systems with predefined policies, procedures, standards, guidelines, specifications, or legislation." In the context of EA we define *compliance* as corporate business and IT systems being in accordance with predefined Enterprise Architecture prescriptions. We will use the terms "compliance" and "conformance" interchangeably. Likewise, "assessing compliance" and "testing on conformance" are considered equivalent. A "project" in this study refers to the regular projects that need to comply with Enterprise Architecture, which, by and large, have a localized scope (e.g. delivering a new business process and related IT applications for a department). In this chapter, we aim to answer the following research question:

> *How can projects, and the business and IT solutions they deliver, be assessed on compliance with a prescriptive EA?*

To address this research question, we will divide it into several sub-questions:

1. *What concepts play a key role in assessing compliance with EA?*
2. *By what process can EA compliance testing be carried out?*
3. *What kind of compliance checks can be utilized in the EA compliance test process, and what are their respective evaluation criteria?*

The underlying goal of our research is to identify and explore core aspects of testing projects on EA compliance. It is our intention to stimulate additional research into the topic. A second, more practical goal is that the results should provide organizations with a working model that can be used to develop their approach for testing their change initiatives on EA conformance.

This chapter will proceed as follows. In the next section, related topics and work are discussed. Following that, we position our study in the context of EA and describe the research approach. The subsequent sections aim to find answers to the respective sub-questions and present our empirical case. The final section is for discussion and conclusions.

6.2 Related Topics and Work

Although we did not find any academic work dedicated to assessing compliance with EA at the time of our research, the topic can nonetheless be linked to other work. In particular, EA conformance testing is related to the fields of *compliance management, software testing* and *auditing*. In terms of compliance management, several areas relevant to our discussion can be acknowledged.

First, due to *legislation*, organizations are required to comply with regulations that have consequences for their business processes and information systems. Non-compliance here may even have penal consequences for an organization's management (El Kharbili et al., 2008). In Europe, important drivers are Directive 95/46/EC, i.e. the Data Protection Directive, and Directive 2002/58/EC, i.e. the Privacy and Electronic Communications Directive (Massacci et al., 2005; Nouwt, 2008). Examples of laws in the United States which demand compliance are the Sarbanes-Oxley Act, the Gramm-Leach-Bliley Act and the Health Insurance Portability and Accountability Act (Kim, 2007; Lankhorst, 2005; zur Muehlen et al., 2007). The Basel Accords, featuring regulations for capital adequacy of the banking sector, form an example of a global regulatory framework (Barr and Miller, 2006).

A second area in compliance management is consistency with international and industry-wide *standards* for processes and products, such as ISO 9001 for quality management and IEC 61508 for safety. There are several reasons for conforming to such best practices, for example clients or strategic partners demanding certification for assurance reasons, and using best practices to improve the organization's processes and products. Conformance to standards is especially important in large and critical systems engineering projects in e.g. the defense, aerospace and telecommunications sectors. See Emmerich et al. (1999), Pfleeger et al. (1994) and Chung et al. (2008) for more about compliance with standards. We will employ some of the concepts in these publications in our own research.

A third relevant area is *security and risk management*, which aims to protect the organization's assets, such as valuable information. Compliance here has an important role to play in preventing both deliberate and unintentional harm to the organization, e.g. by imposing access restrictions. See for example Solms (2005), Drew (2007) and Vroom and Solms (2004) for more on this topic.

All three areas are relevant to our discussion, as an EA can feature constraints and high-level solutions based on any of the above. Needless to say, they are not mutually exclusive. For example, security and risk management are principal concerns of the Basel framework and of international standards such as ISO/IEC 27000.

Assessing projects and their products on compliance with EA can also be related to *software testing*. Several core elements can be distinguished in this discipline (Baresi and Pezzè, 2006; Binder, 2000). First, *test items* refer to the items that need to be tested, e.g. a document or a version of an application. Secondly, the *features* are the specified properties that the test item is required to possess. Thirdly, *acceptance criteria* are needed to decide whether the software is ready for successful usage in the business setting. This is relevant because features are not sufficient for testing, as not every feature is equally important and features may be only partially implemented. Finally, a *test approach* is needed to define the testing techniques to be used in determining whether the test item possesses the features to an acceptable degree. In this chapter we will translate these software testing concepts to the domain of EA conformance testing.

Finally, it is interesting to mention the similarities between the compliance test discussed here and an audit. According to IEEE (1990), an *audit* is "an independent examination of a work product or set of work products to assess compliance with specifications, standards, contractual agreements, or other criteria." Similar to software testing, an audit has several elements (IFAC, 2003), such as the *subject matter* (a work product) that is evaluated against the *criteria* (benchmarks), leading to an *assurance report* (containing a conclusion on whether the subject matter conforms to the criteria). If the goal of an audit is to assess compliance of designs with an Enterprise Architecture, then an audit and the EA assessment discussed in this chapter should be very similar. However, if an audit is to assess whether a business unit does in practice what is intended, then an audit may be a compliance assessment after *run-time* (also taking into account actual execution traces such as process logs). This differs from this chapter's assessment of a project, which is conducted in *design-time* (taking into account artifacts that describe designs of processes and systems) and as such offers preventative potential (Sadiq et al., 2007). Another difference is the fact that the approach described in this chapter is specialized for EA compliance testing. This results not only in several EA-specific concepts being used, but also recognizes the strategic and abstract nature of EA.

6.3 Positioning the Research

Figure 6.1 depicts the different levels involved in working with EA and the relationships between the processes at these levels. The output of each level is input for the lower level. A rounded rectangle represents a process, whereas a square rectangle represents the input and output of a process. In addition, a continuous line denotes the process flow, a dashed line an information or product flow.

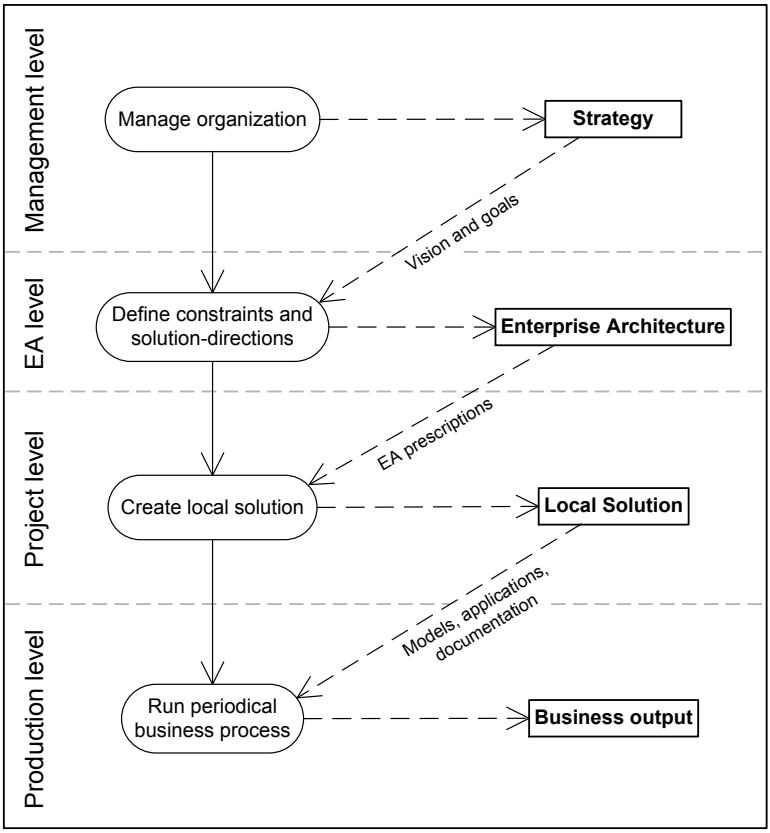


Figure 6.1. High-level overview of the processes related to working with EA

The diagram should not be regarded as modeling one single process, but rather as identifying four distinct processes, each at a different level. The model explicitly shows that the output of each process is input for the level below. Feedback can certainly flow from lower to higher levels, but in order to focus on the essence we have abstracted from that in this diagram. The output of each of the processes will be described in more detail in section 6.5.

This chapter focuses on testing whether the Local Solution does indeed conform to EA. In other words, on assessing whether the project has correctly applied the EA prescriptions in creating the solution. We will therefore focus primarily on the project level, as we expect a Strategy and Enterprise Architecture to be given, and the production process generating Business Output can only be run after the Local Solution has been delivered and adjudged compliant with EA.

As a final remark, please note that, in addition to an EA, an organization can also have one or more Domain Architectures. We will not discuss this here, however, since we consider assessing compliance with Domain Architectures to be very similar to EA compliance testing.

6.4 Research Approach

We adopt a *design science* approach for this study, as methods for assessing projects on compliance with EA is a relevant topic that has not yet received much attention. Design science seeks to create innovative artifacts with the underlying goal to make the analysis, design, implementation, management, and use of information systems more effective and efficient (Hevner et al., 2004).

A distinction can be made between several types of research outputs or artifacts (March and Smith, 1995; Hevner et al., 2004). First, *constructs* form the formal or informal vocabulary or language of a discipline. An example are the rules for creating a class diagram. Secondly, a *model* is a set of propositions expressing relationships among constructs, representing for example problem and solution statements. A *method* is a series of steps used to perform a task in order to obtain a certain result. A method is based on underlying constructs and models, for example because the steps take parts of a model as input. It can take the form of algorithms or guidelines. An example is a systems development method. An *instantiation* demonstrates the feasibility and effectiveness of the models and methods they contain, and thereby provides the empirical part of the study.

In order to answer sub-question 1, we will present in the next section a model describing the key concepts in EA compliance testing. In answering sub-questions 2 and 3, we will subsequently present as a method a series of steps and compliance checks that allow a tester to assess the degree of compliance. This method is the design science artifact that is evaluated and demonstrated in this chapter. This is done by instantiating (putting to practice in a real-life situation) the steps and checks, and by providing relevant statistical metrics.

6.5 Fundamental Concepts in EA Compliance Testing

This section presents an overview of the core elements of EA compliance testing, represented in the EA Compliance Model of Figure 6.2 as a UML class diagram. The bold-outlined classes are the four output products of Figure 6.1. The double-lined class (the Compliance Check) will be described in more detail in section 6.7. The triple-lined class (the Baseline) is described in more detail in section 5.2.5. Since the model will function as the basis for the remainder of our

chapter, its contents will, where relevant, be supported by literature. We have used the model of Emmerich et al. (1997, 1999) as inspiration since it aims at testing on compliance with standards. It also takes as input documents (similar to our project artifacts). Furthermore, it subdivides the model in various parts (similar to the four high-level concepts or gray areas in Figure 6.2). A difference is that Emmerich et al. focus on automated compliance checking (whereas we perform manual checks) and on the field of software development (whereas we focus on the broader and more strategic field of EA).

Four high-level concepts can be acknowledged in compliance testing, represented by the gray areas. These are inspired by the aforementioned core elements of software testing and auditing. First, analogous to software testing there is an *assessment item*, which needs to be tested. This is the set of project artifacts, in which the EA prescriptions should have been applied. An artifact here is a deliverable or intermediate work product, such as a software architecture document (note that this is different from the design science artifact evaluated here). Secondly, a set of *compliance norms* functioning as an evaluation frame is required. These are the EA's prescriptions, possibly complemented with local acceptance criteria. Thirdly, an approach or compliance test will be used to establish (non-)compliance of the items. This comprises several types of compliance checks. Finally, the *EA-compliant business* represents the desired result. We will discuss the model in more detail below. The individual classes of Figure 6.2 will be directly referred to using Capitalized Names, while properties will be referenced with *Italic Capitalized Names*.

An enterprise's Strategy will provide the input for the Enterprise Architecture, as an EA is a governance instrument intended to facilitate the translation from corporate strategy to daily operations (Jonkers et al., 2006). The resulting EA consists of Views and Prescriptions (Foorthuis et al., 2008b). A View typically provides insight into the context and meaning of a system (e.g. an entire enterprise, an IT system or a business service), and its fundamental organization, components and their relationships. As such, a View can depict both the as-is and the to-be situation. It can be utilized as a cognitive aid, in the form of an overview (e.g. a context model), a frame of reference (e.g. a structuring mechanism for analysis purposes), or a shared vocabulary (for communication purposes). A Prescription, focusing solely on the to-be situation, has an explicit guiding function and is required to take the form of a Principle (textual statement), Model (visual diagram) or Policy Statement (exposition containing text and possibly diagrams). These types of Prescriptions explicitly provide constraints or directions and are therefore more directly related to compliance than a View. An example of a Prescription is the principle "Data suitable for re-use shall be identified and stored in enterprise-wide data stores."

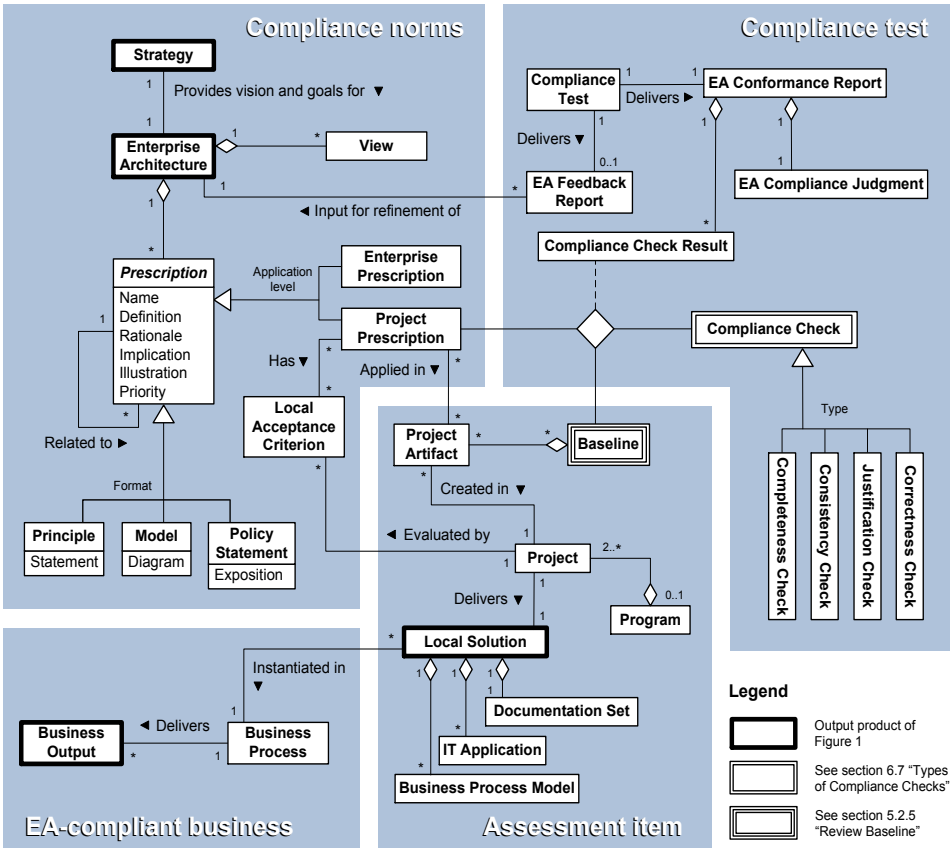


Figure 6.2. The EA Compliance Model

A Prescription is a relatively stable fundamental norm or guideline that has to be complied with. Since the Prescription is the central element in the model, it is presented along with its properties. These properties will be used in section 6.7 to identify and define types of checks. They are based in part on the template for describing principles, as defined by Richardson et al. (1990) and The Open Group (2009). The first property is the *Name*, which should succinctly and identifiably refer to the essence of the Prescription. Secondly, the explicit *Definition* is the compliance requirement, presented as clearly as

possible in the form of a Statement, Diagram or Exposition.[2] A third important property is the *Rationale*, providing the reasons behind the Prescription and thereby elaborating on the business benefits achieved by adhering to it. It should make clear why and when the prescription can be effective, and could as such motivate compliance (Emmerich et al., 1999). Fourthly, the *Implication* describes the (potential) impact and consequences of applying the Prescription in terms of costs, resources and activities. This is input for a cost-benefit analysis when deciding whether or not to apply it and can provide information on how to apply it in practice. The fifth property, the *Illustration*, is valuable because examples can clarify Prescriptions that are inherently ambiguous as a result of their generic nature (Foorthuis and Brinkkemper, 2008a). Finally, the *Priority* indicates the importance of the prescription, stating whether it is mandatory or merely recommended.

A Prescription can be related to other Prescriptions. For example, prescriptions can be ordered *hierarchically* (which is relevant if the EA framework features abstraction levels). The *counterpart prescriptions* described in chapter 3 are another example, in which business Prescriptions with IT implications have closely related counterpart IT prescriptions, and vice versa. As such, they are a mechanism for improving business/IT alignment. In addition, a Prescription can be an Enterprise Prescription or a Project Prescription. The first provides generic constraints (boundaries) and directions (high-level solutions) for an entire enterprise. Prescriptions applied at this level can as such guide the outlining of the enterprise's policy or direct the development and evolution of enterprise-wide services. A Project Prescription, provides generic constraints and directions for localized Projects (or rather, their products). Projects and compliance testing may also need to take into account Local Acceptance Criteria. The reason for this is that the specific situation to be assessed might call for ad hoc variations, e.g. exempting the project from certain EA prescriptions in the case of urgency.

Project Prescriptions are applied by Projects in their Project Artifacts, i.e. deliverables such as software architecture documents. A Baseline collects several Project Artifacts that are reviewed and agreed on by their immediate stakeholders and which form the basis for further development (IEEE, 1990). Through their explicit or implicit application in Project Artifacts, Project Prescriptions can guide the development and evolution of local initiatives by providing constraints and directions which the Projects implementing the solutions should adhere to. A Project, which may be part of a larger program,

2 For reading purposes, we used overriding of a property here (i.e. Definition), which is unusual in OO.

delivers a Local Solution. This consists of a newly designed Business Process Model, a newly developed IT Application and a Documentation Set (i.e. manuals and the final Baseline). Generating Business Output means instantiating the Local Solution in a Business Process, which involves planning and running a real-life instantiation of the process and IT application delivered by the project. First, however, compliance with EA needs to be assessed.

Key elements in performing the Compliance Test are Compliance Checks, norms (i.e. the EA prescriptions and Local Acceptance Criteria functioning as an evaluation frame) and a resulting EA Conformance Report (cf. Emmerich et al., 1999; Baresi and Pezzè, 2006; Chung et al., 2008; Foorthuis et al., 2008b; Farenhorst and De Boer, 2009). A Baseline provides an ideal opportunity for this compliance assessment, as it describes the agreed-upon basis for the remainder of the project and still allows for intervention in case of non-compliance. As the ternary association class shows, the Compliance Check Result is the product of the EA's Project Prescriptions, the Project's Baseline to be tested and the types of Compliance Checks. In other words, given a specific Baseline to be tested, several compliance checks are performed for each Prescription, resulting in a number of Compliance Check Results. See Table 6.1 in section 6.8 for an example of such test results for a given Baseline. Each individual (non-conformant) Compliance Check Result will be an entry in the EA Conformance Report. Four types of Compliance Checks will be identified in section 6.7. The EA Conformance Report also contains a final EA Compliance Judgment, which is the test conclusion stating whether or not the assessed item (i.e. Baseline) complies or not. Finally, the Compliance Test may yield an EA Feedback Report, which provides valuable information to the enterprise architects for updating the EA.

6.6 The Process of Compliance Testing

In this section we will describe the process of compliance testing (i.e. the design science artifact of this study). We will start by presenting several requirements for such a process. A first requirement is the separation of duties (i.e. checks and balances). An actor testing himself on compliance cannot be expected to always produce true and objective results (Solms, 2005). An EA compliance assessment or audit should therefore be performed by other individuals and preferably other organizational units rather than those carrying out the respective project. In the context of this chapter, this means that if an enterprise architect actively participates in a project, he or she should not be the tester performing the conformance assessment.

A second requirement is that assessing EA compliance should not be carried out solely at the end or in the latter stages of the project, since by that time the architectural decisions will already have been implemented. Because such decisions are fundamental, they will be difficult to reverse at a later stage. Compliance testing should therefore be done at stages in the project's lifetime when fundamental analysis and design decisions have matured and have been explicitly stated, but not yet implemented. In this way, deviations from the architecture can be identified while there are still opportunities to correct them. There should therefore be multiple baselines. Ideally, when creating these baselines, the project will have already consulted an enterprise architect (Foorthuis et al., 2008b). A third requirement is that, like in auditing, compliance testing should be part of a larger compliance initiative (cf. Hamilton, 1995; Burditt, 1996). To be more precise, the projects should be encouraged to comply from the start.

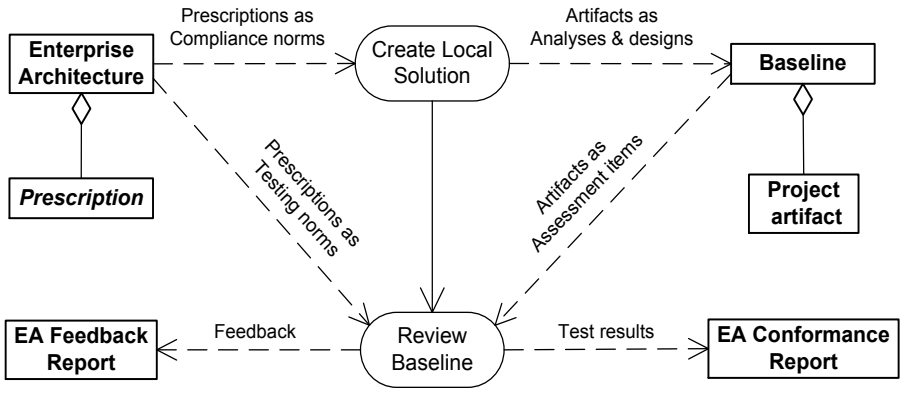


Figure 6.3. Role of EA and project artifacts in projects and compliance assessments

Figure 6.3 shows the relationships between creating the project artifacts and assessing them on compliance. It shows prescriptions having two roles, those of steering norms and those of testing norms. The process "Create Local Solution" represents carrying out a project that is stimulated to conform to EA as described in chapter 4. "Review Baseline" represents the compliance assessment approach. We have grounded this approach in chapter 4's action research study (for the general process), in quality aspects (for the compliance checks; see Appendix 6.B) and in the current chapter's empirical research (to evaluate and sharpen the approach). We have modeled the steps of this testing process in detail in Figure 6.4, meeting the requirements mentioned above. The assessment is performed by the enterprise architect role. The reason for this is that this role

is external to the project, has knowledge of the EA prescriptions (unlike regular auditors), has the interest to let projects conform, and (as EA often is not comprised of absolute legal rules) is able to negotiate with the project.

The use of three baselines shows that the assessment can be carried out at three stages in the project's lifetime: after business analysis and design, after specification of functional requirements and software architecture, and after delivery of the final product.

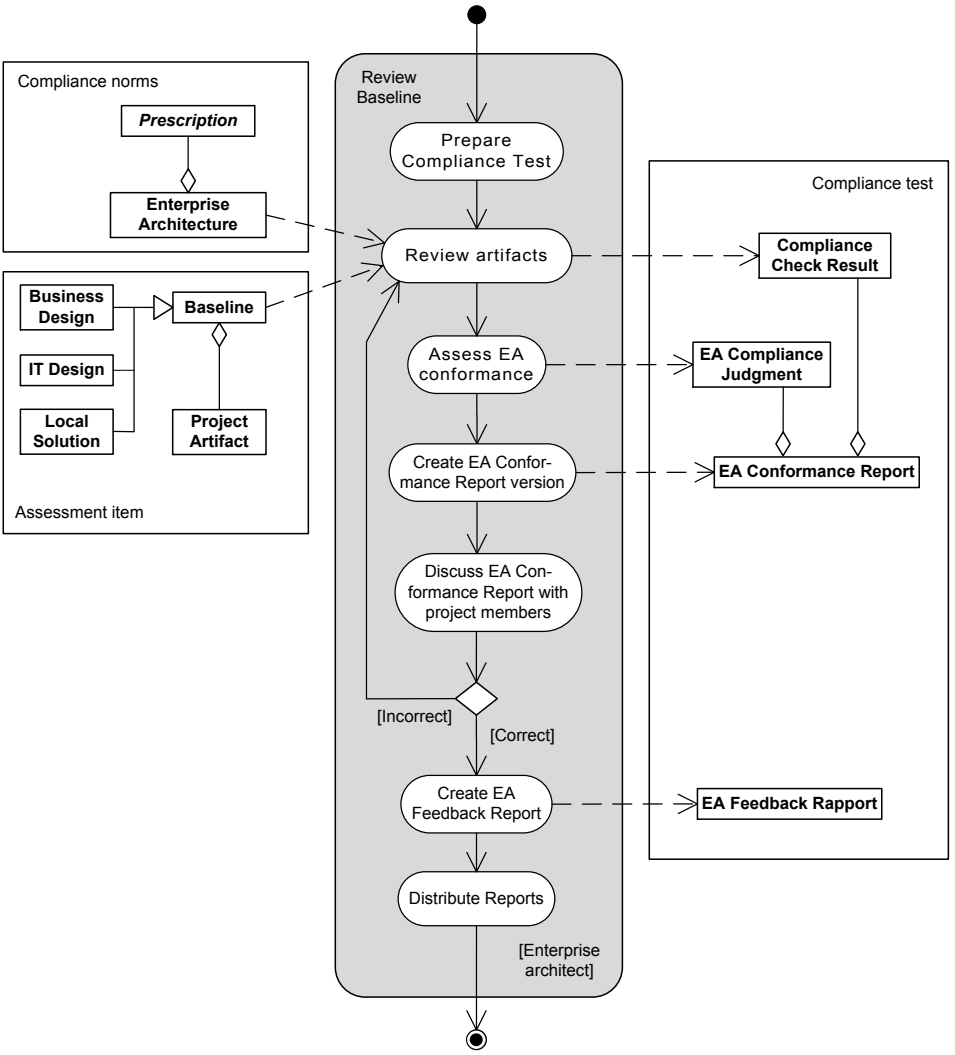


Figure 6.4. Process model for compliance testing ("Review Baseline")

In terms of notation, we used the technique presented in Weerd and Brinkkemper (2008). Below, we will elaborate on the various steps of the model. This model can also be found in chapter 5 (including specific project artifacts).

Process model for compliance testing (also see Review Baseline in chapter 5)	
Prepare Compliance Test	The Enterprise Architect prepares the Compliance Test for use in the specific situation. This includes collecting the Baseline and obtaining the most recent versions of the Prescriptions present in the Enterprise Architecture documentation. In addition, the involved stakeholders should agree on a time planning.
Review artifacts	The Enterprise Architect reviews the Project Artifacts from the Baseline. Reviewing the artifacts implies using Compliance Checks for assessing the EA Prescriptions that have been implicitly or explicitly applied in the Baseline's project artifacts. The four types of Compliance Checks are the *Correctness Check*, the *Justification Check*, the *Consistency Check* and the *Completeness Check*. Applying them yields Compliance Check Results that (possibly only in the case of non-compliance) will be included in the EA Conformance Report. See section 6.7 for more information on the Compliance Checks.
Assess EA conformance	After reviewing the Project Artifacts, the Enterprise Architect passes an EA Compliance Judgment regarding the degree to which the project complies with the EA.
Create EA Conformance Report version	The Enterprise Architect creates a version of the EA Conformance Report, including its meta information in the header.
Discuss EA Conformance Report with project members	The Enterprise Architect discusses the draft version of the EA Conformance Report with the authors of the assessed Baseline. The goal of this step is twofold. First, to clarify the report, if needed. Second, to avoid Compliance Check Results (i.e. review comments) and an EA Compliance Judgment that are invalid due to an incorrect understanding of the Baseline and its knowledge domain. If changes in the EA Conformance Report are required, the Enterprise Architect returns to the "Review artifacts" step.
Create EA Feedback Report	During the review process and the discussions with the project members, the Enterprise Architect may have discovered weak aspects of the EA. Furthermore, the test may have yielded ideas for additional or updated operationalizations of prescriptions (see section 6.8 on empirical evaluation). These can be stated in an EA Feedback Report.
Distribute Reports	The Enterprise Architect distributes the EA Conformance Report to the relevant stakeholders. The EA Feedback Report is sent to the lead Enterprise Architect.

6.7 Types of Compliance Checks

As shown in the EA Compliance Model we can distinguish between several types of compliance checks, which are used in the "Review artifacts" step of the process model. A *compliance check* is an analytical tool or mechanism to assess the current state of compliance (cf. Emmerich et al., 1997). When testing projects on EA conformance, several types of such checks can be distinguished, each assessing a specific aspect of compliance. Like the EA Compliance Model, the identified compliance checks are partly based on insights from the field of automated compliance testing (Chung et al., 2008; Emmerich et al., 1997, 1999). Examples of checks proposed there are the completeness and correctness check (Chung et al., 2008). As these are reminiscent of quality aspects of software engineering, data management and auditing (cf. Zeist and Hendriks, 1996; Pipino et al., 2002; IFAC, 2003; Caballero et al., 2007), we have also studied whether some of these aspects might serve as relevant EA compliance checks (see Appendix 6.B).

The resulting types of checks are described below. For each type, the specific elements of the norms required for the assessment will also be mentioned (in terms of properties and relations of the classes of the EA Compliance Model depicted in Figure 6.2).

- *Correctness check*: verifies whether a given prescription is applied by the project in a way that is in accordance with its intended meaning, rationale and usage. In other words, this check verifies whether the application of the prescription deviates from the prescription as it was intended by the enterprise architects.
  In terms of the EA Compliance Model, the criteria needed for performing the correctness check can be found mainly in the Prescription's *Definition* and *Illustration* properties, as these serve to communicate its intended meaning. However, the *Rationale* and *Implication* may also be relevant here, as they elaborate on its value and usage.
- *Justification check*: verifies whether the (lack of) application of a given prescription is justified, depending on its relevance and priority in the specific situation. The justification check's actual execution is dependent upon certain conditions. First, if the application of a prescription *deviates* from its intended application (which is determined by the correctness check), it needs to be ascertained whether the alteration is justified. Secondly, if a prescription is *not applied*, it needs to be ascertained whether it is justified not to apply it. Thirdly, if a prescription is *applied correctly*, it needs to be checked whether it is indeed justified to apply it. This last sub-check aims to avoid 'blind' conformance which could unnecessarily harm project or

enterprise goals in the specific situation. In short, the justification check verifies whether the project has made the appropriate choice when deciding to either apply, alter or not apply a given prescription.
In the EA Compliance Model, the justification check's evaluation criteria can be found in the Prescription's *Rationale*. The rationale describes the prescription's benefits (which should ideally be consistent with the local situation's objectives) and when it should be applied (which should be consistent with the nature of the local situation). In addition, the *Implication* may be relevant here, since the impact in terms of costs, resources and activities can play a role in the cost-benefit analysis. Furthermore, the *Priority* states whether prescriptions are mandatory or merely recommended guidelines.

- *Consistency check*: verifies whether, if a given prescription is applied, required related prescriptions are also applied. Some prescriptions, especially those at lower abstraction levels, might need to be implemented as a package. For example, the counterpart prescriptions mentioned in section 6.5 and chapter 3. Another focus of the check is to verify whether the prescriptions' applications do not contradict each other, but instead culminate in a consistent and balanced result.
  The consistency check's evaluation criteria can be found in the prescription's relationship with other prescriptions (i.e. the self-reference of the Prescription class).
- *Completeness check*: verifies whether all the prescriptions are applied. Minimally, the prescriptions that have been designated as mandatory (perhaps dependent on specific project situations) need to be applied, so as to avoid projects applying merely a convenient subset.
  The completeness check's evaluation criteria can be found in the Prescription's multiplicity with the Enterprise Architecture. It is the number of Prescriptions (that are of type Project Prescription) represented by the "*" symbol in a real-life instantiation of the aggregation between Enterprise Architecture and Prescription. Or put more simply: the total number of (mandatory) prescriptions relevant for projects. The *Priority* states whether prescriptions are mandatory or not.

The completeness and correctness check types are also mentioned in Chung et al. (2008) in their discussion of compliance with standards. We have adapted them here to fit the EA context. The justification and consistency check types are contributions of the current research (including the study of quality aspects; see Appendix 6.B). We have added the justification check because the relevance of prescriptions can be conditional (cf. Pfleeger et al., 1994) and local acceptance criteria might need to be taken into account. The idea for the consistency check is supported by the respective quality aspect (Pipino et al.,

2002). This check is especially relevant in the context of Enterprise Architecture, because EA aims for a coherent development of business, information and IT, but at the same time has to deal with potentially conflicting stakeholder interests and requirements (cf. The Open Group, 2009). Other quality aspects mentioned were not relevant in the EA context.

The correctness and justification checks are performed at the level of an individual Prescription. The completeness check is performed at the level of the entire collection of Project Prescriptions. The consistency check is performed at the level of a group (package) of individual Prescriptions.[3] This is illustrated in Table 6.1 of section 6.8.

The checks can be applied to all Prescriptions, regardless of whether the Enterprise Architecture focuses on all the aspects often acknowledged, such as business, information, applications and infrastructure (cf. Boar, 1999; Foorthuis and Brinkkemper, 2007; The Open Group, 2009).

Given an applied Project Prescription, each individual check can have one of three outcomes:

- *Passed*: the applied prescription passed the respective compliance check.
- *Failed*: the applied prescription failed the respective compliance check.
- *Needs attention*: the applied prescription might be (or become) compliant. However, it is applied partially or its application is ambiguous (i.e. there is not sufficient information to determine the outcome of the check).

6.8 Empirical Evaluation

To evaluate and illustrate the EA testing process and its compliance checks, we tested two real-life projects on compliance with actual EA prescriptions. The assessments were carried out at Statistics Netherlands (SN), the Dutch national statistical institute. SN had been developing its architectural practice for several years, since 2006. Conformance to its EA was relevant to projects, since the program responsible for developing it provided them with free IT resources (including an adjunct team of experienced redesign architects cooperating with the project members). Compliance testing was done regularly, albeit often in an informal fashion. Since the original number of prescriptions was considered too

3 Note that the EA Compliance Model depicted in Figure 6.2 has been simplified for reading purposes, as it can only contain the checks at the level of an individual Prescription. To model the consistency and completeness checks technically correct, a Project Prescription Group, containing one or more Project Prescriptions, should be added between the Project Prescription and the ternary association.

extensive, SN had – shortly before our tests were carried out – brought down the number of principles significantly. The project artifacts assessed here were created independently of the researchers and enterprise architects.

To be able to identify the arbitrary aspects of testing, both assessments were carried out independently by the two principal researchers, both working at SN at the time. Contact between the testers occurred only before and after a test (to compare results and clarify ambiguous prescriptions or checks), not during it.

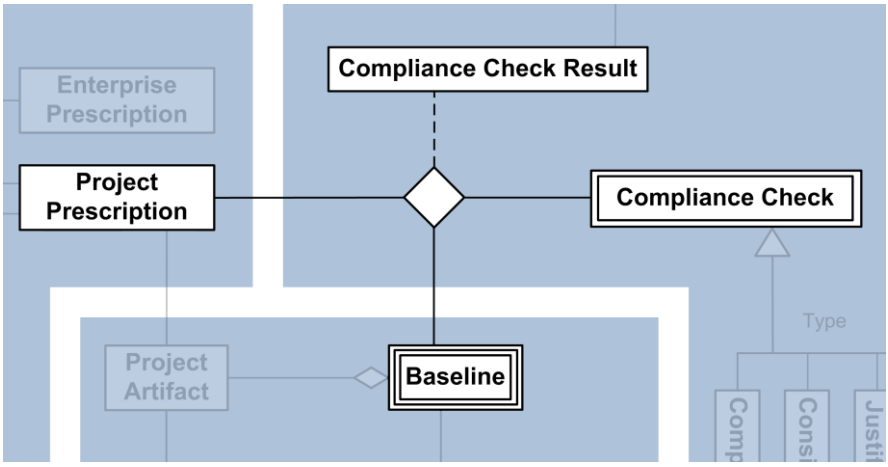


Figure 6.5. Elements required for a compliance assessment

To explain more fully what was required for our compliance assessment, we will refer to Figure 6.5, which is an excerpt from the EA Compliance Model (Figure 6.2). The ternary association presents three inputs for the test (the three highlighted classes connected with a continuous line). First, at the bottom of the diagram, the Baseline represents the object(s) being evaluated. In both projects, these *assessment items* consisted of a business analysis and design baseline. Secondly, the Project Prescriptions denote the *compliance norms*, to which the baseline must conform. The prescriptions here took the form of textual principles. Since the assessment items were business analysis and design documents, only the business and information principles were used as norms. At a later stage, the application and technology infrastructure prescriptions would have to provide the norms to test the baselines containing functional IT requirements and software architecture specifications. As a third input, the Compliance Check consists of four types of verification, which evaluate different aspects of conformance. They can be used in every EA compliance assessment. The compliance check types are part of the overall *compliance test*.

In preparation of this assessment, the two testers discussed the principles in detail, which was needed since it was not always explicitly mentioned in the EA why or how they needed to be applied. This resulted in the clarification of these prescriptions' rationale and implication. For the consistency check, it was also determined which set of prescriptions formed a package of related norms. The first test was subsequently carried out, yielding various Compliance Check Results. As an example, Table 6.1 presents one of the tester's reports.

Using a binomial distribution and no empirical data, the expected number of randomly agreed-upon ratings can be calculated as: $E = n \cdot p = 21 \cdot 0.25 = 5.25$ expected identical scores.[4] However, despite the joint preparation, the first test yielded the surprising result that, with only 3 identical scores, there was even less agreement between the two testers than could be expected on the basis of chance alone. In addition, 6 scores showed extreme differences, i.e. "Passed" versus "Failed" values. For further analysis, Cohen's Kappa was calculated, which is a statistical measure for determining the agreement between two raters. It has a value of between -1 and 1, with the former representing perfect disagreement and the latter perfect agreement. Values near zero, associated with non-significant p-values, suggest that the observed (dis)agreement is attributable to chance (SPSS, 2008). See Landis and Koch (1977) for a more fine-grained interpretation of Kappa scores. With the first assessment's Kappa having a value of -0.086 and a p-value of 0.383, we have to conclude that the two testers agreed no more and no less than if they had performed the assessment randomly. Post-assessment discussions revealed that the inter-rater disagreements could be attributed to ambiguity in all three inputs of the ternary association. In other words, the prescriptions, the compliance checks and the business analysis baseline were all being interpreted differently. Although one conclusion was that strict operational definitions were necessary, the four types of compliance checks were deemed useful. No additional compliance check types were required in order to perform the assessment.

Following the first test, improved operationalizations of both the compliance checks and the prescriptions were created. The operational definitions of the (organization-independent) checks resulted in strict rules for the meaning and application of these checks. They are all included in Appendix 6.A, as they are

4 We are not interested in the two raters both having a specific outcome (e.g. "passed"), but simply in them having an identical outcome. Therefore, one of the ratings should be seen as given, rendering its value irrelevant to the calculation of the expected number of identical scores. The probability of two raters having the same outcome is thus 0.25. This should be multiplied by the number of cells (i.e. 21).

Prescription		Compliance Check Results			
		Correct-ness	Justifi-cation	Consis-tency	Comple-teness
1	The statistical production shall be output-focused and cost aware.	!	!		
2	A rigorous distinction shall be made between a) the actual data that are processed, and b) the metadata describing definitions, quality and process activities.	!	!	!	
3	There shall be no production before relevant metadata is fully and explicitly stated.	!	!		
4	Processes concerning the management function shall be distinguished from all other processes.	×	×		
5	When redesigning statistical processes, the benefits of re-use shall be exploited to the full.	✓	✓	!	×
6	Re-usable data shall be stored in enterprise-wide steady state data stores belonging to one of four interface levels (i.e. Inputbase, Microbase, Statbase and Outputbase).	!	✓		
7	Metadata and (anonymized) data stored in steady state data stores shall be standardized, easily discovered and publicly accessible within SN.	✓	✓		
8	Processing of data shall occur between interface levels, in which data is collected from and stored in the Data Service Center.	✓	✓		
9	Quality versions of steady state data stores shall be identifiable as versions of one and the same data store.	✓	✓		
EA Compliance Judgment: Not passed yet. Especially regarding metadata, important elements are missing.					
Symbols: ✓ Passed ! Needs attention × Failed Not applicable					

Table 6.1. The compliance checks results per prescription (for a given baseline)

re-usable in other organizations. The operationalization of the (organization-dependent) prescriptions, which should be seen as distinct from creating their rationale and implication, also resulted in stricter and more detailed operational definitions. An example prescription is provided in Appendix 6.A. The second test consequently resulted in a significant increase of agreement, with 14 identical scores, no extreme differences, a Kappa value of 0.520 and a p-value of < 0.0005. Although statistically significant and thus not attributable to chance, this value for inter-rater reliability still represents only "moderate" agreement (Landis and Koch, 1977). While discussing the results, it became clear that the deviating scores could still be attributed to the remaining subjectivity of the prescriptions and business analysis artifact, but no longer to a different interpretation of the compliance checks. The conclusions were discussed with the authors of the baselines and feedback remarks were e-mailed to the lead architect.

6.9 Discussion of Research Results

Our research sheds light on the aspects of compliance testing that are specific to Enterprise Architecture. The results indicate that assessing compliance with EA is inherently subjective and interpretive in nature, no different from judicial decisions and academic peer reviews (which often show inconsistent outcomes). There are several reasons for this. First, EA prescriptions often prove to be inherently *abstract*, which is a consequence of their strategic nature and of them aiming at a partially unknown future. This renders prescriptions open to interpretation. Creatively interpreting and translating EA prescriptions to fit them to the specific situation is inherent in working with EA. Secondly, since EA prescriptions and project artifacts have to be read and applied by human actors (analysts, testers, programmers, managers and other stakeholders), *natural language* is the most appropriate format. Natural language, however, is always open to interpretation. Thirdly, when discussing the tests we discovered that we (subconsciously) had used not only the information provided by the artifacts and the EA, but also *personal and contextual knowledge*, e.g. previous experiences with the domain in question which helped understand and give meaning to the assessed baseline. In short, testing requires sense-making, intuition, experience and knowledge of the business context. Assessments cannot therefore be expected to result in total agreement between human testers (i.e. a Kappa value of 1.0). Take, for example, principle 5, "When redesigning statistical processes, the benefits of re-use shall be exploited to the full." Assessing this rather abstract principle not only requires knowledge of existing and potentially re-usable statistical data (inside SN) and IT systems (both inside and outside SN), but also of the goals and requirements of the project in question in order to make a match between potentially re-usable resources and project needs.

There are indications that the factors causing subjectivity in EA compliance testing are not solely present in the organization in which we did our empirical research. Take for example almost any of TOGAF's example set of architecture principles (The Open Group, 2009) to see the above-mentioned abstract and vague nature (e.g. "Data is an asset that has value to the enterprise and is managed accordingly."). In addition, research on EA has regularly found EA prescriptions to be ambiguous (Lindström, 2006; Op 't Land and Proper, 2007; Foorthuis and Brinkkemper, 2008a). This is consistent with research in other fields, since, throughout the years, consensus studies have often demonstrated low or moderate agreement between auditors (for example, Joyce, 1976; Srinidhi and Vasarhelyi, 1986; Amer et al., 1994; Lin et al., 2003). In addition, when considering law and international treaties, the legal rules therein often prove to be ambiguous, and thus call for subtle and subjective compliance

evaluation (Chayes and Chayes, 1993; Zaelke et al., 2005). The results of our study, including the second test with moderate agreement, is consistent with these findings.

Given the above, a Kappa value of 0.520, representing "moderate" agreement, is a satisfactory result, especially for a foundational study. However, this does not imply that research should not strive to improve inter-tester agreement. Given the inherent subjectivity, research could perhaps aim at achieving Kappa values of between 0.61 and 0.80, i.e. "substantial" (Landis and Koch, 1977). What can be done to mitigate the effects of the subjective nature of EA compliance testing? First, our results suggest that prescriptions need to be as operationalized as possible, similar to rendering concepts in social science research measurable. This makes the testing of prescriptions less prone to individual interpretation. The pseudo-formalizations can be inspired by real-life situations, limiting operationalizations to relevant issues. In theory this needs to be done only once, but after an given assessment the pseudo-formalizations may need to be improved as a result of the new testing experience. The operationalizations and examples of their application can also become part of an in-house training on EA compliance testing aimed at improving the assessment process. However, note that in a real-life, non-academic setting operationalizing has its limits, since too many rules will likely result in testers not reading or remembering them. Furthermore, operational definitions may deal only with a limited set of well-known situations, and may be of less use to new and unknown situations. Another way to deal with the interpretive nature of EA compliance testing is assessing (important) projects by two testers and have their joint EA Compliance Report reviewed by the lead enterprise architect. The result should be increased consensus between testers (Trotman and Yetton, 1985; Joyce, 1976). This is therefore not only recommended to decrease the subjectivity of the assessment, but also to boost acceptance of its results by the project members (who will undoubtedly be aware of the interpretive nature of the prescriptions, since they have applied them). Finally, the EA Conformance Report itself should be reviewed and discussed with the authors of the baseline, in order to prevent erroneous check results and judgments. This empirically induced insight is the reason why this step has been added in the "Review Baseline" process model of Figure 6.4.

The results of our study also have ramifications for automated compliance testing. This is a popular topic in many publications on compliance with standards and legislation (cf. Emmerich et al., 1997, 1999; El Kharbili et al., 2008; Sadiq et al., 2007; Chung et al., 2008). Indeed, it is feasible to perform all kinds of checks on documents, models and datasets. Especially when the mere existence of properties can be objectively measured, e.g. compliance with the standard "each user requirement includes a measure of priority" (cf. Emmerich

et al., 1999; Chung et al., 2008). However, our research leads us to suspect that an EA is less suitable for automated compliance testing, as the above-mentioned characteristics of EA prescriptions severely hinder automated verification. Prescriptions are written in natural language, they are often inherently abstract and have been translated to a local situation. Furthermore, testing them regularly requires knowledge that is out-of-scope for machines, for example domain knowledge or information about the non-automated or non-modeled business or its context. Formalizing this might prove impossible or not worth the effort. Arguably, an inference engine capable of testing prescriptions with these characteristics is also sufficiently powerful to carry out the project itself. Tests that could be performed automatically are likely to yield irrelevant and non-substantive outcomes. For the time being, knowledgeable human actors are key in this type of compliance assessment task, as they are capable of identifying and resolving interpretational differences.

We therefore consider it likely that tools (at least in the short-term) will not be able to meaningfully test a substantial part of business processes and IT systems on EA conformance automatically. However, there are definitely areas in compliance testing that could be supported by tools. For example, the operationalization of the compliance checks (see Appendix 6.A) defines strict constraints for the checks' values. These 'meta checks' can be carried out by a tool for recording the values. Furthermore, tools could provide valuable assistance for registering compliance issues. Structured recording would allow for automated calculation of 'compliance scores' of projects and departments, and for post-assessment analyses (e.g. identifying which prescriptions are the most important sources of non-compliance or which departments have a relatively low 'compliance score').

Another discussion altogether is the question of whether our proposed method is suitable for routine application. Since design science is concerned with innovations, this is both a relevant and a difficult question. However, some remarks can still be made, especially concerning the question of whether all four types of checks should always be performed and reported for each prescription (set). If an EA contains many prescriptions, this can yield a large number of compliance check results. It may therefore be practical and more efficient to regard the checks as aspects to be kept in mind, and only report on an aspect if it has compliance issues. It might also be possible to perform the correctness and justification checks at the same aggregated level as the consistency check, thereby allowing for a more superficial test when time is an issue. However, when an organization is in the process of starting up its EA compliance assessment function, we advise to conduct detailed and full conformance tests and to involve multiple testers in each of these assessments. This allows for the testers to develop a shared understanding regarding the

prescriptions and checks, and collaboratively create the necessary operationalizations. When compliance testing is becoming routine and testers have received training, the above mentioned partial reporting and aggregated checks can be carried out, allowing for a more efficient process. This will make the assessment less precise and more vulnerable to subjectivity. However, since reporting is less detailed, the probability of not detecting disagreement also increases (viz. using less detailed categories decreases the probability of observing different scores).

6.10 Conclusions

We set out to explore how projects, and the business and IT solutions they deliver, can be assessed on compliance with EA. This chapter's research has yielded the following contributions.

- The artifact *EA Compliance Model* (Figure 6.2 and supporting text), which identifies the core elements of compliance testing in the context of Enterprise Architecture. In design science terms, this artifact can be categorized as a model. However, the model communicates a world view and is not empirically evaluated here.
- The artifact *Process model* (Figure 6.4 and supporting text). This offers process steps and detailed prescriptions for carrying out several EA-related checks. In design science terms, this artifact can be categorized as a method, taking several parts of the EA compliance model as input. The set of *Compliance Checks* (see section 6.7 and Appendix 6.A) used in the process model may in design science terms be seen as a construct. The process model – including the compliance checks – has been empirically evaluated and illustrated in this chapter.
- The *insights* that resulted from the empirical evaluation with real-life EA prescriptions and project documents. One insight is that our approach can be used to assess real-life projects, albeit the inter-rater agreement is still only moderate. This is related to another insight, that EA compliance testing is inherently subjective and interpretive by nature, due to EA prescriptions being strategic and abstract, the (justified) use of natural language, and the inevitable use of personal and contextual knowledge. This is similar to the inconsistent outcomes in e.g. judicial decisions, academic peer reviews and audits. We therefore do not consider it realistic to expect much from formalized, objective and automated assessments, especially not in the short term. We expect more from operationalizing norms for human-based compliance tests, bearing in mind that perfectly objective tests will most

likely not be within reach. In design science terms, the empirical endeavor can be seen as an instantiation, yielding insights in Enterprise Architecture compliance testing.

We have several suggestions for further research. First, as our empirical research focused on architecture principles, another topic for further investigation is studying whether our conclusions for principles also hold true for models and policy statements. In fact, it can be expected that the compliance checks are not only useful for assessing the application of EA prescriptions, but also of other norms, such as legal rules and industrial standards. In addition, they may not only function as checks performed by testers after application, but also as aspects to take into account by implementers when in the process of conforming to or applying the norms. As a second suggestion, future research can study what kind of tool support is most valuable. Although we do not expect much from automated compliance testing, we have presented several options for tools supporting compliance assessments. A third topic that deserves further attention is how to arrive at optimal operationalizations for human-based compliance assessments. The operationalizations presented in Appendix 6.A can also be subjected to scrutiny. A fourth topic would be to investigate the role of tacit knowledge in testing, which could focus on developing shared implicit meanings regarding prescriptions, rather than on explicit operational definitions. Whatever the topics of future studies, our research clearly shows that minimizing the subjectivity of assessments is something that has to be pursued actively, as objective compliance testing cannot be taken for granted.

Appendix 6.A. Operational Definitions

Operationalization of the Compliance Checks

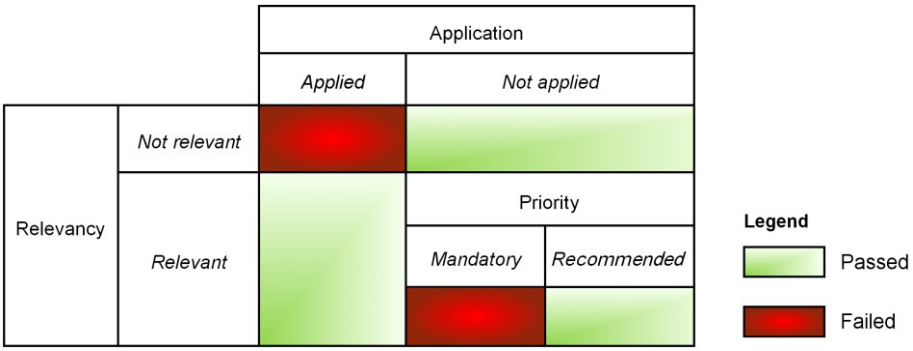
This sub-section presents the operationalization of the compliance checks. Note that these are organization-independent and can thus be re-used in other settings.

1. The three values of the checks are ordinal by nature. From low to high, the order is "Failed", "Needs attention" and "Passed". The "Not applicable" value, in principle assigned up-front, is not considered an intrinsic part of this order.
2. The assessment is limited to testing the desired or future situation – be it short, medium or long term – since the objective is to test the compliance of the (design of the) new business and/or IT system that is to be delivered. The current situation is therefore not assessed when testing a project on conformance.
3. If a prescription is relevant (regardless of whether it is mandatory) and has indeed been applied (regardless of whether it has been applied correctly), the Justification Check results in "Passed". If a prescription is relevant (and mandatory) but has not been applied, the Justification Check results in "Failed".[5] If a prescription has been applied while it is not relevant in the specific local situation (regardless of whether it is mandatory), the Justification Check again results in "Failed". If a prescription has not been applied in a situation in which it is not relevant (regardless of whether it is mandatory), the Justification Check results in "Passed". See statement 4 for more information about the values of the Justification Check.

The table on the next page summarizes this operationalization visually.

4. The instruction in statement 3 focuses on situations in which a strict distinction can be made between "Passed" and "Failed". However, as gray areas may exist, the meaning of the values for the Justification Check will be described in more detail below. Given a prescription:

5 Not all EA prescriptions are mandatory in practice, as some EAs also contain e.g. recommended best practices. This is reflected by the property Priority in the EA Compliance Model of Figure 6.2. A mandatory prescription is also not necessarily relevant. This is due to its priority being determined at the Enterprise Architecture level, while relevancy is determined at a later stage at the application (project) level. In practice, general prescriptions may prove to be irrelevant in specific situations. Note that what exactly is "relevant" is determined here by the tester. It should also be noted that the authors had a discussion about whether priority should be included in the operationalization.



- The "Passed" value indicates that:
  - The project has applied (all the mandatory elements of) the prescription, regardless of whether this has been done correctly or not.
  - The project has not applied (all the elements of) the prescription, either because of non-relevance or because the project has taken the freedom that is inherent in the recommended nature of the prescription.
- The "Needs attention" value indicates:
  - Partial conformance: the project has applied the prescription partially (e.g. only one or several of the mandatory elements, or one mandatory element only to a certain degree), regardless of whether this has been done correctly or not.
  - Insufficient information: there are indications that the project has applied the prescription (e.g. because it is claimed or implied in the Baseline), regardless whether this has been done correctly or not. However, it is not possible to test this on compliance (e.g. because references have been made or implied to additional documents, which are not included in the tested Baseline and are therefore not available for assessment).
- The "Failed" value indicates that:
  - No information whatsoever is available about the application of the prescription, i.e. the prescription seems to have been totally ignored.
  - The project has stated that this (relevant) prescription is not considered relevant.

5. The value of the Correctness Check is dependent on the value of the Justification Check for the prescription in question. The value of the Correctness Check cannot be higher than that of the Justification Check. For the Correctness Check, no distinction is made between mandatory and recommended prescription elements; all elements are considered equal. In

other words, if a prescription has been applied (regardless of whether it is mandatory), it should be applied correctly. Below, the value of the Correctness Check is discussed in relation to the Justification Check.

- If the value of the Justification Check is "Passed" because the prescription is relevant and has been applied, the value of the Correctness Check can result in "Passed", "Needs attention" or "Failed". A value of "Not applicable" is not allowed.
- If the value of the Justification Check is "Needs attention" because the prescription is relevant, but has been applied partially or there is insufficient information to test it, the value of the Correctness Check can only result in either "Failed" (if all elements are "Failed") or "Needs attention" (e.g. if one element is "Passed", one is "Failed" and one is "Needs attention"). The values "Passed" and "Not applicable" are not allowed.
- If the value of the Justification Check is "Failed" because the prescription in question has not been applied and it was relevant to do so, the value of the Correctness Check per definition also results in "Failed".
- If the value of the Justification Check is "Failed", "Passed", "Needs attention" or "Not applicable" and the prescription in question is not relevant, the value of the Correctness Check per definition results in "Not applicable" (regardless of whether the prescription in question has been applied correctly or not).

Summing up, the table below shows the combinations that are allowed and not allowed.

Justification \ Correctness		*Passed*	*Needs attention*	*Failed*	*Not applicable*
Relevancy	Value				
Relevant	*Passed*	Allowed	Allowed	Allowed	Not allowed
	Needs attention	Not allowed	Allowed	Allowed	Not allowed
	Failed	Not allowed	Not allowed	Allowed	Not allowed
Not relevant	*Any*	Not allowed	Not allowed	Not allowed	Allowed

Legend
Allowed
Not allowed

6. The value of the Consistency Check results in "Failed" if specific inconsistencies or off-balances can be found or expected. Therefore, the value does not automatically result in "Failed" if one or more of the underlying Correctness or Justification Checks is "Failed" (as this would in essence simply be equivalent to a Completeness Check on a subset of the prescriptions). However, one or several "Needs attention" values for

underlying Correctness or Justification Checks do automatically result in a value "Needs attention" for the Consistency Check, since it cannot be known whether consistency is maintained.

7. The Completeness Check only results in a "Passed" value if all prescriptions have a "Passed" value for the Justification Check. The Completeness Check assesses whether all relevant mandatory prescriptions have been taken into account, regardless of whether their application is correct. Therefore, the results of the Correctness Check and Consistency Check are not relevant here; these will be taken into account in the final judgment.
8. The final EA Compliance Judgment takes all of the compliance check results in account. A "Passed" value for this judgment indicates complete conformance, and thus a "Passed" value for all underlying checks.

Clarification and Operationalization of Prescriptions

This sub-section presents an example of the clarification of the prescriptions' rationale and implication that preceded the first test. In addition, the operationalization of the respective prescription, which was created between the first and second test, is also included. These operational definitions can, for example, prescribe which compliance check values to assign in which situation. Note that both the clarification and operationalization are organization-dependent.

Statement	8. Processing of data shall occur between interface levels, in which data is collected from and stored in the Data Service Center.
Rationale & implication	The interface levels are the Inputbase, Microbase, Statbase and Outputbase, in which steady state datasets are stored. A statistical process uses data from such a store as input and stores them after processing (e.g. enriching or aggregating) in a higher-level data store in the enterprise-wide Data Service Center. The *rationale* is that this stimulates re-use of data, as these stores are available throughout Statistics Netherlands. The *implication* is that the data stored in these enterprise-wide interface levels need to be relatively stable and of high quality (i.e., there should be no need to correct the data in the immediate future).
Operationalization	Datasets (i.e. statistical products or steady state data stores) should be related to interface levels. This means that each dataset should be explicitly linked to either the Inputbase, Microbase, Statbase or Outputbase (and possibly also the Pre-Inputbase and/or Post-Outputbase). If it is only mentioned that the Data Service Center is or will be used, the values of the Justification and Correctness Checks should be "Needs attention". If the Data Service Center is not mentioned at all, the values of the Justification and Correctness Checks should be "Failed". This prescription is part of a package (i.e. it is related to other prescriptions for the Consistency Check).

Appendix 6.B. Quality Aspects

Quality aspects of data, software and auditing have served as theoretical support for the compliance checks and process steps. This Appendix lists the quality aspects and the rationale for (not) adapting them to our approach.

Software

The Quint model features several quality dimensions for software (Zeist and Hendriks, 1996).

Functionality
- *Suitability*: dependent on one's interpretation, this might be seen as the justification check.
- *Accuracy*: this is the correctness check. However, "accurate information, measurements, and statistics are correct to a very detailed level" (Collins Cobuild Dictionary). Since EA checks are not detailed, due to the strategic and abstract nature of the prescriptions, we prefer the term "correctness".
- *Interoperability*: irrelevant for EA compliance checks. This is a quality aspect specifically for systems (although an EA prescription could be about interoperability, so it could be subjected to a check).
- *Security*: irrelevant.
- *Compliance*: irrelevant. If e.g. "compliance with the law" is an EA principle, then it will be tested as part of checking that specific prescription.
- *Traceability*: irrelevant as a separate check. However, it should be clear how the EA prescription is applied. If this is not the case, then a compliance check can yield the outcome "Needs attention".

Reliability
- *Maturity*: irrelevant.
- *Fault tolerance*: irrelevant.
- *Recoverability*: irrelevant.
- *Availability*: irrelevant, but might make for a good quality aspect for EA prescriptions.
- *Degradability*: irrelevant.

Usability
- *Explicitness*: irrelevant. EA prescriptions can be applied implicitly or explicitly in project artifacts.
- *Customizability*: irrelevant.
- *Attractivity*: irrelevant.

- *Clarity*: regardless of whether EA prescriptions are applied explicitly or implicitly, it should be clear how they are applied. If this is not the case then a compliance check can yield the outcome "Needs attention".
- *Understandability*: an EA prescription itself may be understandable or not, but the conformance check is on its application. It thus does not lead to a separate check. However, it is a relevant issue, since the application of a prescription should be understandable for it to be checked. This is why there is an outcome "Needs attention" (which amongst others can mean that the application is ambiguous).
- *Learnability*: like Understandability, this might be a good quality aspect of a prescription. However, it is irrelevant for its application.
- *Operability*: irrelevant (see Learnability).
- *Helpfulness*: irrelevant.
- *User-friendliness*: irrelevant.

Efficiency
- *Time behavior*: irrelevant.
- *Resource utilization*: this aspect is not entirely irrelevant for EA compliance assessments. If the application of an EA prescription costs more than is gained (from the perspective of the entire enterprise), there is no good reason to apply it. This is covered in the justification check.

Portability
- *Adaptability*: irrelevant. It might be a good quality aspect for an EA prescription: due to its strategic nature, a prescription needs to be translated (adapted) to the specific situation in which it is applied.
- *Installability*: irrelevant.
- *Conformance*: irrelevant. Assessing conformance is the whole point here, and it is tested on several aspects.
- *Replaceability*: irrelevant.

Maintainability
- *Analyzability*: irrelevant.
- *Changeability*: irrelevant.
- *Stability*: irrelevant. It might be a good quality aspect for an EA prescription.
- *Testability*: irrelevant. From the perspective of this research, this obviously is a good quality aspect for an EA prescription.
- *Manageability*: irrelevant as an explicit check. However, applying the prescriptions should be realistically possible, which can be verified as part of the justification check.
- *Reusability*: irrelevant.

Data

Several quality dimensions for data can be acknowledged (Pipino et al., 2002; Caballero et al., 2007).

- *Accessibility*: irrelevant.
- *Appropriate amount*: verified with the completeness check. A related issue is how detailed and comprehensive a compliance assessment and its reporting should be.
- *Believability*: irrelevant.
- *Completeness*: this is the completeness check.
- *Conciseness*: irrelevant as an explicit check. However, see Appropriate amount.
- *Consistency*: this is the consistency check.
- *Customer support*: irrelevant as an explicit check. However, in this regard it should be noted that both the testers and the project members should be available to explain their choices.
- *Documentation*: irrelevant as an explicit check. However, the judgments made by the testers should be documented in an EA Conformance Report.
- *Ease of manipulation*: irrelevant.
- *Free-of-error*: this is the correctness check.
- *Interpretability*: irrelevant as an explicit check. However, if the project artifacts feature e.g. definitions that are not clear or diagrams with ambiguous symbols, a "Needs attention" value is assigned.
- *Objectivity*: irrelevant as an explicit check, although testers should indeed do their work objectively.
- *Price*: irrelevant as an explicit check. However, the involved stakeholders should agree on how much capacity will be put into the test.
- *Relevancy*: this is covered by the justification check, since the prescriptions applied should be relevant for the situation at hand.
- *Reliability*: irrelevant as an explicit check. However, testers should be able repeat their work or show inter-rater reliability (which, as we have seen, cannot be taken for granted).
- *Reputation*: irrelevant.
- *Security*: irrelevant as an explicit check. However, it should be considered whether the EA Conformance Report should be openly published within the organization.
- *Timeliness*: irrelevant. However, the involved stakeholders should agree on a time planning.

- *Understandability*: irrelevant as an explicit check. However, if the project artifacts are not sufficiently understandable, a "Needs attention" value is assigned.
- *Verifiability*: irrelevant as an explicit check. However, the project artifacts should be verifiable.
- *Value-added*: this is the justification check, since conforming should deliver value in the project situation.

Auditing

Principles and quality aspects of auditing (cf. IFAC, 2003; Tewarie, 2010) are also potentially relevant. However, these tend to focus on the quality of the prescriptions, audit process and auditors, leading to aspects such as *Integrity, Objectivity* and *Neutrality*. Although desirable characteristics of testers, these aspects do not provide suitable templates for compliance checks. Other aspects in this context are already covered above, such as *Completeness* and *Consistency*.

Chapter 7

EA Conformance and Benefits

Various claims have been made regarding the benefits that Enterprise Architecture (EA) delivers for both individual systems development projects and the organization as a whole. This chapter presents the statistical findings of a survey study (n=293) carried out to empirically test these claims. First, we investigated which techniques are used in practice to stimulate conformance to EA. Secondly, we studied which benefits are actually gained. Thirdly, we verified whether EA creators (e.g. enterprise architects) and EA users (e.g. project members) differ in their perceptions regarding EA. Finally, we investigated which of the applied techniques most effectively increase project conformance to and effectiveness of EA. A multivariate regression analysis demonstrates that three techniques have a major impact on conformance: carrying out compliance assessments, management propagation of EA and providing assistance to projects. Although project conformance plays a central role in reaping various benefits at both the organizational and the project level, it is shown that a number of important benefits have not yet been fully achieved.[1]

7.1 Introduction

By providing holistic overviews and high-level constraints, guidelines and logic, Enterprise Architecture (EA) aims to achieve coherent and goal-oriented organizational processes, structures, information provision and technology (cf. Boh and Yellin, 2007; Richardson, Jackson and Dickson, 1990; Ross, Weill and Robertson, 2006; The Open Group, 2009; Wagter, Van den Berg, Luijpers and

1 This work has been published as: Foorthuis, R.M., Steenbergen, M. van, Mushkudiani, N., Bruls, W., Brinkkemper, S., Bos, R. (2010). *On Course, But Not There Yet: Enterprise Architecture Conformance and Benefits in Systems Development*. Proceedings of the Thirty First International Conference on Information Systems (ICIS 2010), St. Louis, Missouri, USA.

Van Steenbergen, 2005). Various claims have been made regarding the application and effectiveness of EA, by academics and practitioners alike. At the level of the *entire organization*, for example, benefits in the reduction of complexity and realization of business/IT alignment have been claimed. At the level of *individual systems development projects*, costs and risks are said to be brought down when complying with EA. Since conformance to EA is crucial for gaining the aforementioned benefits (Boh and Yellin, 2007; Foorthuis et al., 2012; Goodhue et al., 1992), various techniques for encouraging project compliance with EA are suggested in the literature. A complete overview of techniques and benefits claimed by academics and practitioners will be presented in section 7.3.

As the need for hypothesis testing on the topic of Enterprise Architecture has been identified in the IS research community (Boh and Yellin, 2007; Kappelman et al. 2008; Niemi, 2006), this chapter aims to critically and empirically verify various claims regarding EA benefits and conformance. To add to theory building, we constructed an empirically supported regression model of determinants of EA success, mainly in the context of projects. An important element here is the extent to which projects conform to the EA's norms or prescriptions (i.e. principles, rules, standards, guidelines, models, et cetera) and to what degree this delivers benefits. Both EA creators (e.g. enterprise architects and managers responsible for delivering the Enterprise Architecture) and EA users (e.g. project members applying EA norms) contributed important perspectives to our research. The first stakeholder group brought in important perspectives regarding enterprise-wide aspects that remain invisible to local appliers. The latter group offered views regarding actually applying EA in practice, aspects of which might remain invisible to the creators of architectural constraints and guidelines. Since we investigated the perceptions of both groups, it was also relevant to test whether differences in evaluations of EA exist. In short, the high-level research question of this chapter is:

> *What benefits can be gained by conforming to EA, and what are the most effective techniques for achieving conformance?*

To address the main research question, several sub-questions need to be taken into account:

1. *What techniques are applied in practice to stimulate conformance of projects to EA?*
2. *What benefits does EA yield for individual projects conforming to its norms?*
3. *What benefits does EA yield for the enterprise as a whole?*

4. *What differences, if any, exist between EA users and EA creators in their evaluative perceptions?*
5. *Which of the techniques applied result in the most effective increase in project conformance to EA, and what are the effects of conformance on the realization of EA benefits?*

The overall theoretical framework is presented in the next section. Following this, the specific claims regarding techniques and benefits – serving as the hypotheses to be tested – are described in more detail by means of a literature review. The subsequent sections present the empirical research approach and results respectively. The final section describes the conclusions.

7.2 Concepts in EA Conformance and Benefits

This section discusses how the concepts in our study of the application and effectiveness of EA are interrelated. Several techniques (or tactics) can be used to stimulate project conformance to EA. Amongst others, for example, assistance can be offered to projects when applying EA prescriptions or projects can be assessed on compliance. See section 7.3 for a complete overview of techniques. Employment of these tactics should lead to conformance of projects to EA, which, in turn, should result in reaping the aforementioned EA-related benefits. The purported benefits of conformance to EA are multifold. For the *organization* as a whole, for example, a coherent enterprise-wide strategy can be implemented – instead of local optimizations – and business and IT can be aligned. For *projects*, for example, costs, duration, complexity and risk are said to be reduced. The next section also presents a complete overview of benefits.

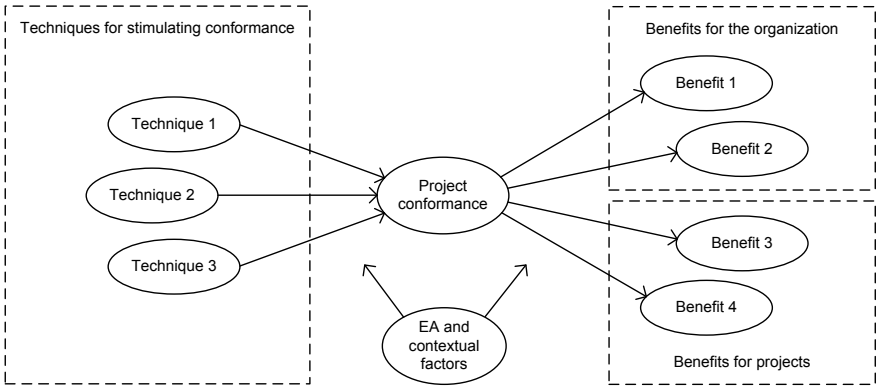


Figure 7.1. Theoretical framework for project conformance and EA benefits

Furthermore, the effects of techniques and conformance might be influenced by several contextual factors, such as the economic sector, organizational size and EA focus (on business, IT or both). Figure 7.1 on the previous page visually presents the overall theoretical framework, which has been used to structure our research and to construct an empirically supported model for EA conformance and benefits.

Needless to say, in addition to conformance-stimulating techniques, more generic techniques are equally crucial for success (Ward and Peppard, 2002). Examples of such best practices are the use of proven project management and system development approaches, and involving high-quality staff in projects. Furthermore, all this takes place in a specific context, where organizational culture, leadership and market conditions have an effect on the organization and its projects. However, these techniques are less relevant in this study since we focus on EA-related aspects.

7.3 Overview of Claimed Techniques and Benefits

We will now describe in more detail the techniques for encouraging EA conformance and the benefits that can be gained when EA is actually applied. These techniques and benefits are drawn from previous chapters and academic and practitioner publications. They will serve as the hypotheses to be tested.

7.3.1 Techniques for Stimulating Conformance to EA

To be able to reap its benefits, it is important that an EA is actually complied with (Boh and Yellin, 2007; Foorthuis et al., 2012; Goodhue et al., 1992). This sub-section provides an overview of tactics that can be employed to increase conformance to EA. For later reference, each technique is coded in parentheses with a capital T (e.g. T1).

Ensure management involvement in EA. EA should enable the achievement of strategic business goals (Morganwalp and Sage, 2004; Obitz and Babu K, 2009). In this context, it may be important for management to formally approve the EA (T1) (Van Steenbergen et al., 2010). Management should also ensure that the choices in the EA are explicitly linked to the strategic business goals (T2). Furthermore, it is necessary for management to actively propagate the importance of EA for achieving these goals (T3) (Boh and Yellin, 2007).

Assess EA conformance. Monitor projects and other initiatives on compliance with the EA's constraints and standards (T4), and use the results to take corrective action (Boh and Yellin, 2007; Ellis, 1993; Foorthuis et al., 2012).

Create an active community for EA knowledge exchange. The division of architectural domains over a number of domain architects, which is often felt necessary in large organizations, carries the inherent risk of fragmentation and misalignment. An active community of EA practice should enable knowledge integration (Van Steenbergen and Brinkkemper, 2009). This manifests itself in organized knowledge exchanges between architects themselves (T5) and between architects and project members (T6). Moreover, some authors stress that architects should be actively involved in projects, as they can assist the projects in defining the solution and applying EA norms (T7). For example, architects could be used as consultants to periodically provide advice, or they can actively participate in the project or some of its stages (Foorthuis et al., 2008, 2012; Slot et al., 2009; Wagter et al., 2006).

Leverage the value of project artifacts. A Project Start Architecture (PSA) is a document created at the beginning of a project. This deliverable inherits and translates the EA's prescriptions – such as rules, guidelines and models – to the specific project situation (Wagter et al., 2006). In this context, a PSA can be regarded as a specific form of what in TOGAF (The Open Group Architecture Framework) is referred to as an architecture contract (The Open Group, 2009). It describes the tangible constraints within which the project must operate. Using a PSA (T8) can therefore stimulate the project to comply with the EA's norms (Wagter et al., 2006). In fact, document templates in general can be employed to encourage conformance (T9) for several reasons. First, they seem likely candidates to be used as 'boundary artifacts' to increase knowledge integration between architects, both between organizational levels and between domains (Van Steenbergen and Brinkkemper, 2009). Secondly, templates can be used to provide projects with pre-defined structures and content prescribed by the EA, and provide the authors with instructions on how to conform (Foorthuis and Brinkkemper, 2008; Wagter, 2006).

Use compensation or sanctioning for stimulating conformance. Incentives and disincentives could increase the readiness of projects to comply with EA (T10). For example, the IT-costs associated with conformance might be compensated for by the EA program (cf. Foorthuis et al., 2012).

7.3.2 Claimed Benefits of Working with EA

We will now describe the benefits, which shall be indicated with a capital B (e.g. B1). The benefits of working with EA can be identified at two levels. First, the *organization as a whole* should profit from EA in several ways:

EA enables management to achieve key business goals. First, EA is said to enable management to pursue a coherent strategy that is optimal for the entire enterprise, instead of local optimizations (B1). Individual domains and departments may strive to pursue local interests (Malloy, 2003). However, the firm as a whole will not benefit from conflicting goals and an EA can provide the required holistic view of the enterprise to balance different interests and solutions (Richardson et al., 1990; Lankhorst et al., 2005). In addition, by taking a holistic and multi-layered view, Enterprise Architecture is a valuable instrument in aligning IT and the business processes it supports (B2) (Bucher et al., 2006; Gregor et al., 2007; Lankhorst et al., 2005; Bradley et al., 2011). This is crucial, as business/IT alignment is an important instrument in realizing organizational value from IT investments (Henderson and Venkatraman, 1993; Bradley et al., 2011).

EA enables management of organizational complexity. Architecture can provide insight into complex problems (B3). Insight can be gained by means of different aspect areas (e.g. business, information, information systems and infrastructure) and levels of abstraction (Capgemini, 2007; Raadt et al., 2004). Complexity can be managed (B4) by using a modular approach – which distinguishes between parts of a system and their relationships – and architectural modeling languages (Lankhorst et al., 2005; Versteeg and Bouwman, 2006). Furthermore, implementing standardized and automated processes should result in less complex technology environments (Ross et al., 2006).

EA facilitates the integration, standardization and deduplication of processes and systems. Years of organic growth have often led to various 'silos' or 'stovepipes', which do not leverage the potential of related or similar processes and systems. The high-level overviews of an EA provide insights into the organization's processes, business structures and information systems. This enables the enterprise to identify processes that could be integrated (since it is beneficial to share valuable information), standardized (since similar processes can be supported by the same systems) or even cut out (since redundancy can be replaced by similar processes) (B5) (Capgemini, 2007; Morganwalp and Sage, 2004; Niemi, 2006; Ross et al., 2006). As a result, costs can be controlled (B6).

EA enables the enterprise to deal with its environment effectively. Markets and businesses change ever more rapidly nowadays, and business processes and systems are highly interdependent. This poses IT problems, as software has to be updated or replaced sooner whilst simultaneously being part of an increasingly complex network of processes and systems. The agility of the enterprise's reaction to the outside world can be improved by EA (B7) by automating the core business processes. This results not only in more resources,

but also in valuable information, which can be utilized in innovative activities (Ross et al., 2006). In addition, by focusing on the contextual relationships, an EA can facilitate co-operation with other organizations (B8) (Jonkers et al., 2006; Morganwalp and Sage, 2004; Bradley et al., 2011).

EA enables effective communication between members of the organization. EA provides a consistent and coherent overview of the fundamental aspects of the organization and the desired future situation (B9). This includes defining and interrelating concepts, e.g. by using models. EA thus provides members of the organization with a shared frame of reference to communicate effectively with each other (B10) (Armour et al., 1999; Bernus, 2003; Foorthuis et al., 2012; Kappelman, 2008; Raadt et al., 2004).

In addition to benefits for the organization, *individual projects* should also benefit from conforming to EA. The following hypotheses can be identified:

Working with EA reduces project costs and project duration. Projects can be expected to save resources (B12) and time (B13) when working in the context of EA, since its business, information, applications and technology decisions guide development work. EA and domain level decisions are a given starting point and do not have to be discussed inside the project (Capgemini, 2007; Mulholland and Macaulay, 2006; Pulkkinen and Hirvonen, 2005; Wagter et al., 2005). A project can thus quickly focus its attention on designing and developing the details of the solution.

Working with EA reduces project risk and improves project success. Although publications tend to discuss the topic only superficially, EA is said to identify and mitigate project risks (B14). The argument that is usually put forward is that EA models – with their views on platforms, applications, processes and connections to other projects – provide insight into project risks (Bucher, 2006; Capgemini, 2007), allowing for timely risk prevention tactics. In addition, projects that conform to EA can benefit from the fact that issues at the enterprise-level have already been solved in the EA, thus mitigating risk and improving the chances of success, instead of building on sand (Capgemini, 2007; Mulholland and Macaulay, 2006; Pulkkinen and Hirvonen, 2005). On a similar note, EA can be used to align the project with its context, resulting in high quality (B15) and relevant functionality (B16).

Working with EA enables projects to manage complexity. EA is said to enable projects to deal with complexity (B17) (Capgemini, 2007). Analogous to controlling complexity at the organizational level, EA facilitates management of project complexity by using aspect areas, levels of abstraction, a modular approach, up-front decision making, and by standardized services, processes

and systems (ibid.; Lankhorst et al., 2005; Ross et al., 2006). This should simplify project tasks, especially since certain issues should already have been resolved by the Enterprise Architecture.

Working with EA speeds up the initialization of a project. An EA provides models of the enterprise, which help to specify the project scope and avoid redundant development activities (Bucher et al., 2006). Furthermore, several decisions have been made up-front and can be readily leveraged, e.g. by using a PSA (Wagter et al., 2005). Therefore, projects that have to conform to EA are expected to get initialized relatively fast (B18).

7.4 Research Design

The research method for testing the model and hypotheses is an online survey and subsequent statistical analysis of its perceptual measures. The target population is defined as "all people working in the Netherlands in commercial or public organizations (either as internal employees or external consultants) who in a professional capacity have to deal with Enterprise Architecture (either as an EA creator, an EA user or both)." The unit of analysis is the individual worker, who is asked about his or her perceptions of EA functioning in practice. The reasons for choosing this unit of analysis is that it allows for obtaining insights from different perspectives (enterprise architects, managers, system analysts, software architects, et cetera) and for asking questions referring to the project and organization level alike (from an individual's perspective, that is). When choosing e.g. a project as the unit of analysis, it is more difficult to obtain these divergent views (as the questionnaire is usually filled in only by the project manager involved) and levels (as analysis is restricted to the project as object of study). See 7.6 for a discussion on 'objective' versus 'subjective' measures.

The design of the survey underwent several iterations. The questionnaire was first created as a written document by the principal researcher, which was reviewed by the other authors and a questionnaire expert from Statistics Netherlands. This led to several improvements in the design, e.g. using question-dependent response categories and textual clarifications. The resulting questionnaire design was used to create the web-survey, which was similarly reviewed. Finally, we verified the web-survey with three test-respondents (who worked for a government agency and an IT service provider). They had to fill in the questionnaire whilst articulating their thoughts out loud, so as to let us gain insight into the minds of respondents. This yielded several small simplifications and clarifications.

Since we did not specifically target executives, promising benchmarking reports would not have increased responses. We therefore opted for a relatively short questionnaire, containing 45 questions. At any moment during the survey

session, respondents could see what percentage of the questions they had filled in, encouraging them to complete it. Because of the relatively short questionnaire, we had limited opportunities to use reflective latent constructs.

All survey questions explicitly referred to the current (or latest) organization in which the respondents actually carried out their work, for example because they were an employee or because they were posted there as an external consultant. The term "Enterprise Architecture" was defined at the beginning of the survey. The first survey question explicitly asked whether the respondent has to deal with EA in his or her work (if not, the survey was terminated). In general, questions featured five closed response categories (e.g. from *Very poor* to *Very good*) and one *No answer* category (in case the respondent did not know or did not want to provide an answer).

Since registers containing contact information of the individuals comprising our target population were not available, we used several communities related to information systems and architecture. First, an e-mail containing the hyperlink to the web-survey was sent to relations and employees of several IT-service providers and IT-intensive organizations. Secondly, the web-survey was advertised at two architecture conferences in the Netherlands attended mainly by practitioners. The data were gathered between October 2009 and May 2010.

In total, we received 293 valid surveys. A questionnaire had to pass several checks to be accepted as valid. First, it had to be completed and submitted. Secondly, it was checked whether there was a basic consistency between key variables. If the respondent's score on B11 was (very) poor, then B1, B2 and B7 were not allowed to all be scored (very) good. Likewise, if the respondent's score on B11 was (very) good, then B1, B2 and B7 could not be (very) poor. Thirdly, since we did not work with website passwords, we performed basic duplicate records checks. However, only unique records were found – and it required merely 11 included variables for a query to return zero duplicates.

7.5 Research Results

The following four sub-sections present: descriptive statistics and sample representativeness; results of testing simple (singular) hypotheses; differences between EA creators and EA users; regression analysis and the resulting model.

7.5.1 Descriptives and Representativeness

The respondents were working for 116 different organizations. Whereas general questions yielded high responses, several individual questions resulted in quite some nonresponse (i.e. item-nonresponse). This was probably due to the fact that such questions demanded very specific experience, which not every

respondent possessed. Males dominate the field, 268 in total (91.5%), versus only 21 (7.2%) of the respondents being female and 4 (1.4%) unspecified. The tables below present the distribution of organizational roles. With regard to Table 7.1, note that individuals can work in multiple roles, resulting in a total of over 100%. Because of its relevance to our research goals, we consider it desirable to have a sample distribution that features a roughly equal number of EA users and EA creators. We conclude from Table 7.2 that this condition is satisfied.

Role		Frequency	Percentage
EA Creator	Enterpr Architect Business & Inform	97	33.1%
	Enterpr Architect Application & Infrastr	95	32.4%
	Manager	39	13.3%
	External EA Consultant	19	6.5%
EA User	Manager	42	14.3%
	Project Manager	39	13.3%
	Project Architect	56	19.1%
	Business Analyst/Designer	34	11.6%
	System & Information Analyst/Functional Designer	26	8.9%
	Software Architect	35	11.9%
	Technical Designer	19	6.5%
	Developer/Programmer	8	2.7%
	Maintenance Engineer	8	2.7%

Table 7.1. Roles occupied by respondents (multiple roles allowed)

Role	Frequency	Percentage
EA Creator	107	36.5%
EA User	109	37.2%
EA Creator and User	65	22.2%
Unknown	12	4.1%
Total	293	100%

Table 7.2. EA Creators and users

# Employees	Frequency	Percentage
<2000	81	27.7%
2000-5000	78	26.6%
≥5000	128	43.7%
Unknown	6	2.0%
Total	293	100%

Table 7.3. Organizational size

In order to assess the representativeness of our sample, we looked at the economic sectors. Since we could not use a pre-defined sampling frame corresponding with our target population (e.g. a population register of EA stakeholders), it was difficult to determine the extent to which our sample constitutes a representative subset. However, we could use previous research on EA for a comparison of sector distributions. Table 7.4 presents the distributions of our survey and those of two other studies. The column on the right (in white) presents the distribution found by Obitz & Babu K (2009) in their survey with 173 respondents drawn from the global IT community (mainly North America). The middle column (in gray) contains our results. The left column presents the distribution found by Bucher et al. (2006).

Since we asked consultants posted at clients' offices to fill in the questionnaire from the perspective of their customer organization, this group was largely dispersed amongst the other sectors. We therefore have also dispersed the Professional services category of Obitz and Babu K (2009) in order to obtain a better comparison. The left and right columns demonstrate that the various industry distributions of these two studies are fairly similar. Our collapsed Public administration, education and research category is large, however, compared to Obitz & Babu K. This is consistent with the fact that the public sector in the Netherlands is large compared to that of North America. The left column presents the distribution of Bucher et al. (2006) of the respondents who indicated that EA is "in use". It features only a subset of our economic sectors, but this distribution is also similar to that of our sample. All in all, given the fact that the distributions are largely similar, we assume there is no reason to suspect that our distribution of economic sectors is not representative.

Table 4. Distribution of respondents across economic sectors							
Bucher et al. (2006)		**Research in this paper**				**Obitz and Babu K (2009)**	
Industry	**%**		**Industry (based on ISIC Rev. 4)**	**%**		**%**	**Industry**
Finance and insurance	62.5	61.8	Financial and insurance activities	30.4	30.4	28.4	Banks, insurance, financial services and capital markets
Industry	12.5	13.2	Manufacturing (products and food) and construction	5.5	6.5	4.9	Industrial goods/engineering, food, beverage, tobacco, pharmaceuticals & biotech
			Agriculture, fishing, forestry and mining	1.0			
Software, IT and Telecommunication	25.0	25.0	Information, communication, entertainment and recreation	12.3	12.3	16.1	Media, information, entertainment, telecom services, travel and leisure
Total	100%	100%	Public administration (including defense)	31.1	32.8	23.5	Government, education, aerospace and defense
			Education and research	1.7			
			Energy & water supply and waste management	5.1	5.1	6.2	Oil, gas and utilities
			Human health and social work activities	2.7	2.7	7.3	Healthcare services
			Trade, transportation, hotel, catering, real estate and other services	10.2	10.2	13.6	Retail, transportation, logistics and other
			Unknown	0	0	N.a.	Professional services
			Total	100%	100%	100%	Total

Table 7.4. Distribution of respondents across economic sectors

7.5.2 Testing Simple Hypotheses on Conformance and Benefits

This sub-section will address the first three sub-questions of this chapter. Since we used ordinal data and had no prior theoretical or empirical information about the distribution of the scores, we used a non-parametrical test. Each statement was subjected to a one-sided *binomial test*. The test proportion used was dependent on the type of question. For example, a first type of question, factual by nature and related to the techniques, verifies specific characteristics of the EA approach (e.g. whether projects are being assessed on compliance with EA). The null hypothesis, assuming the distribution $B(n, 0.4)$, states that EA approaches generally do not possess the respective characteristic in abundance and is thus supported by the *Never* and *Seldom* response categories (one would consequently expect 40% or more of the respondents to fall in either of these two categories). The alternative hypothesis, which states that less than 40% falls within these two categories, is therefore supported by the *Sometimes*, *Frequently* and *Always* categories (i.e. assuming that EA approaches generally do possess the respective characteristic, one would expect significantly more than 60% of the answers to fall in these three categories). See Table 7.5 (except T1) for examples of this type of question. A second type of question, evaluative by nature and related to the benefits, verifies whether EA is seen as a valuable instrument for achieving a specific goal (such as cost reduction). Here, the null hypothesis, assuming the distribution $B(n, 0.6)$, states EA is not particularly valuable and is supported by the *Very poor*, *Poor* and *Neither good nor poor* response categories (i.e. at least 60% is expected to fall in either of these three categories) and the alternative hypothesis covers the *Very good* and *Good* categories (i.e. more than 40% is expected). See Table 7.6 for examples of this type of question. Regardless of the type, respondents in the *No answer* category were always treated as missing values and therefore not included in the test.

The first column of table 7.5 on the next page contains the statement from the survey (i.e. the alternative hypothesis representing the claim to be tested), the second to sixth columns (except for T1) provide the valid percentage of answers, the seventh gives the number of nonrespondents (which are invalid and therefore excluded from the binomial test), the eighth presents the p-value and the final column indicates whether the alternative hypothesis was accepted (p-values between 0.05 and 0.10 are seen as inconclusive). The gray columns present the percentages of respondents that support the alternative hypothesis. An underlined percentage denotes the respective value as the median.

One-sided tests were performed. An asterisk in the p-value column therefore indicates that a reversed test needed to be performed for that specific claim. That is, unlike the hypotheses without an asterisk, the low p-value of this hypo-

thesis shows that significantly more than 40% of the respondents fall in the *Never* or *Seldom* categories. A similar logic applies to statements in other tables with a significant p-value but a rejected H1 hypothesis.

H1 statement	No	Yes	NR	P-value	H1?
T1. The EA is formally approved (i.e. by line management).	20.4%	79.6%	19	0.000	✓

H1 statement	Never	Seldom	Sometimes	Frequently	Always	NR	P-value	H1?
T2. The choices made in the EA are explicitly linked to the business goals of the enterprise as a whole.	0.4%	4.9%	28.5%	52.5%	13.7%	9	0.000	✓
T3. Management propagates the importance of EA.	2.8%	19.3%	46.4%	27.3%	4.2%	4	0.000	✓
T4. Projects are being explicitly assessed on their degree of compliance with EA. [Note: this concerns the number of projects being judged on compliance (not the number of times one project is being assessed).]	4.8%	11.1%	24.9%	42.9%	16.3%	4	0.000	✓
T5. There is an organized knowledge exchange between different types of architects (for example enterprise, domain, project, software and infrastructure architects).	1.5%	12.9%	34.3%	44.3%	7.0%	22	0.000	✓
T6. There is an organized knowledge exchange between architects and other employees participating in projects that have to conform to EA (for example project managers, functional designers, developers and testers).	2.5%	15.4%	44.2%	35.4%	2.5%	8	0.000	✓
T7. Assistance is being offered in order to stimulate conformance to EA. (For example enterprise architects or change managers who help projects to make new designs conform to EA.)	4.9%	19.3%	34.3%	36.1%	5.4%	13	0.000	✓
T8. Projects make use of a PSA (Project Start Architecture).	8.9%	10.0%	24.4%	40.9%	15.8%	14	0.000	✓
T9. Document templates are being used to stimulate conformance to EA. (For example templates that focus attention on the EA by means of guiding texts and by requiring filling in relevant information.)	5.0%	11.4%	33.4%	37.0%	13.2%	12	0.000	✓
T10. Financial rewards and disincentives are being used in order to stimulate conformance to EA. (For example by covering the IT-expenses of a project if the solution is designed and built conform EA, or by imposing a fine for non-conformance.)	65.6%	17.9%	10.3%	5.5%	0.7%	20	0.000*	×

Table 7.5. Techniques used for stimulating compliance

In general, we can conclude that most techniques for encouraging compliance are used regularly, as indicated by the acceptance of the alternative hypotheses in almost all cases. However, quite notable is the fact that financial sanctions are not being used to stimulate EA compliance. No less than 83.5% of the respondents indicated that they are *Seldom* or *Never* used, with the median even falling within the most extreme category (the lowest level). It can be hypothesized that financial penalties are difficult to implement (perhaps especially so in the Dutch culture of tolerance and compromise). However, this survey question also referred to financial incentives and presented respondents with an example of providing projects with free IT-resources if they should conform to EA. It is possible that financial sanctioning (rewarding or punishing) is a tactic that has unexploited potential.

Tables 7.6, 7.7 and 7.8 present the evaluations of the benefits of EA. In general, extreme scores, such as *Very good* or *Very poor*, were not commonly given by the respondents. This is not entirely unexpected, since the respondents are professionals reporting about their work and the subject matter is not as sensitive as certain social or political issues. In addition, most respondents only had a few years of experience with EA, possibly resulting in moderate attitudes.

Looking at Table 7.6, we see that EA, in general, is considered to be a good instrument (B11). Several notable findings are worth looking into. Although various individual hypotheses are accepted, it seems that most positive perceptions are held regarding the *sub-goals*, whereas the *ultimate goals* are not being judged as positively. This is especially apparent in 74.1% of the respondents indicating that EA is a (very) good instrument to provide insight into the complexity of the organization (resulting in our acceptance of this hypothesis), whereas merely 29.4% of the respondents indicate that EA is a (very) good instrument to control the complexity of the organization (resulting in our rejecting this claim). Also, 71.9% state that EA is a (very) good instrument to depict a clear image of the desired future situation, and 55.6% that EA is a (very) good instrument to standardize, integrate and/or eliminate redundant processes and systems (resulting in the acceptance of both statements). However, a mere 13.4% actually indicates that EA is a (very) good instrument to control costs. The relationship with the outside world could also be better, with only 28.2% stating that EA is a (very) good instrument to co-operate with other organizations effectively and efficiently, and 25.3% that it is a (very) good instrument to react to changes in the outside world in an agile fashion. Furthermore, EA does not seem to be a highly effective means for achieving business/IT alignment. In other words, EA yields several benefits that are valuable in their own right and conditional for obtaining further value, but, as yet, has not achieved its full promised potential.

H1 statement EA turns out to be a good instrument to…	**Very poor**	**Poor**	**Neither good nor poor**	**Good**	**Very good**	**NR**	**P-value**	**H1?**
B1. …accomplish enterprise-wide goals, instead of (possibly conflicting) local optimizations.	2.5%	13.5%	31.3%	<u>44.3%</u>	8.4%	18	0.000	✓
B2. …achieve an optimal fit between IT and the business processes it supports.	2.6%	16.6%	<u>38.0%</u>	40.6%	2.2%	22	0.189	×
B3. …provide insight into the complexity of the organization.	1.1%	6.4%	18.4%	<u>64.6%</u>	9.5%	10	0.000	✓
B4. …control the complexity of the organization.	1.9%	21.1%	<u>47.6%</u>	27.6%	1.8%	18	0.000*	×
B5. …integrate, standardize and/or deduplicate related processes and systems.	2.2%	11.2%	31.0%	<u>48.4%</u>	7.2%	16	0.000	✓
B6. …control costs.	5.4%	31.8%	<u>49.4%</u>	11.5%	1.9%	32	0.000*	×
B7. …enable the organization to respond to changes in the outside world in an agile fashion.	1.9%	22.6%	<u>50.2%</u>	24.2%	1.1%	28	0.000*	×
B8. …co-operate with other organizations effectively and efficiently.	1.6%	14.3%	<u>55.9%</u>	25.8%	2.4%	48	0.000*	×
B9. …depict a clear image of the desired future situation.	0.4%	4.2%	23.5%	<u>59.3%</u>	12.6%	8	0.000	✓
B10. EA turns out to be a good frame of reference to enable different stakeholders to communicate with each other effectively.	0.7%	13.0%	<u>40.1%</u>	43.0%	3.2%	16	0.021	✓
B11. EA, in general, turns out to be a good instrument.	1.1%	7.9%	30.0%	<u>56.7%</u>	4.3%	13	0.000	✓

Table 7.6. Evaluations of EA benefits for the organization as a whole

Looking at Tables 7.7 and 7.8, we see that the number of nonrespondents is much higher for questions regarding projects than for those regarding the organization as a whole. The free-text option at the end of the survey provides some clues as to why. For example, some Enterprise Architectures focus not on internal project decisions, but on e.g. high-level project portfolios instead. Some respondents also indicated that all projects had to conform to EA, making it hard to distinguish between conforming and non-conforming initiatives. Furthermore, working with EA was relatively new in several organizations, making it difficult to evaluate projects in the context of architecture, especially because these questions were quite detailed. Table 7.7 shows that projects conforming to EA clearly deliver higher quality. This is interesting, as we included this quality claim in the questionnaire for reasons of completeness, not because of its prevalence in the literature (although claims that EA helps the organization to comply with quality standards such as ISO 9001 can be found). No such convincing support was found for delivering this type of project within time and budget limits. Rejection of better delivery of functionality is somewhat less convincing, since respondents did provide positive evaluations, albeit not in sufficiently convincing numbers. Furthermore, although it appears that EA simply does not offer projects much in the way of time and cost savings, it should also be noted that respondents have scored none of these four standard aspects very negatively.

Interestingly, whereas respondents reported that EA is not particularly capable of controlling complexity at the organizational level, EA does seem to enable projects to deal with complexity at the project level. Given the narrower scope of projects, this makes sense. Organization-wide ambitions will have to deal with far more incompatible systems, processes and stakeholder interests than more locally oriented projects. In addition, EA may provide compliant projects with an advantage over other projects by giving them insight into organizational complexity (for which, as we have seen, EA is very well-equipped). This enables projects to deal with complexity at the local level. A similar explanation may be provided for the fact that the results support the statement that projects conforming to EA are better equipped to deal with risks.

Also interesting is the fact that we did not find support for the hypothesis that projects conforming to EA are initialized faster than projects that do not have to conform. In fact, significantly more than 40% ($p=0.000$) of the respondents stated that these projects actually start up (much) slower than projects not conforming to EA. This might be the result of the additional commitment that EA brings to bear on projects, such as getting acquainted with EA prescriptions, undergoing compliance assessments, dealing with additional stakeholders and balancing possible conflicts between local and enterprise-wide interests. Furthermore, the assumption behind many purported project benefits,

namely that many decisions have already been taken in the EA, may very well be questioned. In this respect, however, it is a notable finding that according to the respondents projects generally do tend to conform to EA.

H1 statement Projects conforming to EA turn out to…	**Much more often**	**More often**	**As often**	**Less often**	**Much less often**	**NR**	**P-value**	**H1?**
B12. …exceed their budgets less often than projects that do not have to conform to EA.	2.4%	15.7%	60.8%	19.3%	1.8%	127	0.000*	✗
B13. … exceed their deadlines less often than projects that do not have to conform to EA.	1.7%	21.3%	59.2%	16.7%	1.1%	119	0.000*	✗
B15. …deliver the desired quality more often than projects that do not have to conform to EA.	3.7%	53.4%	37.0%	5.3%	0.5%	104	0.000	✓
B16. …deliver the desired functionality more often than projects that do not have to conform to EA.	3.8%	40.4%	45.4%	9.8%	0.5%	110	0.136	✗

H1 statement Projects that have to conform to EA turn out to…	**Much better**	**Better**	**Neither better nor worse**	**Worse**	**Much worse**	**NR**	**P-value**	**H1?**
B14. …be better equipped to deal with risks than projects that do not have to conform to EA.	2.9%	48.3%	43.1%	5.2%	0.5%	82	0.001	✓
B17. …be better equipped to deal with complexity (of the project and/or its immediate environment) than projects that do not have to conform to EA.	5.3%	63.6%	26.7%	4.0%	0.4%	68	0.000	✓
H1 statement	**Much slower**	**Slower**	**Neither slower nor faster**	**Faster**	**Much faster**	**NR**	**P-value**	**H1?**
B18. …get initialized faster than projects that do not have to conform to EA.	5.4%	45.9%	38.3%	10.4%	0.0%	71	0.000*	✗
H1 statement	**Always**	**Frequ-ently**	**Sometimes**	**Seldom**	**Never**	**NR**	**P-value**	**H1?**
O1. Projects that are required to conform to EA turn out to actually conform to the architectural principles, models and other prescriptions.	4.2%	61.0%	26.7%	8.1%	0.0%	57	0.000	✓
O2. Principles, models and other architectural prescriptions turn out to be open to multiple interpretations.	2.7%	27.8%	57.0%	11.8%	0.8%	30	0.000	✓

Table 7.7 (right) and 7.8 (left). Evaluations of EA benefits and conformance for projects

The results also demonstrate that principles, models and other architectural norms turn out to be open to multiple interpretations. However, considering the results of chapters 2, 3 and 6, more respondents could have been expected to go for *Always* or *Frequently*. Most respondents opted for *Sometimes*, which is not the strongest support for the alternative hypothesis. One reason might be that prescriptions in most organizations are only moderately ambiguous. Alternatively, it could be that compliance assessments are usually carried out in a collaborative fashion, resulting in reduced disagreement (see 6.9). People might also implicitly assume agreement, with disagreement only manifesting itself when being explicitly confronted with it. See chapter 9 for more on this issue.

We also asked why projects are being assessed on compliance with EA. Of the 275 respondents who stated that projects are being assessed (T4) *Seldom*, *Sometimes*, *Frequently* or *Always*, 49.5% indicated that this is being done in the context of obtaining permission from management for the actual implementation (a "building permit"). Furthermore, 34.5% indicated that it is input for a formal management decision (e.g. re-alignment), 49.5% that the reason is creating project awareness of deviations from the EA, and 28.7% that it is done for post-project awareness.

7.5.3 Differences Between EA Creators and EA Users

We will now focus on the fourth sub-question. *Chi-square* tests (Norušis, 2008) were employed to study whether statistically significant differences exist between evaluations of EA creators and EA users. The tables below present the percentage of EA creators and users giving *Good* or *Very Good* scores, the non-applicable respondents (NAR), the p-value of a 2·2 Pearson chi-square test with 1 degree of freedom, and whether we accept there is a difference in evaluation between EA creators and EA users. We excluded respondents who are simultaneously EA creator and EA user, which explains why the number of reported non-applicable respondents is conspicuously high (especially for projects, as presented in Table 7.10). The tables only show the differences that are either statistically significant or inconclusive.

As can be seen from Tables 7.9 and 7.10, in cases demonstrating a statistically significant difference, EA creators consistently prove to be more positive in their evaluation. This is demonstrated convincingly by the fact that creators are significantly more positive on the question of whether EA, in general, turns out to be a good instrument (B11). Although both groups are quite positive, 71.0% of the EA creators state that EA is a (very) good instrument, against 53.3% of the EA users. In addition, the two statements related to EA's communicative power (depicting a clear image and enabling effective communication) also show a difference. Other significant differences at the organizational level

H1 statement EA turns out to be a good instrument to…	**EA creators: (Very) Good**	**EA users: (Very) Good**	**NAR**	**P-value**	**Difference?**
B2. …achieve an optimal fit between IT and the business processes it supports.	51.6%	37.9%	95	0.052	**?**
B3. …provide insight into the complexity of the organization.	78.6%	66.3%	86	0.048	✓
B5. …integrate, standardize and/or deduplicate related processes and systems.	64.6%	47.6%	91	0.015	✓
B8. …co-operate with other organizations effectively and efficiently.	32.6%	18.6%	118	0.034	✓
B9. …depict a clear image of the desired future situation.	81.0%	66.3%	84	0.017	✓
B10. EA turns out to be a good frame of reference to enable different stakeholders to communicate with each other effectively.	53.5%	35.6%	91	0.011	✓
B11. EA, in general, turns out to be a good instrument.	71.0%	53.3%	88	0.009	✓

Table 7.9. EA creator and user evaluations of EA benefits for the organization as a whole

concern providing insight into complexity, standardization and integration. At the project level, delivering desired quality and functionality, and dealing with complexity and risks demonstrate significant differences.

In short, EA creators are significantly more positive than EA users on several issues. Social psychology literature provides crucial insights for explaining these evaluative differences. Due to their involvement and commitment, EA makers should be regarded as subjective sources of information on EA. The binding effect of an earlier commitment (i.e. becoming an enterprise architect) results in them possessing a relatively positive attitude towards EA, and to not being easily persuaded by critical signals on its effectiveness (Zimbardo and Leippe, 1991). EA users may be no less subjective, though, as they cannot view the overall picture due to their local focus. Moreover, when conforming to EA, projects members have to deal with additional effort and complexity (as evidenced by the fact that all parties agree that these projects tend to get initialized more slowly; see also observation 2 in section 3.4.1). This may temper their enthusiasm regarding EA. Therefore, in order to have a balanced view, it is of paramount importance to take both perspectives into account.

7.5.4 A Model for EA Conformance and Benefits

To investigate which *techniques* have a significant effect on *project conformance to EA* and identify the determinants of *EA benefits*, we carried out several analyses. In order to investigate which techniques are associated with project conformance, we started out by measuring ordinal association (using Kendall's tau-b and Spearman's rho) and carried out univariate regression analyses. This revealed statistically significant bivariate associations between project conformance to EA (O1) and eight out of ten individual techniques (in descending order, according to tau-b: T4, T3, T7, T6, T2, T9, T5, T8). However, in order to control for the influence of other factors and explain the variation of dependent variable project conformance in terms of each technique's unique contribution, we needed to combine the variables in a single *multivariate regression model*. Since dependent variable conformance was measured on a five-point scale, we opted to employ ordinal regression[2] to construct the model (cf. Chen and Hughes, 2004; Norušis, 2009; Weisburd and

2 Although some researchers use linear regression with 5-level ordinal variables (Garson, 2010), we do not consider this the most appropriate technique here, especially given the fact that alternatives are widely available in software packages nowadays. Also note that we use the term "multivariate" to refer to a model with multiple independent variables (cf. Weisburd and Britt, 2007; Leech et al., 2005), not to a model with multiple dependent variables. The term "univariate regression" refers to a model in which the dependent variable has one independent variable.

Statement Projects conforming to EA turn out to…	**EA creators: (Much) more often**	**EA users: (Much) more often**	**NAR**	**P-value**	**Difference?**
B15. …deliver the desired quality more often than projects that do not have to conform to EA.	75.4%	42.3%	157	0.000	✓
B16. …deliver the desired functionality more often than projects that do not have to conform to EA.	52.5%	33.3%	163	0.028	✓
Statement	**(Much) less often**	**(Much) less often**	**NAR**	**P-value**	**Difference?**
B13. …exceed their deadlines less often than projects that do not have to conform to EA.	24.1%	10.6%	169	0.045	✓
Statement	**(Much) better**	**(Much) better**	**NR**	**P-value**	**Difference?**
B14. …be better equipped to deal with risks than projects that do not have to conform to EA.	60.8%	33.3%	141	0.001	✓
B17. …be better equipped to deal with complexity (of the project and/or its immediate environment) than projects that do not have to conform to EA.	76.9%	55.8%	129	0.004	✓
Statement	**(Much) slower**	**(Much) slower**	**NR**	**P-value**	**Difference?**
B18. …get initialized faster than projects that do not have to conform to EA.	45.3%	60.2%	130	0.057	**?**
Statement	**Always or Frequently**	**Always or Frequently**	**NR**	**P-value**	**Difference?**
O2. Principles, models and other architectural prescriptions turn out to be open to multiple interpretations.	20.8%	39.8%	99	0.004	✓

Table 7.10. EA creator and user evaluations of EA benefits for projects

Britt, 2007). This logistic technique is based not on least squares, but on cumulative probabilities instead. In terms of assumptions, ordinal regression requires neither a normal distribution nor identical variance, but there is the strict demand of parallel slopes (which requires that the effects of the independent variables are constant across all categories of the dependent variable). Several link functions are available, each of which performs best in a specific condition. For example, the logit (odds ratio) is typically applied for evenly distributed categories, while the complementary log-log (cloglog) performs better when higher categories are more probable (Norušis, 2009).

We subsequently built two full multivariate regression models, comprising all independent variables. One model included all techniques, the other included all techniques as well as all control variables. Due to a possible complete separation in the data (cf. So, 1993) it could not be determined for these models whether the assumption of parallel slopes was violated or not. Moreover, because the number of cells explodes when many variables are included, dispersion of respondents results in poorer cell filling, making it harder to obtain statistically significant results. Despite the above, both full models did point our attention to three techniques that, even with all independent variables in the model, were highly statistically significant: management propagation of EA (T3), compliance assessments of projects (T4) and assistance for projects (T7). Since the other techniques and contextual variables are controlled for, this is a very strong indication that these three techniques are important determinants of compliance. From here, we built various candidate models by combining several variables, from which it became clear that these three were indeed consistently the most robust techniques and were therefore included in the final model. Variables were recoded to obtain a similar meaning (i.e. a higher number always represents more benefits or more intensive use of a technique) and we collapsed the first two levels of each variable. The tables on the next page present the SPSS output for the techniques and conformance section of the model (see Figure 7.2).

Note that in ordinal regression the coefficients are determined at the level of a variable category (albeit for continuous independent variables only one coefficient is calculated). Although at least one category of every independent variable should be statistically significant[3] for the variable to be included in the

3 In this context, a factor represents an ordinal independent variable. The Wald statistic determines if a given category of a factor significantly differs from the reference category of that factor. The choice of reference category (either the highest or the lowest category) therefore influences the Wald statistic and whether the factor is found to be statistically significant or not. In this case, however, reversing the reference category (i.e. taking the lowest value) does not affect the conclusions.

model (Garson, 2010), all of the respective techniques have multiple categories significant at the 0.05 level. Furthermore, no variable has more than one category with a significance level above 0.05 and all categories are significant at the 0.075 level. In addition, the assumption of parallel slopes is not violated with a p-value of 0.472. The complementary log-log link function, which performs best when higher categories are more likely, provided the best results. The three techniques combined result in a good model fit, with a Nagelkerke R^2 of 0.691 (with that of the logit model being 0.427).

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.
Threshold	[ProjectsConform=2]	-6.299	.803	61.480	1	.000
	[ProjectsConform=3]	-4.508	.772	34.086	1	.000
	[ProjectsConform=4]	-1.061	.572	3.439	1	.064
Location	[ComplianceAssessments=2]	-2.339	.473	24.434	1	.000
	[ComplianceAssessments=3]	-2.513	.442	32.347	1	.000
	[ComplianceAssessments=4]	-1.050	.361	8.460	1	.004
	[ComplianceAssessments=5]	0[a]	.	.	0	.
	[ManagementPropagation=2]	-1.521	.521	8.505	1	.004
	[ManagementPropagation=3]	-.914	.479	3.641	1	.056
	[ManagementPropagation=4]	-1.218	.483	6.369	1	.012
	[ManagementPropagation=5]	0[a]	.	.	0	.
	[Assistance=2]	-.951	.479	3.943	1	.047
	[Assistance=3]	-.982	.466	4.437	1	.035
	[Assistance=4]	-.903	.436	4.298	1	.038
	[Assistance=5]	0[a]	.	.	0	.

a. This parameter is set to zero because it is redundant.

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	270.554			
Final	63.058	207.496	9	.000

Link function: Complementary Log-log.

Pseudo R-Square

Cox and Snell	.596
Nagelkerke	.691
McFadden	.457

Link function: Complementary Log-log.

SPSS output

When interpreting the model, we see that all relationships are positive. Although counter intuitive, in ordinal regression a positive association is represented by negative coefficients. Interpret it as follows for any given technique: after controlling for the other two independent variables in the model, respondents in organizations in which the technique in question is never or seldom used (i.e. the collapsed level 2) are less likely to assign higher conformance scores than respondents in organizations in which the technique is always used (i.e. level 5, or the reference category). In short, the more a technique is used, the higher the achieved level of conformance. The Estimates (coefficients) provide clues as to the magnitude of the effects. Although the complementary log-log link function yields superior predictive and explanatory modeling power here, its coefficients are difficult to interpret (SPSS, 2008). Also, as mentioned above, ordinal regression yields multiple coefficients for a factor when it is ordinal by nature. We therefore calculated a standardized regression coefficient for each independent variable in order to be able to compare the effects of the techniques on conformance. For this, we calculated the frequency-weighted standard error for each factor. While still difficult to interpret in an absolute sense, the resulting standardized coefficients indicate the relative effect size of the techniques. These coefficients are placed near the respective independent variables of Figure 7.2, while the Nagelkerke R^2 (which is easier to interpret) is placed near the dependent variable. From the standardized coefficients we can infer that being assessed on conformance (T4) has the most effect on whether projects will actually conform. The fact that a project will be explicitly confronted with its nonconformance apparently stimulates them to comply with the norms. This could be due to the fact that carrying out compliance assessments is an indication of the importance of conforming or, alternatively, simply to the project's desire to avoid confrontation. Management propagation of the importance of EA (T3) has the second largest influence. Third in rank is providing assistance to the projects in applying the EA's rules and guidelines (T7).

When considering the *benefits*, the results show that a statistically significant positive bivariate association and univariate regression coefficient exists between project conformance and whether EA in general is found to be a good instrument (B11). Running a multivariate regression analysis with all techniques plus conformance as independent variables to explain dependent variable B11 yields one variable with two significant categories (O1 conformance) and two variables with one significant category (T2 EA choices linked to business goals, and T4 compliance assessments). A similar argument can be made for the other benefits, where the strongest association is mostly with conformance rather than with the techniques. This supports the assertion that the three identified techniques indeed do not have a strong direct beneficial effect, but work via project conformance instead.

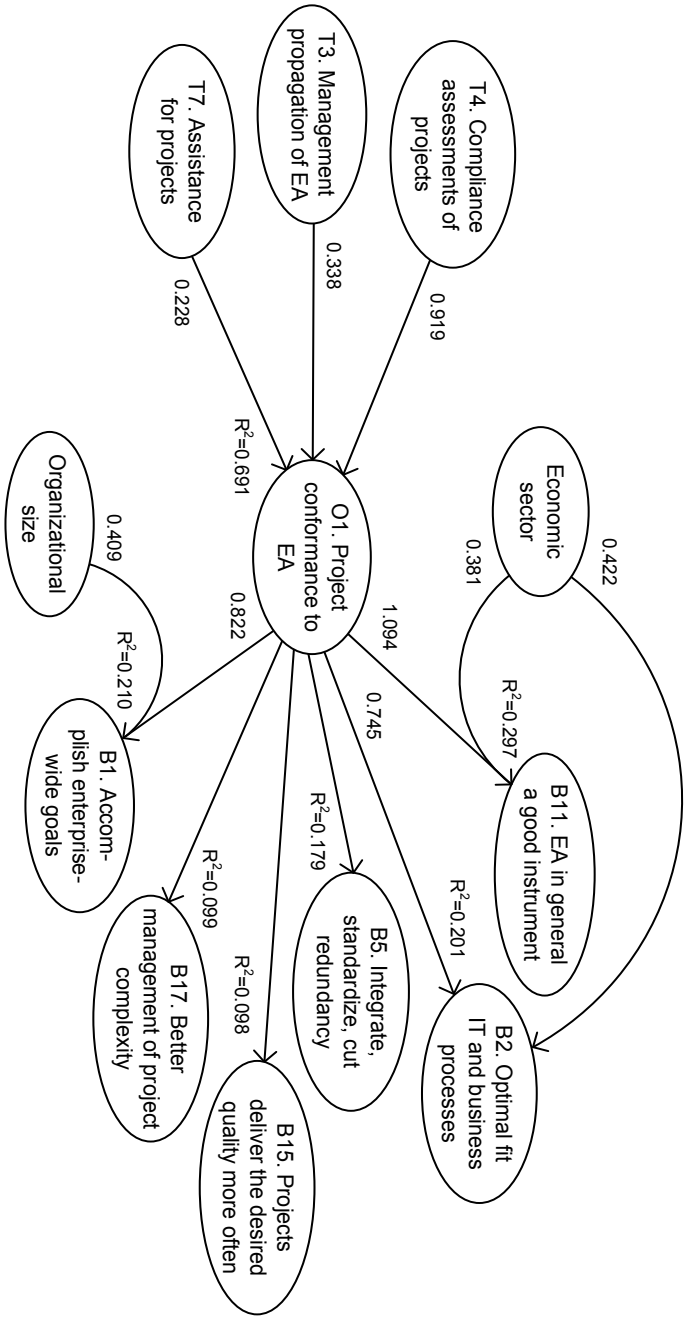


Figure 7.2. The empirical model for EA conformance and benefits

We subsequently studied the relationships between conformance and the individual benefits at both the project and the organizational level. We started out by identifying statistically significant ($p < 0.05$) positive associations (using Kendall's tau-b and Spearman's rho). Next, we created separate univariate regression models, including conformance and the benefit in question. Finally, we studied whether contextual variables could be included to enhance the results with a multivariate model. Regarding the benefits, the logit link function performed slightly better than the complementary log-log. The most interesting effects of project conformance on the benefits are depicted in Figure 7.2, again featuring frequency-weighted standardized coefficients for benefits that are explained by multiple determinants. A complete overview of statistically significant results can be found in Table 7.11.

Four *project benefits* could be attributed to conformance, namely delivering more of the desired functionality (B16) and quality (B15), and better management of complexity (B17) and risks (B14). If there is a high level of conformance, then projects conforming to EA – compared to non-conforming projects – are likely to achieve higher levels of these benefits. Quite interesting is that these results are highly consistent with the results of the direct answers in Tables 7.7 and 7.8, which demonstrated that only hypotheses B14, B15 and B17 were accepted. These findings are rather convincing: they show the internal validity of both the model (as conformance apparently plays a crucial role as a central variable) and the dataset (since direct responses and indirect associations are consistent, which definitely cannot be taken for granted because the respondents are largely unaware of the latter). Furthermore, although the delivery of desired functionality (B16) was rejected in Table 7.7, this benefit is also positively associated with project conformance. This indicates that it may be a benefit of which respondents are not yet fully aware. Indeed, re-examining the corresponding p-value in Table 7.7 reminds us of the fact that the functionality hypothesis was most definitely not rejected as convincingly as the other hypotheses. However, it should be pointed out that a positive association can in principle exist without ever achieving the two highest categories of the benefit. We leave it to the reader to draw his or her own conclusions.

Interestingly, although quite some claimed project benefits proved not to be significantly associated to project conformance, all *enterprise-wide benefits* were indeed significant. The strongest relationships were found for accomplishing enterprise-wide goals (B1), achieving an optimal fit between IT and business processes (B2) and integrating, standardizing and/or eliminating redundancy from related processes and systems (B5). These represent some of the key aims of Enterprise Architecture, the achievement of which in the respondents' experience is dependent on project compliance with EA. Especially for B2 and B5 the important role of projects is not difficult to see: business/IT

alignment and integrating individual processes and systems are typically EA-related issues, but the organization is highly dependent on projects for actual implementation. It is therefore not entirely unexpected to find strong relationships with project conformance here. Weaker, but still statistically significant associations were found for other important goals, such as achieving organizational agility (B7) and providing insight into and controlling the complexity of the organization (B3 and B4). Apparently, project conformance can contribute to resolving the complexity issue, but less so than to the other goals. Controlling costs (B6) and communicating the desired future situation and other concepts (B9 and B10) are somewhere in between in terms of being determined by conformance.

As with the project benefits, we observe the consistency between acceptance of simple hypotheses and the results of the regression analysis. The benefits with the highest Nagelkerke R^2s in Table 7.11 are accepted in Table 7.6 (B1, B5, B10, B11). We also see that B2 is barely insignificant in Table 7.6, which may again point to an unrecognized benefit.

As can be seen from Figure 7.2 and Table 7.11, two contextual variables also make a contribution (visually modeled by arcs). The economic sector partly explains EA being a good instrument (B11), with the *public administration* sector being significantly outperformed by the *financial and insurance* and especially the *others* sectors. The same holds true for business/IT alignment (B2). It therefore seems that it is relatively difficult for public institutions to reap benefits from EA. A reason for this may be the fact that their individual organizational units often have high degrees of responsibility and autonomy, making it harder to demand compliance with standards that are suboptimal from a unit's point of view. Organizational size is a predictor for the extent to which enterprise-wide goals can be accomplished (B1), as organizations with up to 500 workers perform significantly better than organizations with at least 2,000 employees. On the other hand, although we consider the p-value of 0.083 inconclusive here, there are indications that organizations with 500 to 2,000 workers perform less well than organizations with more than 2,000 employees. As can be concluded from the size of the standardized coefficients, the contributions of the contextual factors are relatively small compared to those of project conformance. When *economic sector* is dropped from the model, conformance alone still yields an R^2 of 0.268 when explaining B11, and an R^2 of 0.159 when explaining B2. When *organizational size* is omitted, conformance alone still yields an R^2 of 0.166 when explaining B1. It should be noted that significant effects of *economic sector* were also observed for B7, B15 and B16. However, since the parallel slopes assumption was violated, these were not included in the model. The same holds true for contextual variables in other cases, making it a suitable topic for future research.

Benefit associated with O1 Project Conformance to EA	Kendall's tau-b		Univariate Ordinal Regression (Logit link function)			Multivariate Ordinal Regression (Logit link function)		
	Value	P-value	Nagelkerke Pseudo R^2	Model p-value	Smallest p-value indep	Nagelkerke Pseudo R^2	Model p-value	Smallest p-values indep
B11. EA, in general, is a good instrument	0.424	0.000	0.268	0.000	0.000 **	0.297	0.000	0.000 ** 0.000
Economic sector (related to B11)	N.A.	N.A.	0.040	0.006	0.002 **			
B1. Accomplish enterprise-wide goals	0.353	0.000	0.166	0.000	0.000 *	0.210	0.000	0.000 * 0.000
Organizational size (related to B1)	0.059	0.266	0.028	0.069	0.032			
B2. Achieve optimal fit between IT and business processes	0.333	0.000	0.159	0.000	0.000 **	0.201	0.000	0.000 ** 0.001
Economic sector (related to B2)	N.A.	N.A.	0.055	0.001	0.000 **			
B5. Integrate, standardize and/or deduplicate related processes and systems	0.336	0.000	0.179	0.000	0.000 *			
B10. Good frame of reference to enable different stakeholders to communicate with each other	0.231	0.000	0.111	0.000	0.000 **			
B6. Control costs	0.270	0.000	0.104	0.000	0.007			
B17. Better management of project complexity.	0.199	0.002	0.099	0.000	0.001			
B15. Projects deliver the desired quality more often	0.230	0.001	0.098	0.002	0.013			
B7. Respond to changes in the outside world in an agile fashion	0.219	0.000	0.081	0.001	0.000 *			
B9. Depict a clear image of the desired future situation	0.233	0.000	0.075	0.005	0.049			
B16. Projects deliver the desired functionality more often	0.209	0.003	0.070	0.012	0.007			
B4. Control the complexity of the organization	0.204	0.001	0.063	0.003	0.016			
B3. Provide insight into the complexity of the organization	0.197	0.001	0.060	0.003	0.002			
B14. Better management of project risks	0.157	0.018	0.059	0.017	0.003			
B8. Co-operate with other organizations effectively & efficiently	0.203	0.001	0.055	0.006	0.016 *			

* Multiple categories of the independent variable statistically significant at the 0.05 level
** All categories of the independent variable statistically significant at the 0.05 level

Table 7.11. Overview of significant effects on benefits

Another, more important, remark needs to be made regarding the magnitude of the effects. The Nagelkerke R^2s point to the fact that the effects of project conformance on enterprise-wide benefits are larger than the effects on more locally oriented project-level benefits. Regardless of whether contextual factors are included in the models, the benefits with the highest R^2s (i.e. above 0.100) are at the organizational level, e.g. B1, B2 and B5. This implies that (project conformance to) EA is indeed an important factor in achieving enterprise-wide benefits and goals. This is consistent with the accepted hypothesis B1 (see

Table 7.6), which states that EA is a good instrument to accomplish enterprise-wide goals, instead of possibly conflicting local optimizations. As this is one of the key claims of Enterprise Architecture, these are important findings.

It was verified whether interaction effects exist between included factors, which could increase the explanatory power of the model, but none were found. Furthermore, all relationships were checked for confounding effects by controlling for the influence of contextual variables *economic sector*, *organizational size* and *EA focus*. However, the techniques (when explaining conformance) and conformance (when explaining benefits) retained their significant effects, regardless of whether or not the contextual variables themselves significantly contributed to the model.

Furthermore, since Figure 7.2 is technically comprised of several regression models (each Nagelkerke R^2 represents a separate, independent statistical model), the model as a whole does not have the property of transitivity. Therefore, effects of techniques cannot be calculated in terms of benefits. Take also into account that the project benefit variables are not absolute measures but represent the degree to which conforming projects outperform non-conforming projects on the respective aspects. Finally, the relatively low Nagelkerke R^2s on the right-most arrows do not mean that these benefits are not observed in practice (revisit Tables 7.6 to 7.8 to verify this), but that conformance and economic sector only explain part of the variation of the EA benefits. Further research should therefore focus on identifying other relevant factors, such as quality aspects of the EA itself.

7.6 Conclusions and Further Research

This survey study has yielded several contributions to the field of EA. In answering the first research question, we have shown which techniques for stimulating compliance with EA are used in practice. The research results show that, except for sanctioning, all techniques identified are used in practice. To address the second and third research questions, we presented the evaluative perceptions of people who have to deal with EA in a professional capacity. Evaluations prove to be positive on many accounts, both for individual systems development projects and the enterprise as a whole, but sub-goals (e.g. gaining insight into complexity) seem to be more easily achieved than ultimate goals (e.g. actually controlling complexity). With regard to the fourth research question, we have shown that EA creators and EA users differ in their evaluations regarding EA on many accounts, with the former having a relatively positive attitude. As an important implication of this, future research on EA should take both perspectives into account, so as to prevent one-sided representation and

less valid results. In answering the fifth research question, several positive relationships were found between techniques, conformance and benefits. We started out by identifying eight significant associations between compliance stimulating techniques and actual conformance. Using multivariate regression analysis, three techniques in particular have been identified which together explain project conformance to EA to a large extent. Finally, compliance with EA is shown to be positively associated with several benefits at both the project and the organizational level. These findings also show that project compliance is an important factor in obtaining value from the usage of EA. This is not only because the identified techniques seem to work *via* conformance, but also because conformance helps in realizing the key goal of gaining *enterprise-wide benefits*. The empirical results therefore establish project compliance with EA as a crucial factor in organizational performance. Another finding of this study is that some of EA's benefits may not yet be fully recognized by its practitioners.

Although our dataset and model demonstrated highly consistent results, there are several limitations to consider. First, we have been measuring perceptions of respondents instead of objective results. This is not problematic, however, as this is often the case with evaluative survey research. Moreover, perceptions have long ago been established as a valid indicator of organizational performance. Furthermore, so-called objective measures tend to have their own fundamental shortcomings, such as definitions that differ between organizations in such a way as to threaten comparability (Dess and Robinson, 1984; Venkatraman and Ramanujam, 1987; Wall et al., 2004). Furthermore, our dataset proves to be quite internally valid, as direct responses (Tables 7.6, 7.7 and 7.8) and associations are highly consistent on crucial aspects. Secondly, the usual limitations of causal analysis based on observational rather than experimental data apply. This also shows that the use of the aforementioned perceptions is a satisfactory approach, since using 'objective' measures (such as actual costs) will not yield more valid results in a non-laboratory setting. This is simply because it is impossible to fully control for non-EA factors, such as organizational culture when measuring simultaneously, or economic crises in the case of longitudinal research. That being said, however, regression analysis is an excellent method to simulate a true laboratory setting as much as non-experimental settings allow.

Thirdly, although the EA conformance and benefits model adheres to the strict assumptions of ordinal regression, it is important to mention its limitations. At 50%, the number of empty cells is high, rendering some additional chi-square Goodness-of-Fit measures unreliable (although they did pass). On the other hand, it does not seem that the empty cells are the result of biasing nonresponse. Empty cells are in part the result of the skewed distribution – which made binomial testing and the complementary log-log link

function so effective – and the relative absence of extreme values in general. Consequently, this does not lead to the conclusion that a bias exists, as empty cells simply represent empirically less relevant categories. Reducing the number of empty cells can be achieved by collapsing adjacent levels. However, as ordinal information is lost, statistical power decreases (rendering levels statistically insignificant). It also often results in the parallel slopes test yielding an either violated or inconclusive outcome. Another drawback of using ordinal regression, or at least the complementary log-log, is the fact that interpreting the results is less precise (although this does prevent the false precision to which other methods are prone).

Despite the limitations mentioned, we consider this a valuable contribution nonetheless. Not only because it offers important insights into the factors that determine project compliance with and effectiveness of EA, but also because no other research seems to quantitatively model project conformance at all. Note that our insights may also be relevant for other forms of conformance, e.g. regulatory compliance. Furthermore, our findings are not only interesting from an academic perspective, but also highly relevant for practitioners.

However, because of the limitations and lack of comparative research, some modesty is appropriate. We therefore consider the model presented here to be a first version, as it should be tested further. In this context, we have several suggestions for future research. First, a more sophisticated concept of project conformance might yield more fine-grained insights. A distinction could be made between different aspects, for example architectural compliance regarding business, information, applications and infrastructure (cf. Boh and Yellin, 2007). Alternatively, the four compliance aspects (or compliance checks) as described in chapter 6 and Foorthuis et al. (2012) could be used to structure the conformance concept. Finally, a distinction could be made between compliance regarding project deliverables and the process of executing a project. Note that more sophisticated constructs may result in even higher levels of item-nonresponse than we observed, as the questions will be more detailed and therefore relatively difficult to answer. A second suggestion for future research concerns the fact that conformance and the contextual variables only explain part of the variation of the benefits. More factors in addition to or in interaction with conformance should therefore be taken into account, e.g. various EA practices and quality aspects, or the type or size of projects. Thirdly, additional analysis methods could be used in order to study the effects that remain hidden in this study due to the shortcomings of ordinal regression (such as the violation of the parallel slopes test). Regardless of the specifics of future research, however, this study has clearly shown that EA offers different kinds of value, but that additional effort is required from the IS community to fulfill more of its promised potential.

Chapter 8

Tactics for Internal Compliance: A Literature Review

Compliance of organizations with internal and external norms is a highly relevant topic for both practitioners and academics nowadays. However, the substantive, elementary compliance tactics that organizations can use for achieving internal compliance have been described in a fragmented manner and in the literatures of distinct academic disciplines. Using a multidisciplinary structured literature review of 134 publications, this study offers three contributions. First, we present a typology of 45 compliance tactics, which constitutes a comprehensive and rich overview of elementary ways for bringing the organization into compliance. Secondly, we provide an overview of fundamental concepts in the theory of compliance, which forms the basis for the framework we developed for positioning compliance tactics and for analyzing or developing compliance strategies. Thirdly, we present insights for moving from compliance tactics to compliance strategies. In the process, and using the multidisciplinary literature review to take a bird's-eye view, we demonstrate that compliance strategies need to be regarded as a richer concept than perceived hitherto. We also show that opportunities for innovation exist.[1]

8.1 Introduction

With the advent of stricter legal demands, industrial best practices, security concerns, ethical codes of conduct and IT management standards, the topic of internal compliance has become highly relevant for both practitioners and

1 A preliminary version of the framework has been published as: Foorthuis, R.M., Bos, R. (2011). *A Framework for Organizational Compliance Management Tactics*. In: GRCIS 2011 (CAiSE 2011 Workshop), LNBIP 83, pp. 259–268. Berlin: Springer-Verlag. The typology of tactics and the guidelines for developing compliance strategies have been submitted to a journal.

academics (MacLean and Behnam, 2010; Short and Toffel, 2010; OCEG, 2009; Cleven and Winter, 2009; Schneiberg and Bartley, 2008; Harris and Cummings, 2007; Tyler and Blader, 2005; Emmerich et al., 1999). Simply put, internal compliance aims at ensuring that organizational actors' behaviors and outputs conform to the norms (see also 8.3.1). This form of compliance can relate to various types and levels of prescriptive systems that guide and constrain organizations. International and domestic laws and regulations, industry-wide standards and best practices, and organizational guidelines, rules and procedures all require organizational actors to conform to norms. Different types of prescriptive systems have different raisons d'être. Laws and regulations are mostly concerned with mitigating societal risk and encouraging ethical behavior (MacLean and Behnam, 2010; Sadiq and Indulska, 2008). Industrial best practices and organizational procedures usually aim at mitigating organizational risk, improving competence, effectiveness and efficiency, and achieving compliance as an end in itself (Szulanski, 1996; O'Dell and Grayson, 1998; COSO, 1994). Business and IT management standards, such as Enterprise Architecture principles, mainly focus on achieving organization-wide business goals, alignment, integration, complexity control and agility (Lankhorst et al., 2005; Gregor et al., 2007; Boh and Yellin, 2007).[2]

The topic of compliance has fascinated scholars for centuries. As early as the 1600s, Thomas Hobbes touched on the delicate issue of the *compliance problem* (Gauthier, 1991; Hollis, 1994; Hartman, 1996). He stated that, although compliance with 'contracts' may be better for the group as a whole and it may be in an individual actor's best interest to agree to contracts, it may very well not be in his interest to actually comply with them. Following this logic, it is necessary for internal regulators to actively pursue and assess compliance. This is also true in an organizational context, as compliance with the norms may be in the best interest of the organization as a whole, but may not lead to optimal results from the perspective of complying individuals, projects or departments. This is not merely a philosophical stance, given the scandals society has seen at organizations such as Enron, WorldCom and Parmalat (Kump and Rose, 2004; El Kharbili et al., 2008; MacLean and Behnam, 2010). Moreover, several studies demonstrate that non-compliance in organizations is widespread (Meyer and Rowan, 1977; Healy and Iles, 2002; Malloy, 2003; Tyler and Blader, 2005). This makes compliance a strategic issue in the current era, especially considering the high financial and non-financial costs organizations have to pay for their

2 Note that, although the previous chapters of this doctoral thesis focus on compliance with Enterprise Architecture, this chapter investigates compliance in general.

non-compliance. With regulations such as the Sarbanes-Oxley Act, transgressing organizations and individual CEOs and CIOs face severe penalties, such as fines and imprisonment (Volonino et al., 2004; Braganza and Franken, 2007). Scandals and unethical firm behavior can also severely damage an organization's reputation due to dissatisfied customers, shareholders, employees and other stakeholders (Philippe and Durand, 2011; Rossouw and Van Vuuren, 2003; Harris and Cummings, 2007). Demonstrating compliance with regulations, industrial best practices and ethical norms, on the other hand, can yield not only legitimacy, but also a good reputation and the benefits that come with that, such as attracting large institutional investors and customers (ibid., Meyer and Rowan, 1977; Emmerich et al, 1999; Malloy, 2003; Currie, 2008; El Kharbili et al., 2008).

Organizations experience difficulties, however, in implementing their compliance management approaches (Hurley, 2004; Sadiq and Indulska, 2008; MacLean and Behnam, 2010), possibly due to a lack of awareness of the full spectrum of actions that can be taken (cf. Straub and Welke, 1998). At the same time, both the compliance stimulating tactics (i.e. compliance techniques such as training and penalties) that comprise these approaches and the concept of compliance itself have been described in the extant literature in a fragmented manner and from very different perspectives. Consequently, there is the need for a structured overview of generic ways for encouraging compliance (cf. Cleven and Winter, 2009). This chapter therefore aims to answer the following research question:

> *What compliance tactics can be used by an organization to increase, achieve or maintain compliance with internal and external norms?*

A structured overview of such techniques, aiming to be as complete as possible and drawing upon multiple disciplines, has to the best of our knowledge not been published before. We will present the inventory of 45 generic compliance tactics as a typology, based on a multidisciplinary literature review of 134 publications. This chapter will also deliver two additional supporting contributions. First, we present an *overview of fundamental insights into compliance*. Along with definitions of key concepts, this will provide the basis for a conceptual structure or *framework* that can be used as an analytical tool for classifying, studying and presenting existing compliance-stimulating tactics. This structure will therefore be used for creating the typology of compliance tactics. In a process of 'picking and choosing' from the typology, such tactics form the fundamental elements of a broader compliance strategy. Therefore, as a second additional contribution, we will present a discussion on how internal regulators can use the typology to develop an overall and coherent organizational *compliance management strategy*. In addition to this practical purpose

underlying our study, the classic and state-of-the-art insights presented in this chapter serve as an introduction to the topic of compliance for newcomers. Academics and practitioners already acquainted with the field may find that this chapter broadens their horizons.

It is important to note that the focus of this study is on *internal compliance*, i.e. organizational compliance. The organization is not a black-box in this study. Our perspective is not that of governments and other societal institutions, but that of an organization's internal regulators – such as senior managers, policy drafters and compliance officers – aiming at a compliant organization. The organization-wide policies and norms are created and implemented by these regulators. However, the organization does not operate in a vacuum and named creation and implementation processes are driven largely by external pressures from governments, competitors, customers, suppliers, partners and institutions such as NGOs and labor unions (cf. DiMaggio and Powell, 1983; Scott, 2003; Meyer and Rowan, 1977; Currie, 2008; Short and Toffel, 2010; Weaver, Trevino and Cochran, 1999a; Ward and Peppard, 2002). Figure 8.1 shows the organization, its internal actors and typical pressures exerted by external stakeholders.

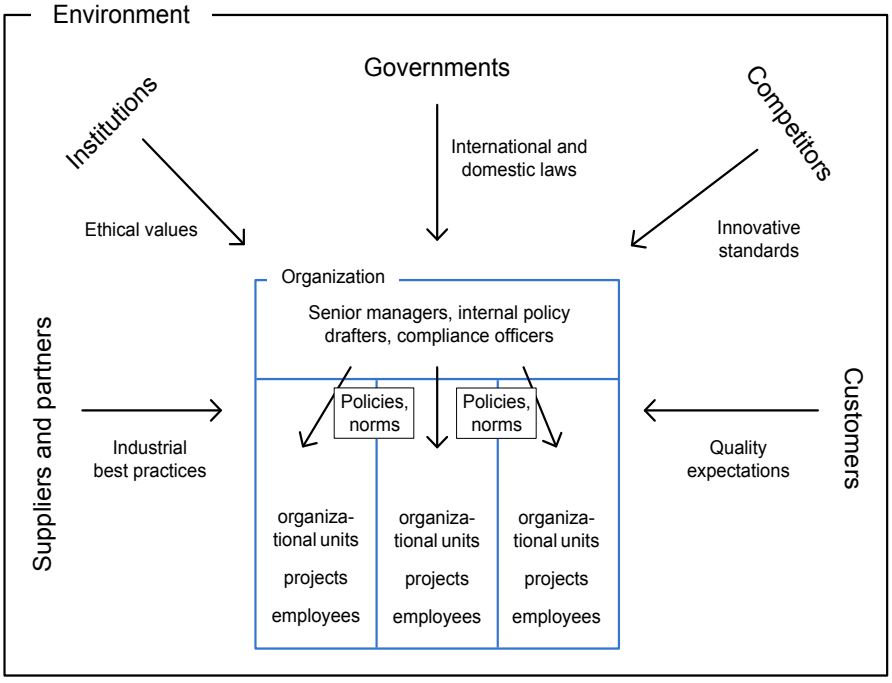


Figure 8.1. The organization and its normative environment

After determining and interpreting the relevant pressures and translating them into internal policies, the various organizational units, projects, programs – and the individuals of which they are comprised – are expected to conform to them. Although organizations have been known to adopt symbolic compliance measures instead of substantively changing their operations (MacLean and Behnam, 2010; Short and Stoffel, 2010; Meyer and Rowan, 1977), we focus here on organizations that genuinely strive to be compliant. It is here that the underlying goal of this chapter lies, as we investigate what tactics an organization has at its disposal for achieving a satisfactory level of compliance.

A concept commonly used when discussing compliance measures taken by an organization is that of internal controls. An *internal control* is usually defined as a formal process designed to provide reasonable assurance of achieving effective and efficient operations, reliable (financial) reporting, and compliance with laws and regulations (COSO, 1994; Luthy and Forcht, 2006; Namiri and Stojanovic, 2007). However, in this study we will introduce the concept of *compliance tactic* instead, which we define as a measure that can be taken, or a technique or mechanism that can be used, to encourage compliance of relevant organizational actors. The concept of tactics allows us to identify the theoretical essence of compliance endeavors rather than their practical implementation. See section 8.3 for more on this.

This chapter proceeds as follows. In section 8.2, our research approach is described. Section 8.3 defines and discusses fundamental compliance concepts. Section 8.4 introduces the conceptual structure and typology. Section 8.5 presents a detailed description of the typology's compliance tactics. Section 8.6 discusses findings of the literature review and presents insights for developing a compliance management strategy. Section 8.7 is for conclusions.

8.2 Research approach

We employed a structured literature study for our research, as this provides an appropriate method to investigate the fundamentals of compliance and enables us to identify the wide array of techniques devised in distinct disciplines. Science can benefit from drawing from different fields, as a topic can be enriched by the exposure to distinct and potentially relevant theoretical backgrounds (cf. Webster and Watson, 2002; Malone and Crowston, 1994). The disciplines we have drawn upon are those of *management* and *business studies* (e.g. corporate compliance and ethics programs), *law* and *political science* (e.g. environmental agreements and determinants of compliance), *information systems* (e.g. security policies and informational privacy), *philosophy* (e.g. business and contractarian ethics), *organizational sociology* (e.g. institutional

factors), *economics* and *accounting* (e.g. compliance audits), *engineering* (e.g. technology for data protection), and *social psychology* (e.g. influence mechanisms).

Based on Tranfield et al. (2003) and Brereton et al. (2007), we have structured our literature study as follows. In the first phase, the research project was planned. This entailed specifying initial research questions, gathering knowledge on methodological aspects of literature reviews, and specifying search criteria for identifying relevant publications. Since the identification of compliance tactics would be a crucial part of the study, we concluded that publications should be searched for in several academic disciplines. In addition, as the nature of the study was less a 'truth finding' mission than a broad and open-minded identification effort, quality criteria for journals and conferences could not be too strict (i.e. limiting the reviewed publications to only a handful of the fields' top journals was not an option). Nonetheless, the norm was that a publication be academically peer reviewed, unless a technical report or practitioner publication yielded a significant insight.

In the second phase, potentially relevant literature was identified and collected. Key search terms were "compliance", "conformance" and "conformity". Other terms used were "compliance strategy", "compliance management", "compliance policy", "compliance auditing", "corporate compliance" and "organi[z|s]ational compliance". The search was conducted in academic indexing services, such as JSTOR, EconPapers and PiCarta, in broader listings such as GoogleScholar, and in search engines of specific journals. Title, abstract, keywords and occasionally conclusions informed the decision of whether or not to include the paper in the set of candidate publications. The literature was collected by the principal researcher and an information specialist of Statistics Netherlands' library. All in all, over 200 (mostly digital) publications were collected in this phase.

In the third phase, a literature database was created for systematic storage of publication characteristics to be gathered during the actual review process undertaken in the fourth phase. The database was based on the concept matrix of Webster and Watson (2002) and data extraction guidelines of Tranfield et al. (2003) and Kitchenham et al. (2009). It allowed storage of information such as the publication's title, authors, unit of analysis and substantive conceptual contribution. In addition, a review protocol was established to ensure that the review process would be carried out in a systematic fashion (see Appendix 8.A). The protocol contained the inclusion and exclusion criteria for the definitive selection of publications, the steps of the review process, additional conditions, definitions and data extraction guidelines (cf. Brereton et al., 2007). In addition, several publications were studied or roughly scanned in this phase, both to obtain fundamental insights and to identify promising additional references. A

preliminary version of the analytical structure was created, as this would function as the two-dimensional framework in which the tactics would be positioned. In order to prevent leaving the reader with only a set of fragmented tactics, the research goal was also complemented with the sub-goal regarding the development of compliance strategies.

In the fourth phase, the actual reviewing of the collected publications was conducted, i.e. identifying the compliance tactics and gathering insights into compliance strategies. Each decision to review a specific publication was based on the likelihood that it provided a new tactic or deeper insights into strategies or known tactics. A total of 134 publications was reviewed (excluding methodological and peripheral articles). See Tables 8.1 to 8.4 for an overview. The reviewing process was conducted by the principal author. Journal articles and conference papers were reviewed fully, whereas of books only the relevant sections were analyzed. After reviewing a publication, a descriptive record was added to the literature database (see Appendix 8.B for several examples). The identified compliance tactics, if any, were paraphrased and added to the preliminary tactics overview. Subsequently, the text in this document was iteratively coded to develop the typology of tactics (see section 8.4 for a definition of typologies). We used the method of Miles and Huberman (1994) for this coding process, as it aims at creating a classification or typology (in contrast to Grounded Theory, in which codes are developed to create a causal theory). A code in our study represented a (candidate) tactic. Two kinds of coding processes were used in the study. First-level coding, working mainly on the source text, is the process of creating summarized pieces of data and their respective codes. The first-level coding activities resulted in the creation of a preliminary classification of tactics. After 35 publications had been reviewed and coded in this manner, an iterative and creative process of pattern coding was initialized to run parallel with the continuing review and first-level coding activities, resulting in a more mature set of tactics. Pattern codes are descriptive pieces of data and their respective codes, representing patterns found in the underlying publications. Based on the first-codes, they evolved into the final versions of the compliance tactics presented in section 8.5. In the process, first-level codes could be split up into several pattern codes, or they could be combined into a single pattern code (see Appendix 8.C for an overview of splits and combinations). This was due in part to the fact that the first-level codes were based more directly on the underlying individual publications, whereas the pattern coding was aimed at generalizing the tactics across all publications. Part of the latter process was also to position the tactics within the analytical structure (the two-dimensional framework presented in section 8.4). Important criteria for defining a definitive (pattern code) tactic were mutual exclusiveness and a conceptual abstraction that allowed for a clear and presentable descrip-

tion. The framework was also finalized during this phase, after going through several iterations. Furthermore, knowledge on compliance management and strategies (presented in section 8.6) was gathered in this phase, as part of the review process.

The fifth phase was writing the review report, which culminated in this chapter. An initial and short version was presented as a paper at an international workshop on compliance in order to obtain feedback.

Discipline	Number of publications
Management and Business	34
Law and Political Science	19
Information Systems	30
Philosophy and Sociology	22
Engineering	15
Social Psychology	6
Economics and Accounting	8
Total	134

Table 8.1. Number of publications per discipline

Period	Number of publications
1970s and before	3
1980s	5
1990s	34
2000s	79
2010s	13
Total	134

Table 8.2. Number of publications per period

Concept	Number of publications
Fundamental compliance concepts (sections 8.3 and 8.4)	63
Compliance tactics (section 8.5)	91
Compliance strategy (section 8.6)	52

Table 8.3. Number of publications per concept

Level of analysis	Number of publications
Individual employee	44
Collective (projects, organizational units)	60
Organization	87
(Inter)national bodies	24

Table 8.4. Number of publications per analytical level

8.3 Fundamentals of Compliance

This section defines and discusses key concepts that function as the basis for our study, such as compliance, conformity, actors, norms and policies. The nature of compliance is also explored, resulting in the insights used to structure the two-dimensional framework that forms the foundation for our typology.

8.3.1 Compliance – Definitions and Key Concepts

There is no generally accepted definition of the term *compliance* (Faure and Lefevere, 2005; Pupke, 2008). Many authors define compliance as (the extent to which there is) adherence to laws and regulations (e.g. Zaelke et al., 2005; Faure and Lefevere, 2005; Mitchell, 1996; Schneiberg and Bartley, 2008) or to prescriptions in general, including industrial standards and internal policies (e.g. Kim, 2007; Daniel et al., 2009). Some authors also seem to include unwritten, ethical norms (e.g. Welcomer, 2002; Badea and Pana, 2010). Other authors go beyond compliance as a status-oriented concept and define the term as a process (e.g. Caldwell and Eid, 2007; Meeuwisse, 2010) or ability (e.g. IIA, 1997), or emphasize in their definitions the organizational structures and processes to ensure adherence to them (cf. Pupke, 2008). The term compliance has also been extended to include underlying goals, such as transparency and protecting an organization's reputation (e.g. Panitz et al., 2010; Jourdan and Oehler, 2005; Pupke, 2008).

In the literature there may be even less agreement on the term *conformity* (cf. Bond and Smith, 1996). Similar to compliance, conformity is regularly used as adherence to prescribed rules (Merton, 1957; Schapiro, 2003; Currie, 2008; Mitchell, 1996; Ellis et al., 1993; Tyler and Blader, 2005). Conformity has also been contrasted with compliance, with the latter following an explicit or implicit request, and the former referring to a state of accordance in the absence of a request (Cialdini and Goldstein, 2004). In this context, conformity is sometimes said to necessarily involve a change in belief or behavior (Zimbardo and Leippe, 1991; Rowe, 2005), whereas an actor can be compliant without a

position change (see below). In addition, conformity is seen as a broad concept that allows both public agreement and internalization of norms, whereas compliance represents public agreement without private agreement (Levine and Resnick, 1993; Bond and Smith, 1996). In addition, conformity is often used to specifically refer to the phenomenon that organizations within a particular institutional sphere tend to become more similar as time progresses (Scott, 2003; DiMaggio and Powell, 1983). Finally, conformity is also seen as being comprised of both procedures and underlying goals (Philippe and Durand, 2011). The term *conformance*, likewise, is not used in a single, specific manner. For example, Falkl (2005) distinguishes between compliance and conformance, with the former referring to a binary adherence to a strict norm (necessitating a pass-or-fail outcome) and the latter describing how well the norms are matched (allowing for adherence of certain aspects and non-adherence of others). Chopra and Singh (2006) use conformance to refer to a (software) agent adhering to the norms in terms of its design, whereas compliance refers to this issue in terms of an agent's behavior. Other publications also use the term conformance in different ways (cf. Merton, 1957; The Open Group, 2009; Alter and Wright, 2010; Currie, 2008; Panitz et al., 2010). Given the lack of agreement illustrated above, we will not distinguish between the three terms in our study unless explicitly specified.

In this study we define *compliance* as the extent to which there exists a state of accordance between an actor's behavior or products on the one side and predefined, relevant and explicit norms on the other (cf. Zaelke et al., 2005; Kim, 2007; Faure and Lefevere, 2005; Mitchell, 1996; Abdullah et al., 2009). Norms in this respect can be rules, procedures, conventions, standards, guidelines, principles, legislation or other prescriptions. Although we do not focus on compliance with the implicit, broader spirit of the norms, we do acknowledge (relatively high-level) principles as norms – on the condition that they be made explicit. Unwritten ethical norms are therefore also excluded from our definition. Although such norms can be external input from the organizational environment, in the context of this study they should be explicitly specified in an internal policy. A compliant state can be achieved regardless of the motivations, causes or circumstances that have led to it (Zaelke et al., 2005; Mitchell, 1996). In our view, therefore, an actor can be compliant without internalizing the norms and without necessarily changing his beliefs or behavior. Furthermore, compliance includes adherence that is unintentional and of which the regulated actor is unaware. Finally, compliance should be distinguished from effectiveness, as a compliant state need not necessarily result in achieving the desired end goals (Mitchell, 1996; Faure and Lefevere, 2005; Zaelke et al., 2005). To achieve compliance, an organization usually requires active *compliance management*, which we define as the organizational processes

and mechanisms intended to avoid, provide insight in, and deal with violations of and encourage compliance with relevant internal and external norms (cf. Abdullah et al., 2009; Caldwell and Eid, 2007). To prevent unethical business conduct and avoid regulatory penalties and loss of reputation, compliance management includes implementing structures and processes (see section 8.6.2). However, there are many more measures that can be taken. It is the primary aim of this chapter to identify these compliance tactics.

The term *norms* (or *prescriptions*) serves as a general denotation that encompasses more specific forms such as laws, standards, rules, principles and guidelines. Therefore, norms can refer to general, abstract (but explicit) principles or to detailed rules – or anything in between. They can also refer to prohibitive norms (so-called proscriptions). Norms can thus be both prescribing and constraining by nature. Furthermore, they can be legally required or voluntary by nature. Norms can relate to both behavior and products. Requiring a project to use the organization's standard system development method is an example of norms relating to behavior. Requiring the products produced by a business process to comply with organization-wide quality standards is an example of norms relating to products. Finally, prescriptions can (and probably will) change as time progresses. A coherent and goal-oriented set of norms is referred to here as a *policy* (cf. Garner, 2004; Kagal et al., 2003; ILRI, 1995).

When applying norms or assessing them on conformance, several aspects or dimensions should be taken into account (Foorthuis et al., 2012). A prescription should be applied *correctly*. Its use, or lack of it, should also be *justified* in the respective situation. Another issue is whether related prescriptions are applied *consistently*. A final concern is whether the *complete* set of (mandatory) norms is applied, as opposed to merely a convenient subset. Given the latter, one relevant issue concerns whether norms are mandatory or not. In practice, quite some prescriptions prove to be voluntary in nature, e.g. industrial best practices. Adherence to the norms then is more akin to the narrow sense of conformity as defined by Cialdini and Goldstein (2004), i.e. adherence without a request. In other cases, such as internal guidelines, there may be a request, but the norms may have a comply-or-explain status. Even when norms are truly mandatory, they are not always perceived as such in practice (Boss et al. 2009).

An *internal regulator* is a policy maker and upholder, such as a senior manager, policy drafter or compliance officer. We define an *actor* as an organizational entity acting within an organization, and equipped with cognitive capabilities, preferences, beliefs, values and at least some degree of autonomy (Hollis, 1994; Jones, 1991; Thiroux, 1977). As such, an actor can be e.g. an organizational unit, a project or an individual employee. In the context of this chapter, an actor is expected to comply with the norms (i.e. he is a regulated actor or regulatee). See section 8.3.3 for more on actors.

A distinction can be made between two types of non-compliance (cf. Schapiro, 2003; Merriam-Webster, 2011). First, a *transgression* (or *violation*) refers to a situation in which a norm is not complied with, e.g. by breaking a law or rule. A reason for this might be that the actor in question had no interest in conforming to this specific norm or simply did not know how to comply. Secondly, *subversion* refers to a situation in which an actor, for his own individual interest, attempts to undermine the entire compliance system itself, or at least an essential part of its norms. For example, when the implementation of standards is carried out in such a fashion as to demonstrate their inferiority and the need to abandon them altogether. In an organizational context, subversion might point to fundamental political problems, structural conflicts of interest or competing norm systems. An organization that is the result of a merger, for example, may have competing sets of architectural standards.

We define a *compliance tactic* as a measure that can be taken, or a technique or mechanism that can be used, to encourage compliance of relevant organizational actors. Tactics can range from top management's organization-wide governance mechanisms to lower management localized measures. Furthermore, a tactic can be preventative, detective and corrective in nature (Sadiq and Indulska, 2008; Straub and Welke, 1998). Tactics can also be formal or informal by nature, and they need not be processes. As one tactic is typically not sufficient to obtain compliance, multiple tactics need to be combined into a coherent strategy. A *compliance management strategy*, therefore, is a general plan or pattern featuring a coherent set of compliance tactics that aims to bring the organization to a state that is compliant with relevant norms, at least to a sufficient level (cf. Quinn, 1996; cf. Mintzberg, 1987; see section 8.6 for an elaborate discussion on compliance strategies). Such a strategy may aim for *holistic compliance*, which incorporates three elements: coherent instead of fragmented compliance efforts (Volonino et al., 2004; Cleven and Winter, 2009), a long-term scope (Sadiq and Indulska, 2008), and the ability of the approach to cover multiple laws, standards frameworks or internal procedures simultaneously.

In section 8.1 we have stated that we will use the concept of *compliance tactics* instead of *internal controls*. There are several reasons for this. First and foremost, our use of tactics enables us to focus on the substantive essence of compliance endeavors, whereas internal controls focus attention to practical implementation. Second, we focus on identifying ways for stimulating compliance, i.e. more or less generic and atomic elements that can be included in a broader compliance management strategy. An internal control, however, is not such a pure and elementary measure, but an aggregate concept in itself. Per definition, it comprises multiple elements that should be considered as separate tactics in a list of re-usable measures (such as monitoring and ensuring

employee competency). A third reason why we focus on compliance tactics instead of internal controls, is that the latter concept is too narrow as a result of focusing on formal processes, thereby excluding several relevant compliance measures. Tactics, on the contrary, can be formal or informal, and they are not required to be processes. A fourth and final reason is that, in another sense, the concept of internal controls is too broad for the purpose of this study, focusing not only on compliance but also on other goals, such as general risk mitigation and efficiency and effectiveness of business activities.

8.3.2 The Nature of Compliance

In this section we will discuss some fundamental insights into compliance that will form the basis for our two-dimensional framework. In different fields, the literature on compliance distinguishes between two broad types of theory, namely rationalist and normative approaches (Chayes and Chayes, 1993; Grossman and Zaelke, 2005; March and Olsen, 1998; Malloy, 2003; Hollis, 1994; Li et al., 2010; Bulgurcu et al., 2010; Tyler and Blader, 2005; Zaelke et al., 2005; Mitchell, 1996). These theories provide distinct insights into compliance-related behavior and underlying motivations of states, organizations and individuals. The *rationalist view* focuses on the actor's calculation of benefits and costs in his decision on whether or not to comply. This approach uses a "logic of consequences", which sees actors as choosing rationally among alternatives. Game theory is a regularly used lens here to analyze behavioral motivations, using the prisoner's dilemma to model the Hobbesian compliance problem described in this chapter's Introduction (Kraus and Coleman, 1987; Hollis, 1994). In a rationalistic perspective incentives and disincentives will alter the outcome of the actor's calculation. Therefore, one major approach used here is enforcement (or command-and-control), in which *punishment* is used to deter unwanted behavior. *Rewards* are an additional means in the rationalistic perspective, increasing compliance by changing the cost-benefit calculation to the actor's advantage.

As a second perspective, the *normative view* focuses on cooperation and assistance as a way of encouraging compliance (Mitchell, 1996; Zaelke et al., 2005; Malloy, 2003; Chayes and Chayes, 1993). This approach uses a "logic of appropriateness", which views actions as based on identities, roles, obligations, and considerations of appropriate, fair and legitimate action. Normative theories do not take the stance that an actor's behavior is irrational, but tend to broaden the scope to prevent reducing the discussion to costs and benefits. Actors are seen as following the institutionalized rules and practices that link particular identities to particular situations. These rules need to be internalized and viewed as legitimate by those subject to them. Not restricted by the somewhat cynical

Hobbesian perspective, it is acknowledged that compliance may be hindered if rules are ambiguous, complex or continuously changing, or if they are too numerous or not easily available. Non-compliance may also be the inadvertent result of deficient routines or a lack of capacity, knowledge or commitment. For all these reasons, non-compliance should be *managed* instead of being sanctioned. Methods to increase compliance therefore often focus on increasing the actor's capacity to comply. This is effectuated by cooperating, providing support and encouraging shared discourse in order to render rules clearer, more persuasive and easier to commit to.

Rational and normative models are not mutually exclusive, but rather complement each other and provide different lenses for analyzing influences on compliance behavior (Tyler and Blader, 2005; Welcomer, 2002; Zaelke et al., 2005; March and Olsen, 1998; Malloy, 2003). Both perspectives are relevant to our research. For example, organization-wide standards may be dismissed for rational reasons, as conforming to them may take additional time and effort. Or it may be that the organizational units and employees conform to industrial standards because they value their identity as "professionals" or their role as "managers". Governmental organizations may also feel "obliged", or consider it "appropriate" not to spend tax payers' money unnecessarily. Both perspectives should therefore be taken into account.

8.3.3 Levels of analysis

Although theories from both the rational and normative perspective often regard actors that need to comply as unitary agents, a comprehensive perspective on compliance also needs to be able to disaggregate an actor into multiple sub-actors (Chayes and Chayes, 1993; Malloy, 2003; Zaelke et al, 2005). An organization is comprised of structural units, such as divisions and their sub-units, and of temporary initiatives, such as programs and their projects and teams. Furthermore, all of these entities will have individual members. Motivations for compliance-related behavior may differ between these different sub-actors (Malloy, 2003; Braganza and Franken, 2007), thus requiring different compliance measures. We deal with this issue in our study by acknowledging three conceptual levels. First, the level of the enterprise as a whole, in which "enterprise" can be taken to mean the entire organization, a division or even a network of organizations (cf. The Open Group, 2009). This is the level at which the internal regulators are located and at which the policies are determined – although there may obviously be pressure from higher (external) levels, which are out of scope here. The second level accommodates various types of collectives that are expected to comply. They exist within the enterprise, such as departments and their sub-units and programs and their projects and teams.

These collectives typically have a more local scope and may have a political agenda that can, at least in part, be inconsistent with the wider enterprise and its policies. The third level is that of individuals, who may be directly expected to comply (e.g. in the case of information security procedures) or who may be part of a collective that is requested to comply (e.g. in the case of a project implementing a medical administration system that needs to comply with privacy regulations). In both cases, the decisions and behavior of individuals are determinants of actual compliance. However, although an individual may be inclined to comply, the project of which he is part may not.

8.4 A Typology of Compliance Tactics

Based on the fundamental insights discussed above, this section will present the two-dimensional conceptual structure within which the tactics for stimulating compliance will be positioned. The horizontal dimension represents the focus of the compliance solution, for which the fundamental characteristics of both the rationalist and the normative compliance approaches are used as defining elements. As these types of theory provide different perspectives on behavioral motivations for compliance, they can accommodate tactics of a different nature. The rationalist perspective puts forward *inducement* (the use of incentives or rewards) and *enforcement* (the use of disincentives or penalties), whereas the normative perspective offers *management*[3] of compliance (the use of cooperation, assistance and persuasion). After most tactics were identified in the literature review, we also added *assessment* (the use of e.g. self-reporting, external audits and self-reflection in order to obtain insights and achieve transparency). The tactics herein were originally placed in other columns. However, since assessment is a prerequisite for both the rational and normative approaches (cf. Faure and Lefevere, 2005), and the set of management tactics grew to be relatively large, we decided to acknowledge this as a separate class. Another rationale for this is that assessments can be expected to have a deterrent effect by themselves, which constitutes another reason for them to be regarded as an autonomous group of tactics (Short and Toffel, 2010; Foorthuis et al., 2010).

3 We use "management" here to refer to the ways in which the normative approach encourages compliance, since this term is widely used in the literature. Note that we use "compliance management" in a broader sense, viz. also encompassing inducement, enforcement and assessment.

Organizational Level		Focus: Inducement	Enforcement	Assessment	Management
	Enterprise	Mandating compliance officers to provide incentives Developing guidelines for rewarding	Mandating compliance officers to provide disincentives Developing guidelines for punishing Making examples out of non-compliers	Gaining insight into enterprise-wide compliance rates Reflecting on culture in terms of compliance Auditing the compliance function Using self-reporting Installing a whistle-blower hotline Training compliance assessors Subjecting operations to third party scrutiny* Internal regulation by information*	Creating internal commitment by external justification Properly specifying policies Actively disseminating policies Preventing non-compliance Ensuring management support Understanding & using social structures Gathering and creating knowledge Facilitating communities of practice Socialization of newcomers Implementing self-regulation*
	Collective	Funding compliance-unrelated expenses Providing political support for other initiatives Celebrating successes	Rejecting the project deliverable Terminating the project	Using IT-systems for storing and managing auditable information Automatically assessing compliance Manually assessing compliance	Providing assistance Compensating for compliance costs Selecting compatible and knowledgeable employees Using internal market logic*
	Individual	Offering formal rewards Offering social rewards Offering professional rewards	Imposing formal penalties Imposing social penalties	Providing performance feedback	Training regulated actors Employing social psychological mechanisms Providing organizational support Signing an agreement

Figure 8.2. Typology of Compliance Tactics

The vertical dimension represents the organizational level at which the tactics are applied, i.e. the level at which the internal regulators' effort is made (note that it does not denote the actor at which the tactic is targeted). The *enterprise level* is the level at which the internal policy and its norms are formulated, perhaps based on external input. This is also the level at which the compliance management strategy is developed and at which senior management, compliance officers and organization-wide auditors operate. The *collective level* is the level of tactics for stimulating compliance of organizational units and temporary initiatives, such as projects that need to conform. The *individual level* accommodates tactics targeted at individual employees that are expected to comply.

Figure 8.2 is a visual representation of the full typology. The tactics positioned within it are discussed in detail in section 8.5 (innovative tactics are marked with an asterisk and will be discussed in 8.5.10). We will refer to the empty two-dimensional structure described above as the framework, whereas the structure including the tactics – this chapter's core contribution – will be denoted as the typology. A *typology* is used to describe conceptually derived interrelated sets of ideal types (Doty and Glick, 1994). Such types are defined by more than one attribute simultaneously (i.e. they are multidimensional by nature), with the order of the attributes being irrelevant (Marradi, 1990). A typology does not feature discrete, mathematical decision rules for classifying, and mutual exclusiveness and exhaustiveness cannot be entirely guaranteed (Doty and Glick, 1994; Rich, 1992; Smith, 2002). Our inventory of compliance tactics constitutes a typology, since they are defined by multiple attributes (the two dimensions of our framework plus any idiosyncratic characteristics to distinguish them within a given cell), are theoretically derived conceptual constructs (i.e. based on literature instead of e.g. empirical-based cluster analysis), and mathematical decision rules are not provided.

The framework can be used to position and characterize *individual tactics*. However, the framework can also be used to describe an organization's *compliance management strategy*, which is a general, integrated plan or pattern consisting of multiple tactics with the intention of achieving a satisfactory level of internal compliance. As a strategy utilizes multiple tactics, it typically covers several cells of the framework. We will return to the topic of compliance strategies in section 8.6.2. First, however, we will explicate the individual tactics of the typology.

8.5 Compliance Tactics

This section describes the typology's tactics, which have been identified during the literature study. Innovative tactics from the (inter)national laws and regulations level are translated to internal tactics for organizations in section 8.5.10.

The tactics are represented by ***bold italic text*** and can be found in the visualized typology presented in Figure 8.2. *Regular italic text* is (amongst others) used for showing relationships between tactics.

8.5.1 Enterprise Level Inducement and Enforcement

A first tactic at the enterprise level is ***mandating compliance officers to provide incentives***. A problem for those directly responsible for achieving compliance, e.g. security officers, is that they often lack the line authority over the employees in their compliance scope (Malloy, 2003; Boss et al., 2009; SIA, 2005). This means specifically that it will be very difficult for them to punish transgressors themselves. Rewarding complying employees, however, can be expected to be a less sensitive issue due to its positive character. ***Developing guidelines for rewarding and punishing*** results in enterprise-level standards, which should prevent rewards and penalties being given arbitrarily and inconsistently throughout the organization. This will increase the level of perceived fairness and consistency of the procedures (i.e. procedural justice), which is a significant determinant of compliance (Li et al., 2010; Weaver et al., 1999b; Tyler and Blader, 2005; Malloy, 2003). Making such norms and conditions explicit may also increase their perceived 'mandatoriness', which can further boost compliance levels (Boss et al., 2009). Although more difficult than the first tactic, it will still be necessary to ***mandate compliance officers to provide disincentives***, or at least introduce formal procedures to investigate possible non-compliance and contact transgressors' line managers to discuss punitive measures. In addition, ***examples can be made out of non-compliers*** by severely and visibly punishing notable transgressors. Even if the organization does not intent to e.g. fire or prosecute all employees that have committed a severe transgression, such examples may deter potential future non-compliers (cf. Paternoster and Simpson, 1996; Straub and Welke, 1998; Currie, 2008).

8.5.2 Enterprise Level Assessment

As an assessment tactic at the enterprise level, ***gaining insight into enterprise-wide compliance rates*** is necessary for both internal compliance management and external reporting. Important features of such a centrally available integrating analysis function are flexible reporting to different stakeholders, integration with workflows (feedback of non-compliance to those responsible and definition of escalation structures), integration with planning activities, remediation tracking and risk classification (Panitz et al., 2010; Racz et al., 2010). A central reporting function can be supported by business intelligence technology (Volonino et al., 2004; Daniel et al., 2009). Local data, such as audit trails, can be extracted and loaded in a central data warehouse, enabling

aggregated reporting and holistic knowledge-development. Analytical and statistical techniques can be used to discover patterns. Standardized data models are valuable in this context, as they facilitate improved integration of local data and allow inter-organizational benchmarking (Kim et al., 2007; Panitz et al., 2010). A thorough investigation evaluates existing compliance and ethics programs, e.g. by benchmarking and using external auditors and informants (cf. Weaver et al., 1999b; Arjoon, 2006). With the insights gained, the organization can ***reflect on its culture in terms of compliance***. This can be seen as a comprehensive and deep diagnosis of the corporate culture and its behavior in terms of compliance and ethics (Rossouw and Van Vuuren, 2003). This need not be an incidental affair but can be part of an ongoing process. As part of this exercise, one goal would be to gain insight into the degree of policy-induced compliance (i.e. compliance *as a result of* the compliance management approach) versus externally determined compliance (e.g. a shift in values at the societal level) (Mitchell, 1996). If compliance is the result of the chosen approach, it should be determined if actors have accepted and internalized the norms or act on rational grounds instead (Tyler and Blader, 2005). Reflecting also entails understanding non-compliance, which might be the result of high compliance costs, a poor organizational climate, a lack of technical knowledge or complex, ambiguous or difficult-to-find rules (Chayes and Chayes, 1993; Pulich and Tourigny, 2004; Zaelke et al., 2005; Mitchell, 1996). Moreover, it should be assessed whether non-compliance merely consists of transgressions or that subversion is also involved. It should also be asked how both formal internal controls and informal organizational aspects contribute to or detract from desirable compliance behavior (Weaver et al., 1999b). More fundamentally, norms and policies should be evaluated on their desirability and completeness, an endeavor that may require engagement of both internal and external stakeholders (Rossouw and Van Vuuren, 2003; Welcomer, 2002; SIA, 2005). It should furthermore be verified whether existing policies actually contain practical and valuable norms, as opposed to e.g. 'ivory tower' standards. Depending on the situation, there are also different forms, domains and methods of reflection. Risk analysis is one important form of reflection, focusing not only on risks regarding non-compliance, but also on risks in achieving the company's objectives. In the domain of security and privacy, for example, a risk analysis can use questionnaires as a method for measuring employees' attitudes towards compliance with encryption rules and identifying reasons for non-compliance (Gaunt, 1998; Hurley, 2004). Such questionnaires can also be used for more practical purposes, such as identifying lacking skills in order to specify training requirements and learn what type of new personnel to hire (ibid.). All insights mentioned above should inform the development of a new compliance

management strategy. In addition, the mere act of openly discussing ethics and norms tends to encourage good behavior (Treviño et al., 2006).

Auditing the compliance function is a more tangible means for gaining enterprise-level insight into the current state of affairs (IIA, 1997; Hamilton, 1995; IFAC 2003; Hayes et al., 2005; SIA, 2005). Such assessments focus on entire compliance programs and on the system of internal controls that aims to guarantee compliance. Even the audit function itself can be verified, e.g. against generally accepted accounting principles. ***Using self-reporting*** of compliance status from actors may constitute an effective tactic for obtaining knowledge on compliance levels of individual actors (Heyes, 2000). Self-reporting of transgressions can directly induce self-correction, but a report can also be a motivation for having compliance verified in more detail by an independent assessor. The degree to which self-reporting is a suitable means may depend on the intentions of the actor in question (Stanton et al., 2005) and the degree of trust in the relationship (Burgemeestre et al., 2009). ***Installing a whistle-blower hotline*** ensures that employees can safely report violations internally (Paternoster and Simpson, 1996; Weaver et al., 1999a). Such a function should guarantee professional treatment of the report, and anonymity to appease fear of retaliation (Geva, 2006). Another tactic at the enterprise level is ***training compliance assessors***, such as auditors, which is necessary in order to ensure professional competence (cf. Hayes et al., 2005; IFAC, 2003). It is also desirable because it stimulates that both assessments performed and measures taken are consistent throughout the organization, increasing perceived fairness (cf. Tyler and Blader, 2005; Foorthuis et al, 2012).

8.5.3 Enterprise Level Management

As a crucial aspect of compliance management at the enterprise-level, ***creating internal commitment by external justification*** can be achieved in various ways. One fundamental way is to ensure the internal policy itself is consistent with the norms of the organization's environment. This not only yields external support, but also mobilizes commitment of internal participants (Meyer and Rowan, 1977). Organizations may choose, for example, to be consistent with new, prestigious or fashionable systems development approaches, project management methodologies and other industrial standards. Another way to create commitment to internal policies is to have them justified by highly professionalized external consultants. Their blessings can strengthen internal legitimacy and prevent the rise of internal dissidents (ibid.). ***Policies should also be properly specified*** in order to be effective. The mere act of specifying norms may increase their perceived 'mandatoriness' (Boss et al., 2009) and prevent 'moral laxity' (Geva, 2006). The nature of the norms should be decided for each policy.

First, the *abstraction level* should be decided upon, namely opting for high-level principles versus detailed rules (Arjoon, 2006; Burgemeestre et al., 2009). A rule-based approach assumes that actors will not hide behind the rules. A principles-based approach assumes that actors can and will reflect upon the outcomes of their actions, and that they will not abuse the freedom inherent in such an approach. A second but related decision concerns the *degree of discretion* that the regulated actor is granted, i.e. stating performance objectives versus precise methods to achieve them (Philippe and Durand, 2011; Schneiberg and Bartley, 2008). As norms are often found to be ambiguous, group-specific and context-dependent, it is crucial that they be *specified* as clearly and explicitly as possible (Mitchell, 1996; Rossouw and Van Vuuren, 2003; Foorthuis et al., 2012; Malloy, 2003). A prescription statement should be precise and detailed, albeit not too precise and detailed, since to express one thing is to exclude the other (Chayes and Chayes, 1993). A norm's rationale should also be explicitly stated. A rationale describes the reasons behind the prescription, i.e. the business benefits that can be achieved or the threats that can be averted, and should act as a motivator for compliance (Richardson et al., 1990; Emmerich et al., 1999; Pahnila et al, 2007). Explicit norms and their rationales may be especially important in cases where employees tend to have incorrect theories regarding the world (cf. Treviño et al., 2006). Norms should also be prioritized to guide decisions in case of conflicts, and examples can be provided to help with their interpretation (Geva, 2006; Foorthuis et al., 2012). Finally, policies should neither be too long nor too short (Pahnila et al, 2007). The mere existence of a policy obviously does not ensure compliance. After specifying, therefore, ***the policies need to be actively disseminated*** throughout the enterprise, with the intention to inform the respective population of regulated actors of the existence, content and importance of the policy, and to convince them to comply with it (cf. Zaelke et al., 2005). In order for norms to influence behavior, it is important that they are salient and 'activated' in the particular situation to which they apply (Malloy, 2003). The policy should not only be actively communicated ('push'), but also be easily accessible via e.g. the organization's intranet ('pull') (cf. Gaunt, 1998; Pahnila et al., 2007). The internal communications staff should be involved to make maximum use of existing facilities. The tone of the communication (e.g. 'tell' or 'sell') is dependent upon the audience and the nature of the relationship (Braganza and Franken, 2007). As part of the dissemination process, the internal regulators can require employees to acknowledge receipt of the policy and even to acknowledge their intention of complying with it (Weaver et al., 1999b).

Instead of merely prohibiting certain undesired acts, they can also be ***prevented*** altogether, usually by restricting behavior preceding the transgressive act (Straub, 1990; Mitchell, 1990; Straub and Welke, 1998). For example,

chaperoning may prevent illegal transactions, with a compliance officer accompanying and supervising crucial meetings (cf. SIA, 2005). In addition, using deontic concepts (such as permissions, obligations, prohibitions, dispensations and delegations) and technical means such as encryption and firewalls, IT-systems and data can be electronically secured from inquisitive but unauthorized actors (Cuppens-Boulahia and Cuppens, 2008; Breaux et al., 2009; Kagal et al., 2003). Another important factor in achieving compliance is ***ensuring management support*** for policies and compliance related matters. Research has shown that commitment of senior management has important implications for the scope and control orientation (e.g. rationalistic versus normative) of compliance programs (Weaver et al., 1999a). Support entails, firstly, that management actively and visibly propagates the importance of the policy and of compliance with its norms (Pahnila et al., 2007; Boss et al., 2009; Foorthuis et al., 2010; Puhakainen and Siponen, 2010; SIA, 2005). In addition to jawboning, this includes approving a policy, so as to grant it a formal status. Secondly, management should mobilize resources, by making decisions that may not benefit all local organizational units, and by providing compliance personnel with access to senior management (Boh and Yellin, 2007; Malloy, 2003; SIA, 2005). Thirdly, management should set the example in words and deeds by showing adherence to the policy, as its norms will lose credibility otherwise, leaving middle managers and regular employees discouraged to comply (Rossouw and Van Vuuren, 2003; Tyler and Blader, 2005; Puhakainen and Siponen, 2010; Pulich and Tourigny, 2004). Needless to say, a condition for providing support is that management is aware of the necessity of compliance. This could mean that they should be *made* aware by compliance officers.

As organizations are not unitary actors, it is increasingly recognized that ***understanding and using social structures*** is crucial for obtaining compliance (Zaelke et al., 2005; Malloy, 2003). For example, internal power relationships between e.g. CEO, CFO and CIO can play a role in compliance with Sarbanes-Oxley (Braganza and Franken, 2007). Promoting the policy and actual compliance are dependent on the support and commitment of key decision makers. Such support and commitment can be stimulated by gestures of goodwill. Another way of using social relationships for increasing the likelihood of compliance is empowering those key actors (Zaelke, Stilwell and Young, 2005), for example by expanding or extending their mandates or by other tactics mentioned in this chapter, such as *funding* and *assistance*. Both the selection of such tactics and the specific implementation of a given tactic may depend on the nature of these existing social relationships. Good informal personal relationships should also be mentioned here, as they allow for better cooperation, discussions on compliance and fine-grained insights into the actors' interests and reasons for non-compliance (cf. Wasserman, 2009).

Gathering and creating knowledge can be valuable for several reasons (Braganza and Franken, 2007; Straub and Welke, 1998). First, as the semantic, conceptual, technical, procedural and judicial aspects of external policies can be quite complex, the organization needs to prepare itself for policy implementation. This entails collecting and understanding not only those policies and their norms, but also any additional sources that can help with their interpretation. Secondly, the organization can explore academic knowledge and orient itself to generic practitioner reference models for compliance. Examples of the latter are Red Book 2.0, i.e. the GRC Capability Model (OCEG, 2009) and frameworks for auditing (e.g. IFAC, 2003). There are also frameworks for general governance (COSO, 1994) and IT governance, such as COBIT (IT Governance Institute, 2000) and SAC (Mair, 2002). Entire reference models may be implemented or only specific elements may be used. A combination of approaches may also be employed, as their focus is often complementary (Luthy and Forcht, 2006). COSO has a broader scope, for example, but COBIT provides more detailed specifications. Thirdly, the enterprise needs to build knowledge on how best to apply and deal with the norms, given its own unique characteristics and context. It is likely that this knowledge has to be created from practical experiences within the organization itself. Fourthly, external policies may not only constrain a business organization, but may also provide competitive opportunities and drivers for innovation. Compliance often entails keeping business records and process logs (see also the *gaining insight into enterprise-wide compliance rates* and *using IT-systems for storing and managing auditable information* tactics). When dealt with from a holistic framework, this can yield improved insights into the entire organization. Such insights can be used not only for taking corrective action, but also for improving overall efficiency and the organization's competitive position (Volonino et al., 2004). More specifically, they provide opportunities for redesigning processes to reduce complexity and redundancy, and to improve information quality and risk management (ibid.; Braganza and Franken, 2007; Racz et al., 2010). Once a compliance knowledge base is built, its contents should be made available. A central repository, such as the company's intranet (Kerrigan et al., 2003; Braganza and Franken, 2007), provides a necessary but passive way of knowledge dissemination. Therefore, it is likely that more active complementary activities are required, such as *training*.

Another significant way of disseminating knowledge is by ***facilitating communities of practice***, in which practitioners can discuss and share explicit, tacit and cultural knowledge and norms (Wenger, 2000; Choo, 2006). Such communities can organize knowledge exchanges, by which the different types of experiences and knowledge mentioned in *the gathering and creating knowledge* tactic can be communicated, negotiated and made more explicit.

Communities of practice, therefore, enable both creation and dissemination of knowledge. Moreover, being social communities, they can help promote, institutionalize and internalize norms, create commitment, and as such encourage compliance (cf. Daniel et al., 2003). Such communities are largely self-organized and informal in nature. However, although management need not formally control them, communities may be facilitated by providing them with resources, time and freedom.

A related tactic is the institutionalized ***socialization of newcomers***, which is an enterprise-wide means to facilitate newcomers' learning about desirable and effective organizational behavior and to promote a culture of compliance. It is associated with the development of positive attitudes, such as higher job involvement, organizational commitment and compliance with organizational standards (Pulich and Tourigny, 2004). In this regard, newcomer orientation provides a way to communicate organizational norms and values (and why they are deemed important), the organization's mission and vision, and its appraisal and reward system. This can be communicated through *training*, mentorship programs, role modeling, corporate videos, welcome sessions and induction programs (ibid.; Treviño et al., 2006; Hallier and James, 1999). This should increase newcomers' sense of belonging, integrate them within the organizational culture, and teach them the values, norms, beliefs and preferred behaviors. Instead of leaving it entirely to HR, managers should be actively involved in newcomer orientation (Pulich and Tourigny, 2004) and promote a culture of compliance (SIA, 2005). (See the *ensuring management support* tactic for other ways in which management can contribute.) Socialization processes may take the form of organizational rituals, ceremonies, storytelling and other symbolic acts (Islam and Zyphur, 2009; Thralls, 1992; Pulich and Tourigny, 2004). However, rituals and ceremonials can also have a counterproductive effect, such as role distance and instrumental attachment (Hallier and James, 1999; Islam and Zyphur, 2009). Examples of rituals are *rites of passage* (consisting of symbolic acts to allow employees to transition to a new role and normative setting) and *rites of renewal* (consisting of symbolic acts that are periodically staged to reassert the dominance of certain organizational values) (Islam and Zyphur, 2009; Thralls, 1992).

8.5.4 Collective Level Inducement and Enforcement

As an incentive at the collective level, certain ***compliance-unrelated expenses might be funded***, as a reward for compliance with the policy. The IT costs of a project, for example, are sometimes centrally funded on the condition that it conforms to the enterprise architecture (Foorthuis et al., 2010, 2012). In addition, compliance can be rewarded by ***providing political support*** for other

initiatives of the actor in question, such as an approval of ambitious local programs or support for the appointment of a department's senior representative at an influential position within the organization. Another tactic is the organization-wide ***celebration of successes*** if they are achieved in a compliant fashion. Publicly acknowledging successes not only fosters team coherence, but also values that are intrinsic to high performance (Hefner and Malcolm, 2002). This will demonstrate to other actors that compliance need not be a restriction and may even increase chances of success.

A project or department can be punished for non-compliance by ***rejecting the project deliverable*** (Project Management Institute, 2004). This can occur, for example, if a developed software solution has not been described in sufficient detail to meet the standards set by the party responsible for maintaining it in production (especially if this is an external party). Rejection need not be final, since the deliverable may be accepted after reworking it in accordance with the norms. However, in extreme cases, ***terminating the project*** may be a serious alternative.

8.5.5 Collective Level Assessment

Using IT-systems for storing and managing auditable information ensures verifiability (Currie, 2008; Daniel et al., 2009). Compliance often entails keeping business records, so as to facilitate standard control and reporting processes and to ensure the possibility of future assessments. Although systems at the enterprise level will in practice also store records (e.g ERP-systems), keeping log trails mostly involves business applications of specific organizational units. In general, systems need to be able to store time-dependent data, offer version-control, register employees updating information, authenticate data (e.g. checksum functionality), enable fine-grained permanent deletion of privacy-sensitive data, and back-up and archive data with third parties (Peterson and Burns, 2006). Logging process and decision trails in IT-systems renders actors traceable, the awareness of which may have a direct deterrent effect and makes this a tactic in its own right. However, trails storage is also a prerequisite for performing assessments. Compliance assessments of log trails and other artifacts of decisions, processes, systems and projects are conducted to verify whether the norms are actually complied with in practice (Ellis et al., 1993; Botha and Boon, 2003; Foorthuis et al., 2012; Agrawal et al., 2006). A recent survey (n=293) found the use of compliance assessments to be the most important determinant of conformance to organizational standards, probably due to assessments emphasizing the importance of compliance and to actors' desire to avoid confrontation (Foorthuis et al., 2010). The results of such an assessment or audit can be reason to take corrective action. The object of

scrutiny here can be behavior, such as when it is verified whether a project conforms to the standards of the relevant project management or systems development methodology. In addition, an assessment can verify product quality by reviewing the project's design documents or by checking the delivered output of a production process against the quality standards. As a result of our definition of compliance, what is central in an assessment is whether the behavior and products are consistent with the norms, not if they are consistent *because of* the norms. Finding the actual causes of compliance is explored in the aforementioned *reflecting* tactic. Several types of assessments can be acknowledged, which will be discussed below.

Automatic compliance assessments determine electronically whether an organization and its processes and data conform to the norms. Such a verification process uses formal process models, meta models, rules and constraints. A distinction can be made between design-time (e.g. when designing business processes), run-time (when actually running business processes) and after-the-fact (when verifying audit trails) compliance checking (Ly et al., 2008). Research has been conducted on implementation in various technologies, such as Formal Contract Language, First-Order Predicate Logic, Concurrent Transaction Logic, Event Algebra, Concurrent Temporal Logic and Linear Temporal Logic (Governatori et al., 2006; Kerrigan et al., 2003; Ly et al., 2008; Kim et al., 2007). Automated verification offers large coverage – due to fast automated checking – and accurate and consistent results – due to the required formalization of norms (El Kharbili et al., 2008; Hurley, 2004). This type of surveillance is therefore well suited for continuous routine monitoring. Automated systems may also assist managers in organizing written assessment reports, help assign responsibilities to employees, and enforce procedures instead of merely verifying them (Agrawal et al., 2006). Employing automated solutions therefore has the additional benefit of freeing up resources that can be reallocated to other purposes (Hurley, 2004). Despite these benefits, however, ***manual compliance assessments*** will remain necessary. Not all norms are suitable for automated checking, not only as a result of inherently abstract and multi-interpretable prescriptions stated in natural language, but also because of the importance of sense-making and personal and contextual knowledge in the verification process (Chayes and Chayes, 1993; Foorthuis et al., 2012). Automatic compliance assessments therefore may often result mainly in self-evident outcomes. Conducted by human agents, manual assessments can on the other hand be used for sophisticated, subtle, subjective and situated evaluation. This may be especially relevant in specific cases in which an in-depth audit is required. Examples of methods that can be employed are interviewing employees, observing operations, and reviewing records and documents (ibid., Short and Toffel, 2010).

8.5.6 Collective Level Management

Providing assistance to projects or organizational units can increase compliance levels. For example, technical and personnel assistance can be provided to ensure that norms are explained and that sufficient guidance, knowledge and capacity are available (Braganza and Franken, 2007; Zaelke et al., 2005; Foorthuis et al., 2010). Individuals can also be offered help and assistance when confronted with ethical and compliance issues, e.g. by a telephone advice service (Weaver et al., 1999b). Such facilitating conditions may also positively impact attitudes towards complying (Pahnila et al., 2007). Knowledge can relate to the norms directly (helping with their interpretation) or to required technical expertise. As a specific form of assistance, ***compliance costs can be compensated for***, so as to let compliance be a budget-neutral aspect of business (Mitchell, 1996; Braganza and Franken, 2007). Apart from accessible *knowledge repositories*, *facilitating communities of practice* and *training*, knowledge can be brought in by ***selecting compatible and knowledgeable employees***. Selecting here refers not only to hiring personnel from outside the organization, but also to matching internal employees with projects, and moving individuals between subsidiaries on secondment (Harris and Cummings, 2007; Braganza and Franken, 2007). Critical selection is also important when hiring or appointing employees that have to make ethics and compliance-related decisions in ambiguous situations (Treviño et al., 2006). Selection criteria are not restricted to specific knowledge (resulting from relevant education or working experience), but also involve congruent and accepted ethical standards (ibid.; Tyler and Blader, 2005; Geva, 2006; DiMaggio and Powell, 1983) and the expectation of whether candidates will abide by the organizational rules (Pulich and Tourigny, 2004; Ogbonna and Harris, 1998). In the case of external consultants a welcome bonus may be that they are less biased and are unhampered by the organization chart (Burditt, 1996). During the selection process, compliance personnel may go as far as to check a candidate's disciplinary or complaint history (SIA, 2005).

8.5.7 Individual Level Inducement and Enforcement

At the individual level, ***offering formal rewards*** is a well-known inducement tactic. This can take a variety of forms, such as pay raises, promotions, awards, bonuses, days off, paid vacations, sabbaticals and stocks (Bulgurcu et al., 2010; Stajkovic and Luthans, 1997; Paternoster and Simpson, 1996). Interestingly enough, an organization should not blindly offer incentives. In the case of employees who have already internalized the respective norms, rewards may work counterproductive, as providing incentives to act morally might

undermine the intrinsic value of ethical behavior or might lower the responsibility felt by individuals (Treviño et al., 2006; Brekke et al., 2003). ***Offering social rewards*** focuses on proven informal incentives, such as compliments, praise and commendations, a word of thanks, personal mention and appreciation in oral or written assessments, celebrating heroes, and the increase in one's self-respect, reputation and status that come with that (Stajkovic and Luthans, 1997; Rossouw and Van Vuuren, 2003; Bulgurcu et al., 2010; Pulich and Tourigny, 2004). In addition, adherents can also be ***offered professional rewards***, such as interesting courses or challenging and prestigious assignments.

There are also several tactics related to punishment at this level. Ample research has been carried out on penalties, often from the perspective of deterrence theory. Severity, certainty and celerity have been shown to be crucial factors in this context (Paternoster and Simpson, 1996; Tyler and Blader, 2005; Bulgurcu et al., 2010). ***Imposing formal penalties*** brings with it threats such as monetary or legal sanctions, demotion, loss of occupational position and jeopardizing future job prospects (Paternoster and Simpson, 1996; Bulgurcu et al., 2010; Straub and Welke, 1998). Usually, an organization will make use of 'progressive discipline', in which oral warnings are followed by written warning, suspension and finally job termination (Pulich and Tourigny, 2004). Another type of disincentives for individuals is ***imposing social penalties*** on violators. These more intangible tactics might take the form of reprimands, 'naming and shaming', suspension, unfavorable mention in oral or written assessments and the consequent loss of self-respect, reputation and status (Malloy, 2003; Braganza and Franken, 2007; Bulgurcu et al., 2010; Paternoster and Simpson, 1996).

8.5.8 Individual Level Assessment

Providing performance feedback is a proven and inexpensive management tactic for improving employee behavior (Kluger and DeNisi, 1996; Stajkovic and Luthans, 1997; Pulich and Tourigny, 2004). This tactic derives its power from providing the employee with objective information on his performance, preferably presented in an immediate, positive and specific fashion. The focus should be on the task rather than the person. Examples of desired behavior can also be provided. The information can trigger a performance-improving reaction within the employee, for example because he is encouraged to reduce the discrepancy between his performance and the standard or because of an inner motivation to raise the bar.

8.5.9 Individual Level Management

Training regulated actors clarifies the rules and the measures taken against transgressors (Mitchell, 1996). In the context of security policies, for example, a training should communicate and spread understanding of the norms ("encrypt e-mails"), provide required knowledge (information classification rules) and teach necessary skills (using encryption software) (Puhakainen and Siponen, 2010; Braganza and Franken, 2007; Straub and Welke, 1998). More in general, an important goal is making employees aware of the prescriptions' underlying rationales and benefits, and of the consequences and risks of non-compliance (e.g. making the organization vulnerable to an outside attack). This awareness should influence the attitudes of employees and the consequent intentions to comply. Communicating the penalties and rewards during the training may likewise influence attitudes (Bulgurcu et al., 2010; Straub and Welke, 1998). Organizations should organize frequent compliance trainings (MacLean and Behnam, 2010). Furthermore, different types of training may be required for different types of employees. For example, technical people may need less training on encryption tools than do sales people (Puhakainen and Siponen, 2010). In order to increase motivation, training should also focus on tasks relevant to the course participants (ibid.).

Employing social psychological mechanisms, in essence, consists of a wide variety of compliance techniques to influence individuals (Zimbardo and Leippe, 1991; Cialdini and Goldstein, 2004). For example, the *door-in-the-face* technique involves making a large request, which is likely to get rejected. The actor may subsequently reciprocate the requester's 'concession' by his or her own concession, i.e. complying. When the *that's-not-all* technique is employed, the target is presented with an initial request, after which a bonus is added to the deal. The increased benefits, perceptual contrast and the urge to reciprocate often result in compliance. The *foot-in-the-door* technique works by first asking the compliance-target to comply with a small and easy request. After compliance is assured, a larger and often related request is made, resulting in compliant behavior. Another technique here is to use the *obedience to authority* rule, which seems deeply ingrained in human nature. This rule makes it very hard to say "no" to authority figures, even if the request would inflict damage to others. A final technique we will mention here is *good cop/bad cop*, in which one professional takes a harsh approach in trying to have the actor comply. His colleague subsequently takes a soft and conciliatory approach, pretending to be allied with the actor and promising to prevent the severe penalties the bad cop threatened him with (Cialdini, 1987). See the social psychological literature for more techniques. The organization could also have personnel ***sign an agreement*** (Gaunt, 1998; Straub, 1990). Working with confidentiality agreements, for

example, is common when employees have to work with sensitive data. Explicitly agreeing with a policy may increase the commitment felt by the regulatees, as they are given responsibility and accountability. Note that all employees have a 'psychological contract' with their organization, taking the form of expectations regarding the duties of the organization and of themselves. Such expectations tend to be implicit, so managers should try and clarify them (Pulich and Tourigny, 2004). Another managerial tactic is ***providing organizational support***, in which employees receive professional help when dealing with personal problems that obstruct good functioning (Pulich and Tourigny, 2004). Some deviant behaviors may be dealt with directly, e.g. by anger management programs or other types of correctional counseling. However, support may have a more indirect character, for instance when the employee is confronted with problems such as divorce, sickness or loss of a family member. Providing support may not only help the individual employee, but can also be of value to the organization by preventing escalation at work.

8.5.10 Tactics and Innovations in Compliance

Driven by regulatory crises, new visions and rulemaking experiments, scholars in law, sociology and political science have defined innovative forms of regulation at the (inter)national level (Schneiberg and Bartley, 2008; cf. Faure and Lefevere, 2005; cf. Zaelke et al., 2005). In the organizational sciences, however, daring and innovative new tactics seem to be few and far between (an obvious exception being the use of enabling IT to assess and control compliance, as described in the *automatically assessing compliance* and *preventing non-compliance* tactics).

At the (inter)national level, new and innovative forms of regulation may have one or several of the following characteristics (ibid.). First, although traditional schemes often relied on state agencies for regulation and enforcement, new forms often also rely on non-state actors such as NGOs to act as watchdogs and assert pressure. Secondly, although regulation was traditionally used to suppress competition, some new forms have embraced it as a means to achieve regulatory goals. For example, tradable permit systems set a maximum level of allowed pollution, subsequently issue permits amounting to that level, and let firms choose their individual pollution levels by having them trade those permits. Thirdly, instead of detailed and universal prescriptions, new regulatory forms increasingly stimulate self-regulation of 'regulated' actors. For instance, those actors can define their own standards through collective dialogue. Such processes may be driven by state-defined high-level goals, but allow for individual freedom. Fourthly, whereas traditional forms made extensive use of formal sanctions in an enforcement approach, new forms often rely on

information-based schemes in which rating and ranking, naming and shaming, peer reviews and benchmarking, price-driven processes, and empowered non-state actors play a crucial role. Sanctions are not an integral part of the regulation, nor are they administered by the state. Given actual transparency, rewards and penalties in such an approach are instead invoked decentrally by consumers, investors and advocacy groups in terms of products consumed, investments made and reputations defined. A California law, for example, resulted in improved behavior by forcing restaurants to display health inspection letter grades in their windows (Schneiberg and Bartley, 2008).

Although we could not find them in the organizational sciences literature, the analogues (or translations) below can be defined as candidate tactics for internal compliance. They are marked with an asterisk in Figure 8.2.

- ***Subjecting operations to third party scrutiny***. If an organization sincerely strives to be in compliance, it may motivate its members by calling upon external parties. For instance, a large energy firm could provide an NGO with access to its plants in order to have operations scrutinized. This would not only ensure critical compliance assessments, but society's knowledge of such an endeavor would also have positive effects on the company's reputation. The involved parties should make strict agreements regarding public disclosure of the results, in order to allow the company sufficient time to address any violations. Another expected condition for this approach, in which external parties are granted access willingly, is that the firm be reasonably confident about receiving positive evaluations.
- ***Using internal market logic***. Competition can be introduced within an organization for obtaining compliance-related goals. For example, by letting multiple teams draft a proposal for a business project that has to implement or comply with e.g. regulations or internal IT standards. Management can subsequently decide which proposal offers the optimal solution, taking into account both business goals and policy constraints. Note that we positioned this tactic at the Collective level of the typology as a result of our example implementation. However, a spin-off version of this tactic could possibly be applicable at the Enterprise level.
- ***Implementing self-regulation***. Self-regulation could be implemented within the organization by an enterprise-wide policy containing high-level targets and abstract principles, allowing actors to conform to them by translating these principles to their own explicit and more detailed rules, according to local circumstances. It would be crucial that enterprise-wide regulators restrict themselves to guarding that local units conform to the high-level goals of the policy (e.g. selling mortgages ethically) and achieve its targets (e.g. having a tiny percentage of clients with difficulties paying off their

debts). This is a consequence of the self-regulation concept, using abstract principles and focusing on end goals. The internal regulators therefore cannot readily assess compliance with their principles, since these are too abstract and the norms that are sufficiently tangible for assessments are owned by the 'regulatees' (e.g. local offices). Opportunism and free riding are evident risks in a self-regulatory scheme. However, such risks may be relatively manageable within an organization by asserting internal pressure. The organization's regulators would also be able to review and approve the self-written tangible local norms before implementation begins. Moreover, they would assess the achievement of the end goals. A wholly different approach to internal self-regulation would be to still create detailed rules at the enterprise level, but regularly rewrite them in cooperation with regulated actors as knowledge of and experience with applying those rules is build up.

- ***Internal regulation by information***. Regulation by information could be implemented by internally publishing information about actors' compliance performance. For example, if compliance assessments of projects or units with internal IT standards are conducted, the results could be presented on the organization's intranet or in a newsletter. As actors' reputations are at stake, such disclosure may have a significant effect on compliance results, especially when the most important norms are widely accepted. Compliance reporting of individuals may be more difficult. However, conforming behavior may be communicated in a positive manner, including any bonuses these individuals may have received as a reward for it. This approach may not be a single tactic, but rather a mix of tactics drawn mainly from the Assessment column and may also be combined with self-regulation. Another option would be to completely dispense with creating explicit norms, as transparency could lead to the organizational community determining acceptable levels of behavior by itself.

8.6 Discussion

In this section we will discuss the results of our literature review. Subsection 8.6.1 presents the general findings. Subsection 8.6.2 focuses on developing coherent compliance strategies, which is relevant because a fragmented set of tactics is not sufficient for effective compliance management.

8.6.1 General findings

We start our discussion with a short overview of each academic field's contributions to this study. The fields of *law* and *political science* prove to have the most mature conceptualizations of compliance and related concepts. These

insights therefore figure largely in section 8.3. The reviewed literature in the field of *philosophy* was also used mainly for the foundational insights presented in that section. The organizational sciences – such as *management, business studies, information systems* and *organizational sociology* – were used mainly for the identification of tactics and insights into strategies. As stated in section 8.5.10, except for IT-related solutions, the organizational sciences do not seem to report on many innovations and experiments in compliance. It is mainly the fields of law, sociology and political science that have described innovative forms of regulatory implementation at the (inter)national level. Translating them to the organizational domain, we have defined four analogues of innovative candidate tactics for internal compliance.

Interestingly, during our literature study we practically did not find any publications presenting a general and comprehensive perspective on organizational compliance strategies. Note that the compliance strategy item in Table 8.3 does not refer to publications that put forward such rich conceptualizations of compliance strategies, but to publications that in some way present input for such a view (as such, they will be referenced in section 8.6.2 on strategies). Most publications presenting organizational compliance solutions do not focus on general insights into compliance strategies, but instead aim to make the case for a specific compliance view or approach, employing a selected set of tactics (e.g. Tyler and Blader, 2005; Weaver at al., 1999a; Panitz et al., 2010; Puhakainen and Siponen, 2010; Agrawal et al., 2006; Straub, 1990; Li et al., 2010; Boss et al. 2009; Namiri and Stojanovic, 2007; Foorthuis et al., 2010; Governatori et al., 2006; Breaux et al., 2009; Peterson and Burns, 2006; Cuppens-Boulahia and Cuppens, 2008; Straub and Welke, 1998; Racz et al., 2010; Bulgurcu et al., 2010; Kerrigan et al., 2003; Kim et al., 2007; Pahnila et al., 2007). Although some publications do present a neutral, non-evaluative and broad overview of compliance tactics available, the number of identified tactics tends to be quite limited (Braganza and Franken, 2007; Pulich and Tourigny, 2004; Weaver et al., 1999b; SIA, 2005). Moreover, only a limited number of publications have provided an integrated or high-level discussion on the concept of compliance strategies and programs (e.g. COSO, 1994; Luthy and Forcht, 2006; Burgemeestre et al., 2009). Notable in this regard is Weaver's et al. (1999a) view of ethics programs as organizational control systems. Such programs are characterized by a control orientation (enforcement versus management), have a scope in terms of formalization, specialization and hierarchy (in terms of e.g. ethics officers and staff), and consist of other elements such as the ethical codes of conduct, communication systems, training programs and disciplinary measures. However, Weaver et al. still present a limited number of tactics and focus only on formal initiatives. Furthermore, the bird's-eye view of our literature study yielded insights that are quite distinct

from each other and sometimes even incompatible. A still broader conceptualization, allowing for all kinds of approaches, is therefore required. Section 8.6.2 aims to present such a rich conceptualization of compliance strategies.

Another finding concerns cell volume. Figure 8.2 makes clear that the Assessment and especially Management columns are abundantly filled, whereas the Inducement and Enforcement columns do not contain as many tactics. This could be the result of the arbitrary nature of typologies and the subjectivity of the research. However, studying the assessment and management tactics in more detail makes clear that this is not the case. Many of these individual tactics – such as *socialization of newcomers, selecting employees, facilitating communities of practice* and *reflecting on culture in terms of compliance* – offer rich opportunities and choices when implementing them (see section 8.5 for details). In other words, the assessment and management tactics are not defined with finer granularity than their inducement and enforcement counterparts. Rather, it should be concluded that the assessment and management approaches offer a wider variety of ways for encouraging compliance. Another aspect concerns the vertical dimension, with the Enterprise level accommodating relatively many tactics. Note that the tactics at this level are not necessarily employed directly by senior managers, since *gaining insight into enterprise-wide compliance rates* and *properly specifying policies*, for example, will be executed by staff members. However, senior management should be aware of their responsibility to initiate tactics at this level.

8.6.2 Moving From Compliance Tactics to Compliance Strategy

In section 8.5 we have described a large number of compliance measures. Although this typology of tactics constitutes the core contribution of this chapter, a fragmented set of tactics is not sufficient for effective compliance management. Therefore, this section aims to present a rich conceptualization of compliance management strategies and discuss crucial aspects of developing such a coherent strategy. Not surprisingly, in most organizations it will first be necessary *to put the compliance management function in place*. This may encompass the installment of an independent audit and compliance department – including its officers and staff with clearly defined roles, responsibilities and authority (Gaunt, 1998; Weaver at al., 1999b; Arjoon, 2006; SIA, 2005). Depending on the situation, the scope of such initiatives tends to vary widely in terms of personnel and supporting structures (Weaver at al., 1999a; SIA, 2005). An important implementation aspect is the necessary separation of duties, so as to guarantee independent and objective assessments and audits (Solms, 2005; SIA, 2005). In addition, employees occupying relevant positions should be

provided with proper mandates, authorizations and authority (Agrawal et al., 2006; Arjoon, 2006; COSO, 1994).

A key responsibility of the compliance function is the development of a compliance management strategy. As stated, however, we did not find any publications presenting a general and all-encompassing perspective on organizational compliance strategies. The remainder of this section aims to present such a conceptualization. We will draw on the general strategy research of Mintzberg (1987) for this purpose. There are several reasons for using Mintzberg's five views on strategy. First, the concept of organizational strategy is ambiguous and multifaceted (French, 2009), and Mintzberg's comprehensive view also allow for perspectives on strategy that are incompatible for a given situation (e.g. a predefined plan versus a pattern discovered after the fact). Second, Mintzberg's conceptualization is widely accepted.

The most dominant view is that of strategy as a ***plan***, a consciously intended course of action. The compliance strategy here is therefore developed purposefully and in advance of execution. Goal-setting will be an important element (Quinn, 1996), especially regarding the level and nature of compliance with policies in question. Note that striving for a 100% compliance level may not only be unrealistic, but could also yield unwanted side-effects. The organization would run an increased risk of developing a bureaucratic culture of 'overconformity'. Adherence to the rules would then become an end in itself rather than aim at achieving goals, resulting in rigidity and an inability to adjust to individual cases (Merton, 1957). Employees will consequently hide behind the rules and absolve themselves from any responsibility. In addition, a strong focus on compliance and monitoring may lead to a 'surveillance culture', distrust, a distinction between 'them' (i.e. the compliance officers) and 'us', a lack of commitment and even resistance (Tyler and Blader, 2005; Currie, 2008; Short and Toffel, 2010). As has been suggested in political science, an acceptable level of overall compliance may therefore be better than a standard of strict compliance (Chayes and Chayes, 1993). The organization may only be able to choose such levels in the case of standards and internal procedures, whereas in the case of laws and regulations full compliance is required. Even regarding regulatory compliance choices have to be made, however, as it may be possible and desirable to move "beyond compliance" and do more than strictly necessary (Short and Toffel, 2010). Organizations have on the other hand also been known to merely act as symbolic compliers, instead of taking substantive action (see below). In addition to determining the degree of compliance, it should also be decided for each policy *how* to comply. Organizations often have some leeway as to the exact nature of achieving compliance goals, even with external norms (Philippe and Durand, 2011). For example, organizations can comply with transparency laws (e.g. disclosing their

investments) but refuse to conform to underlying norms and values of ethical business (and e.g. continue their investments in the weapons industry). In addition to goal-setting, more mundane decisions have to be made regarding *budget*. Pursuing a rationalistic command-and-control approach, with a heavy focus on monitoring and enforcement, is a very expensive road to travel (Tyler and Blader, 2005). In addition to budget, *time* is also an important aspect. Although strategy is not associated with short-term thinking, setting out to change the organization's compliance culture, for example, may require an extensive and long-term change initiative with repeating reinforcement of norms and an uncertain outcome (Gaunt, 1998; Ogbonna and Harris, 1998). The combination of compliance goals and available time and budget may require *goal prioritizing*. Schraaf (2005) describes a 2x2 matrix for setting priorities on the basis of the dimensions risk (in terms of negative impact) and non-compliance rate. Issues with both a high risk (e.g. high fines) and high internal non-compliance rate receive the highest priority.

The second view of strategy is that as ***perspective***, a way of perceiving the world. This is strongly related to the organization's worldview, culture and 'character'. An important aspect here is that strategy is a shared perspective, part of the organization's collective mind. Especially relevant in our context is what view the organization has regarding the nature of compliance. What account does it have of why its units, projects and employees comply or do not comply with policies? Are organizational actors rational agents calculating the benefits and costs of compliance decisions or are they good-faith actors valuing their identity and in need of effective means and knowledge? Or is the worldview a combination of both? This perspective, whether conscious or not, will guide strategic and day-to-day compliance decisions.

A third view is strategy as a ***ploy***, a maneuver to outwit a competitor or opponent. In terms of compliance, the organization may try to attract investors by being the first to adhere to the new rules of Sarbanes-Oxley or the Basel accords, or to innovative industrial standards. In contrast, the organization may also choose to lower compliance levels temporarily in order to achieve a strategic and highly visible business result. A ploy in the context of compliance could also be taken to mean obfuscating non-compliance (Heyes, 2000) and conducting mainly symbolic compliance activities (Short and Stoffel, 2010; Weaver et al., 1999b; Meyer and Rowan, 1977). Such symbolic compliance refers to the concept of *decoupling policy from practice*, a form of window-dressing in which an insignificant compliance program is implemented. Such programs are ineffective because they are disconnected, i.e. the organization avoids their crucial elements – such as monitoring and punishing – being integrated into the central, task-related business activities. This results in non-compliance, as processes are not continuously monitored for compliance,

processes are not seriously affected by the program, and transgressors are not confronted with disciplinary measures. However, to the outside world public claims are made about significant compliance efforts and the organization being in compliance. Research has shown that organizations may get away with decoupling, but that this can also lead to severe financial and reputational damage (MacLean and Behnam, 2010). As stated earlier, in this chapter we will assume an organization genuinely strives to be compliant.

A fourth view sees strategy as a ***position***, a means of locating an organization in its environment and a mediating force between the organization and its external context. The compliance strategy in this view is used to position the enterprise in the market, for customers and other stakeholders, and in terms of which ethical principles to adhere to (and to what degree). It should also be decided which professional standards and quality norms to comply with, and which to demand from e.g. suppliers. This also points to the fact that the organization has an active relationship with its environment and should determine whether or not to try and influence external regulators' policy making processes (cf. Meyer and Rowan, 1977; Schneiberg and Bartley, 2008). Indeed, one painless way to be compliant is to ensure newly devised norms are consistent with existing behavior (Downs et al., 1996). Apart from this external orientation, the compliance strategy should also be positioned internally. It should, in other words, be aligned with the overall business strategy and with the core beliefs and values of the organizational culture. In this regard, senior management should make clear what the *purpose* of the organization is. Purpose could be regarded as the statement of an organization's moral response to its broader defined responsibilities, not as an amoral plan for exploiting commercial opportunities (Bartlett and Ghoshal, 1994). Several questions should also be considered regarding the ambitions of integration. One question concerns whether holistic compliance is desirable (Volonino et al., 2004; Cleven and Winter, 2009; Panitz et al., 2010), i.e. the extent to which compliance management intends to deliver central and integrated (instead of fragmented) compliance efforts, covers multiple internal and external policies, and has a long-term scope. Another issue is that it should be decided whether compliance management itself should be integrated with enterprise risk management and overall governance efforts (Dawson, 2008). As described in a previous section, integrated, holistic compliance may yield improved insights, which can be used for increasing consistency and reducing complexity of processes and systems.

When strategy is seen as a ***pattern***, the focus lies on the pattern that can be observed in a stream of actions. This fifth view focuses on two important aspects of compliance strategies. The first is that strategy as a plan is neither sufficient nor necessary, as there should be *actual behavior* in the form of

decisions and actions. In our context this implies that day-to-day business processes are not decoupled and shielded from, but actually integrated with and affected by compliance-related considerations (MacLean and Behnam, 2010). The use of informal tactics may also be more immanent in these day-to-day behaviors than in predefined plans. A second important aspect is that of *coherency* in those decisions and actions (Mintzberg, 1987; Quinn, 1996). A compliance strategy should focus on the interdependence and internal consistency of goals, planned action and actual conduct. Moreover, and arguably the most crucial part in the context of this study, a compliance strategy should encompass one or more coherent sets of tactics aimed at achieving a targeted compliance level. The framework and typology presented in section 8.4 can be used to predefine (or analyze in retrospect) such sets. Given the fact that the typology is the core contribution of this chapter, it is this aspect that is especially interesting here. The remainder of this section will therefore focus on the factors involved in creating these intervention mixes, i.e. relevant and coherent combinations of compliance tactics.

In general, a strategy drawing its tactics from both the rationalist and normative perspective seems to be the most promising approach (Grossman and Zaelke, 2005; Wasserman, 2009; Tyler and Blader, 2005; Short and Toffel, 2010; Paternoster and Simpson, 1996; Braithwaite, 2007). From the rationalist model, especially enforcement is often seen as a necessary element. According to Grossman and Zaelke (2005, p. 78), for example, the "proper balance of the two models thus seems to be a compliance enforcement system that also encourages the norms and incentives that lead to voluntary compliance, while maintaining the bedrock foundation of enforcement and deterrence to alter the calculations of those less inclined to voluntarily comply." In terms of the framework of section 8.4 this means minimally picking tactics from both the Enforcement and Management columns.

However, a compliance strategy is heavily contingent upon the situation. Most fundamentally, the choice of which exact combination of tactics to include depends strongly on whether a rationalistic or normative orientation weighs more heavily. In this context, several strategies or "modes" can be identified (Rossouw and Van Vuuren, 2003). For example, a primarily rational "compliance mode" would focus on formalizing norms, monitoring compliance-performance and sanctioning of transgressions. Tactics would be drawn mostly from the Enforcement and Assessment columns. A primarily normative "integrity mode" would focus on reflecting on the culture, top management support, internalization of values, providing assistance and other forms of managing non-compliance. Tactics would thus be chosen mostly from the Management and Assessment columns. Note that the choice of such a mode or

strategy depends not only on ambitions, but even more so on the starting point, i.e. the current compliance culture, routines and context of the organization (ibid.; Short and Toffel, 2010). As stated in the previous section, it should also be noted in this context that the Management and Assessment columns offer a wider variety of tactics, and thus more opportunities for tailoring the strategy to the specific setting.

However, it is too simplistic to presume that a single combination of tactics in the strategy is sufficient. It may very well be necessary to define intervention mixes at a lower level. For example, each *reason for non-compliance* may have its own set of tactics, as does each type of actor (Schraaf, 2005). In addition, each *geographical establishment* may have its own unique intervention mix, since organizational cultures and legal requirements differ between locations (cf. Arjoon, 2006). Furthermore, different *policies* may require different sets of compliance tactics, as compliance with internal standards presumably allows more discretion than compliance with mandatory external legislation. Internal regulators should also think about how to *sequence* or escalate the use of tactics for distinct types of situations. An approach known as 'responsive regulation' (Ayres and Braithwaite, 1992; Braithwaite, 2007) states that in most cases regulatees do not have to be coerced into complying and can be persuaded through e.g. explanation and education. However, for actors demonstrating increasing (risk of) non-compliance, an escalation path can be followed with increasingly intrusive and coercive measures taken. Such an approach, therefore, differentiates between different types of actors, risks or behavior, and deals with each accordingly. It is exactly the perception that a regulator can and if necessary will resort to varying degrees of tougher enforcement tactics that allows him to be 'soft' to most actors most of the time. Such a strategy could then draw its tactics from all columns of the framework. For some actors management tactics would suffice, whereas for others a combination of enforcement and assessment tactics would be necessary. It should be noted, however, that a compliance strategy should not try to include as many tactics as possible, as an effective strategy generally develops around a limited number of key ideas (Quinn, 1996).

Within a given mix of tactics, specific organizational traits such as power relationships and culture determine how best to deploy and use them. In short, the exact set of intervention mixes and their usage are contingent upon the specific characteristics of the enterprise in question (Schraaf, 2005; cf. SIA, 2005; cf. Arjoon, 2006; cf. Ayres and Braithwaite, 1992). Consequently, devising a compliance strategy is also a creative endeavor inspired by the organization's unique situation, not simply a matter of mechanically following a simple method.

National and organizational culture can be important factors in deciding on which levels to draw tactics from. An individualistic culture – emphasizing freedom, creativity and individual responsibility and autonomy – will be more likely to think in terms of individuals complying with norms (cf. Bond and Smith, 1996; Ralston et al., 1997; Goncalo and Staw, 2006). Such a culture can thus be expected to yield a strategy with relatively many tactics from the individual level, as individual employees and their individual managers will be held responsible for conforming to the (mandatory) norms. On the other hand, a collectivistic culture – placing more emphasis on organizational identity, collaboration, a shared vision, a consistent reputation and solidarity – will be more likely to focus on group conformity (ibid.). General compliance levels may be higher in such a culture, but the compliance ambitions may likewise be higher. Therefore, when the organization is faced with unsatisfactory compliance levels, a collectivistic culture can be expected to employ tactics from the collective and enterprise levels. Note that this would not make tactics at the individual level superfluous, as measures at the enterprise level (e.g. *developing guidelines for punishing* and *mandating compliance officers to provide incentives*) often imply the availability of tactics at the individual level (e.g. *imposing formal penalties* and *offering formal rewards*). In both types of culture the focus of the compliance strategy may shift as time progresses. A strategy drawing heavily on tactics from the individual level may go hand in hand with an increasing employee experience of unfairness, since colleagues may be rewarded or punished very differently for quite similar behavior (cf. Li et al., 2010). In time, the organization may find itself forced to develop enterprise-wide guidelines for punishing and rewarding.

8.7 Conclusions and further research

Our research constitutes a high-level and comprehensive view on the topic of internal compliance. We did not come across any publications in the organizational sciences with a similar broad scope and distanced view, acknowledging the value of all possible approaches. Most research instead focuses on the development of a compliance strategy or program from a specific perspective, with a limited set of tactics deemed superior. Such research thus presents specific instances of approaches and strategies, whereas our aim of this study was to take a more high-level perspective to provide a neutral and complete overview of generic ways to bring the organization into compliance. It is possible to analyze and position these tactics using the overall framework and typology presented in this chapter. This study has put forward rich conceptualizations of both compliance tactics and compliance strategies. Concep-

tualizing internal compliance in terms of tactics and strategies also allows for a purer view on the topic than the standard view of internal controls does. Because of the bird's-eye view of this study, our conceptualizations are also presented neutrally and non-evaluative, thus without making the case for specific, superior approaches.

The core contribution of this chapter is the typology of 45 generic compliance tactics, the development of which has been based on a large interdisciplinary literature review of 134 publications drawing from both classical and state-of-the-art insights. To the best of our knowledge, such an overview has not been published before and this study thus fills a gap in the literature on internal compliance. Focusing on compliance tactics (rather than on internal controls) ensures we have captured the substantive essence instead of implementation activities. The resulting overview of tactics can be used as a reference work and inspirational resource by both practitioners and academics. A second contribution is the multidisciplinary overview of core insights presented in section 8.3, resulting in the development of the two-dimensional framework of section 8.4. The cells of this framework can be used for positioning and characterizing compliance tactics (resulting in the typology, i.e. Figure 8.2). The framework as a whole can also be used for describing and developing coherent and balanced compliance strategies. In this context, a third contribution is the broad and all-encompassing conceptualization of a compliance management strategy and the overview of crucial aspects of developing one. More in general, this chapter serves as an overview of fundamental insights into the topic of compliance, for academics and practitioners on the one hand, and for newcomers and knowledgeable professionals on the other.

Several limitations should be mentioned. As stated in section 8.4, a drawback of typologies is that their exhaustiveness cannot be guaranteed. Indeed, since we have chosen to draw from multiple disciplines, a huge number of publications on compliance could potentially be reviewed and not all of these could possibly be included in our review. As a consequence, we cannot guarantee that we have identified all existing tactics. To deal with this issue, however, we continued reviewing up to the point that the inventory of tactics was saturated, no new tactics were found, and new publications only served to support existing tactics. A second limitation, and another known drawback of typologies, is that mutual exclusiveness of the identified types cannot be guaranteed. We have dealt with this problem by mentioning explicitly when certain compliance tactics are related or overlapping. A third limitation is that the reviews were conducted by the principal researcher only. This has the advantage that it lowers the risk of inconsistent reviews. However, a drawback is that the definition of tactics will be more prone to an individual's subjectivity.

This risk was mitigated by regularly discussing the defined tactics with co-authors and other colleagues. In this context it should also be noted that the concepts of tactics and strategies have no absolute meaning in themselves and are inherently flexible, regardless of the research approach (Mintzberg, 1987).

The typology of tactics and the broad view on compliance management strategies may serve as a foundation for further research. A first opportunity for future research is putting the innovative candidate tactics to practice, for example by employing an action research approach. A second suggestion for further study is to verify whether individualistic cultures indeed mainly use individual level tactics, whereas collectivistic cultures also put enterprise and collective level tactics to use. As far as we know, this topic has not yet been studied. A third avenue for future research is to investigate more deeply how to develop a compliance management strategy, given the large amount of tactics available. For example, the elementary tactics in the typology can be used as input for studying opportunities for new and innovative strategic intervention mixes. In the process, more tactics may also be discovered or devised, not only because new ideas may drive innovation, but also because of the fact that certain cells of the framework are not filled as abundantly as others. A final area for further study is the development of additional theoretical perspectives on compliance strategies, using Mintzberg's five views or other conceptualizations.

Appendix 8.A. Review protocol

Research questions

- What are the fundamental concepts in compliance?
- How can compliance tactics be classified?
- What tactics for stimulating compliance are acknowledged in the literature?
- How can compliance tactics be integrated in a compliance management strategy?

Inclusion and exclusion criteria

Inclusion criteria compliance tactics:

- Preferably academic (operationalized as at least one of the authors affiliated with a university at the time of writing) and peer reviewed.
- Non-peer reviewed (technical report).
- Non-peer reviewed and non-academic (practitioner publication). This is only permitted if the publication has a unique contribution to the research.
- English or Dutch (preferably English).
- The final decision on whether to review the publication is made on the basis of title, abstract and, if useful, conclusions and scanning through the publication.
- Papers in which compliance is the core topic are preferred, but this is no strict criterion.

Exclusion criteria compliance tactics:

- Publications that are neither in English nor in Dutch.

Steps in a review of a publication

Directly after reading the publication, two actions are undertaken.

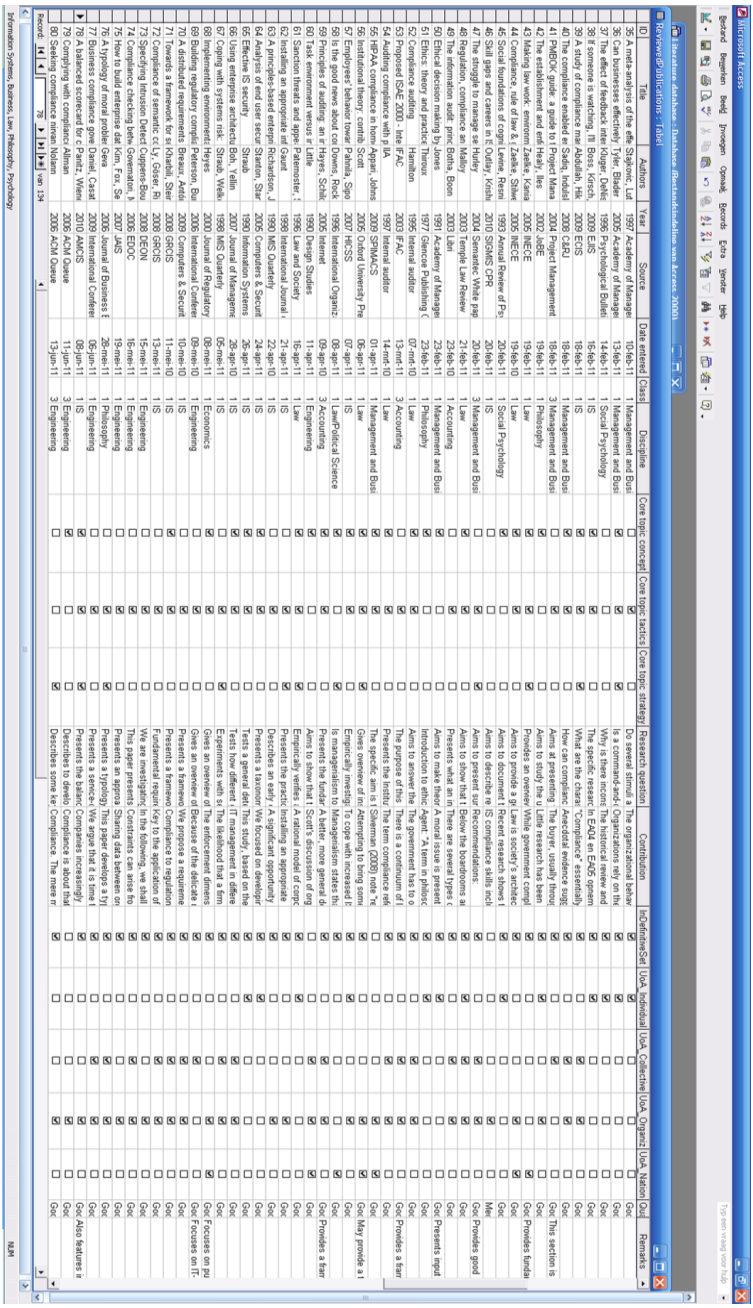
- An entry is added to the literature database (see below).
- Relevant passages from the publication are captured in the first-codes-document (first-coding). A name (first code, representing a tactic name) is attached to it in the process. Text can be paraphrased or copy-and-pasted from the publication. These first-code texts can later be used as input for the pattern-coding process.
- If the publication contains knowledge relevant to the topic of compliance management strategy, relevant text is copied-and-pasted to the strategy section of the first-codes-document.
- If the pattern-coding process has already been started, the relevant pattern code(s) is (are) created or updated. Important criteria for defining a definitive pattern code (i.e. tactic) are mutual exclusiveness and a conceptual abstraction that allows for a clear and presentable description of the code.

Literature database
Directly after reviewing a publication, a relevant description of it is stored in the literature database. The following information is stored.

- ID: Number assigned automatically (primary key).
- Title: Title of the reviewed publication.
- Authors: Authors of the reviewed publication.
- Year: Year that the reviewed publication was published.
- Source: Journal, conference, etc in which the reviewed publication is published.
- Date entered: Date that this record is entered (and, in principle, that the publication is reviewed).
- Classification: Academic peer-reviewed, academic non-peer reviewed, or non-peer reviewed non-academic. If the classification is 'non-peer reviewed non-academic', then the Remarks section should explain the value of the publication.
- Discipline: Information Systems, Business, Law, Philosophy, Psychology.
- Core topics: The relevancy to one or more of our core topics. In other words, whether the publication explicitly covers:
  - Compliance as a concept (mainly for the definitions and framework)
  - Compliance tactics (for identifying tactics and filling of the framework)
  - Compliance strategy concept (for knowledge on creating strategy based on framework)
- Research question: The question or aim of the reviewed publication.
- Contribution: Free format text mentioning the contribution of the publication to our research.
- InDefinitiveSet: Whether the publication is included in the definitive set of relevant publications, and likely to be referenced in the final publication. Can also be Null (i.e. not yet decided).
- Unit of Analysis: Individual (e.g. Psychological research), Collective (teams, projects and departments within an organization), Organization (enterprise-wide), Nation (also multiple nations, i.e. an international scope).
- Quality evaluation: Subjective remarks concerning the quality of the study. Value are "Good", "Medium", "Inadequate".
- Remarks: Any other remarks, for example what significant contribution a non-peer reviewed non-academic offers (e.g. providing a unique insight or a clarifying illustration of a tactic in practice).

Other remarks
A publication can be relevant to more than one of our core topics.
A publication can have multiple levels of analysis, depending on the concept.
An academic book is considered to be peer-reviewed.

Appendix 8.B. Screenshot of Literature Database



Appendix 8.C. Coding Traceability

Chapter 9

Conclusions

9.1 Research Questions and Conclusions

The main research question of this dissertation is:

> *MRQ*: *What are effective practices for working with projects that are required to comply with Enterprise Architecture, and what benefits and drawbacks are induced by compliance?*

In order to address this main question, it was subdivided into more concrete research questions and sub-questions, the findings of which are presented below.

> *RQ1*: *What are appropriate definitions of the various architectures at the project, domain and enterprise level, and what are their interdependencies and contents?*

The answer to this question is provided by the framework of chapter 2, in which the concepts Enterprise Architecture, Domain Architecture, Project Architecture, Project Start Architecture and Software Architecture are defined and interrelated. Figure 3.2 of chapter 3 presents a compact overview of all these concepts. Enterprise Architecture is a high-level and somewhat abstract architecture providing solution guidelines and constraints, similar to mid-level Domain Architectures. A Project Architecture, on the other hand, is focused on actual implementation of more or less local solutions, which need to be compliant with the EA and any DAs. Project Start Architecture and Software Architecture can be regarded as constituents of the Project Architecture.

The second research question is:

> *RQ2*: *What best practices can be identified for projects that have to comply with EA?*

Chapter 3 focuses on investigating this question, identifying several EA-related best practices and observations from practice. Candidate best practices that have been put forward in this chapter are providing projects with advice, having architects participate actively in projects, using a (phase-dependent) PSA and encouraging conformance by means of artifact templates. Notable observations are the ambiguity of EA prescriptions, the added project complexity of working with EA and the awareness and knowledge stimulating role of the PSA. These best practices and observations have been empirically tested in chapter 7.

RQ3: *What artifacts are relevant for projects conforming to EA, how are they related to EA, and how are they created and tested on conformance?*

This question has been addressed by creating a layered artifact and process model for EA-related projects. Examples of important new EA-related project artifacts are the EA Conformance Report, the PSA template and the EA Feedback Report. The model's first layer (chapter 4) specifies by which processes these artifacts are created and what the relationships between the processes are. Each process is also described in detail at the second layer (chapter 5). The model is based in part on the observations and best practices yielded by RQ2, such as encouraging conformance by providing advice, working with a PSA and conducting compliance assessments. The effects of these practices have been empirically measured, the results of which are presented in chapter 7.

RQ4: *How can projects, and the business and IT solutions they deliver, be assessed on compliance with a prescriptive EA?*

To address research question 4, it was divided into several sub-questions, which will be discussed below.

RQ4.1: *What concepts play a key role in assessing compliance with EA?*

This question is addressed by the detailed class model of chapter 6 (Figure 6.2), which positions and interrelates fundamental concepts in EA compliance testing. One important element is the Enterprise Architecture, which amongst others consists of Project Prescriptions (i.e. architectural norms with which projects should comply). These Prescriptions may take the form of Principles, Models or Policy Statements. Another crucial element is the Project, which delivers the Local Solution that should ultimately yield business results. During

its lifetime, a Project will create Project Artifacts (i.e. deliverables such as Software Architecture Documents and Use Case Models). These are typically the items which should be assessed on compliance by using Compliance Checks.

RQ4.2: *By what process can EA compliance testing be carried out?*

This process is described as one of the processes of the artifact and process model mentioned above. See chapter 6 for a detailed overview of the process and the four compliance checks used within it.

RQ4.3: *What kind of compliance checks can be utilized in the EA compliance test process, and what are their respective evaluation criteria?*

As part of the assessment process, four compliance checks can be used when verifying compliance. The compliance checks are the Correctness Check (is the prescription applied in accordance with its intended meaning, rationale and usage?), the Justification Check (is the application of a given prescription – or the lack thereof – justified, depending on its relevance and priority in the specific situation?), the Consistency Check (given a prescription, are related prescriptions applied in a coherent way?) and the Completeness Check (are all prescriptions applied?). The checks can be found in section 6.7. The evaluation criteria are described in terms of the properties and relations of the classes of the EA Compliance Model depicted in Figure 6.2.

RQ5: *What benefits can be gained by conforming to EA, and what are the most effective techniques for achieving conformance?*

To address research question 5, a survey study has been conducted. In total, 293 valid surveys were returned, by respondents working for 116 different organizations. The dataset was verified in terms of representativeness. A multivariate regression analysis was performed in order to create a statistical model and test various hypotheses. Several sub-questions have been taken into account.

RQ5.1: *What techniques are applied in practice to stimulate conformance of projects to EA?*

The empirical study has shown that most of the identified techniques are used in practice. Important examples of such compliance tactics are:

- Knowledge exchanges
- Providing advice
- Working with a PSA
- Compliance assessments
- Using document templates
- Having management propagate EA.

Interestingly, financial incentives and disincentives are barely used in practice.

RQ5.2: *What benefits does EA yield for individual projects conforming to its norms?*

The research has shown that projects benefit in several ways from working with EA. These benefits are delivering the desired quality more often, being better equipped to deal with risk and being able to manage complexity more effectively. Several hypothesized project benefits could not be confirmed, such as exceeding deadlines and budgets less often, and delivering the required functionality more frequently. EA simply did not have a significant effect on these aspects. The results also showed that EA has a downright negative impact on the speed of initializing projects. This is probably due to one of the observations found in chapter 3, namely Enterprise Architecture introducing additional project complexity (viz. getting acquainted with abstract and non-practical EA prescriptions, dealing with additional stakeholders, balancing possible conflicts of interests and undergoing compliance assessments).

RQ5.3: *What benefits does EA yield for the enterprise as a whole?*

The results show that several organization-wide benefits are achieved as a result of EA. Important benefits are accomplishing enterprise goals, gaining insight into organizational complexity, depicting a clear image of the future situation, providing a communicational frame of reference, and achieving integration, standardization and deduplication of related processes and systems. Hypothesized benefits not confirmed are achieving business/IT alignment and agility, controlling costs and complexity, and co-operating with other organizations effectively and efficiently. All of these latter claims were rejected because EA does not seem to have a significant impact on these goals, not because EA has a negative effect.

RQ5.4: *What differences, if any, exist between EA users and EA creators in their evaluative perceptions?*

The results show that EA creators and EA users generally agree in their evaluations, in the sense that both are positive (and in some cases negative). However, on various benefits, both at the enterprise and the project level, EA creators are significantly and consistently more positive than EA users. This is on the one hand probably due to the creators' involvement and commitment, the binding effect of which results in them possessing a relatively positive attitude. On the other hand, EA users arguably have a relatively negative attitude as a result of their inability to see the overall picture (due to their local focus) and of them having to deal with additional complexity and effort (see claim B18 in section 7.5.2 and observation 2 in section 3.4.1). Because of the subjectivity of these two groups, it is of paramount importance to take both perspectives into account for attaining a balanced view.

RQ5.5: *Which of the techniques applied result in the most effective increase in project conformance to EA, and what are the effects of conformance on the realization of EA benefits?*

The results show that most techniques identified are used in practice. However, after controlling for other effects, only three tactics have a significant impact on compliance with EA: compliance assessments, management propagation and assisting projects. Compliance of projects subsequently results in an increased ability to achieve EA-related benefits. At the enterprise level, conformance has significant effects on achieving business/IT alignment, accomplishing enterprise-wide goals and integrating, standardizing and deduplicating processes and systems. At the project level, conformance is shown to have significant effects on the ability to manage complexity, delivering the desired quality and delivering the desired functionality. Interestingly, project compliance with EA has the strongest effects on organization-wide benefits, whereas projects themselves benefit to a lesser extent and in more subtle ways. This is not only consistent with accepting the singular claim of EA being a good instrument to accomplish enterprise-wide goals (B1 of RQ5.3), but is also a strong indication that project conformance to EA is an important factor to realize this key claim. The project level plays an important part in achieving organization-wide goals (the association between O1 and B1 is direct and explicit evidence of this, the association between O1 and organization-wide benefits in general – amongst others B11, B1, B2, B5, B10 and B7 – is implicit and indirect evidence of this).

RQ6: *What compliance tactics can be used by an organization to increase, achieve or maintain compliance with internal and external norms?*

The extensive multidisciplinary literature study of chapter 8 has revealed that a large number of tactics exist for stimulating conformance to norms. No less than 45 compliance tactics have been identified. These tactics differ in their nature (enforcement, inducement, assessment or management) and their application level (enterprise, collective or individual). Consequently, the tactics have been presented in the form of a typology. Several guidelines for moving from compliance tactics to compliance strategy have also been provided.

9.2 Discussion

Given the fact that we conducted an *equal status sequential mixed method study* (Tashakkori and Teddlie, 1998; see also chapter 1), we need to address the consistency between the separate sequential studies comprising this dissertation. We will start with the substantive research results, followed by a short methodological discussion.

Based on the participative research and literature, chapters 3, 4, 5 and 6 present several techniques for stimulating project compliance with EA. Notably, these chapters put forward conducting compliance assessments as an important technique, i.e. the Review Baseline activity in the artifact and process model. Chapter 7's statistical results show that conducting compliance assessments (T4) is the most effective way to increase compliance. Other techniques repeatedly put forward in chapters 3, 4 and 5 are enterprise architects actively participating in projects and providing projects with advice. Active participation is tested in chapter 7 (as T7) and indeed found to have a significant effect on conformance. Providing advice is tested in chapter 7 as knowledge exchanges between architects and project members (T6), but did not have a significant effect after controlling for other techniques and factors. Furthermore, chapter 3 suggests using templates as a means for stimulating project conformance (T9), but in the statistical study this was also not found to increase compliance significantly.

Given the above, we can draw some conclusions regarding the status of the practices. In chapter 3 we acknowledged four levels of best practices (good idea, good practice, local best practice and industry best practice). Being based on a limited number of projects in one organization, the practices identified in chapters 2 to 6 (research phase 1) can be regarded as best practices with the status of *good practice*: candidate practices tested in one or more projects, but not based on comparative data from other organizations and thus in need of further validation. Chapter 7 (phase 2) has provided this comparative empirical validation for several important practices. We therefore conclude that conducting compliance assessments, having management propagate the EA, and letting architects participate actively in projects can be granted the status of *industry*

best practice. These are practices that have been determined to be the best approach for all or most of the organizations in an industry (viz. EA-using organizations), based on inter-organizational benchmarking and analysis of performance data. Note that the other practices are not dismissed as being useless, since they have proven themselves valuable locally and thus retain their status of good practice. We will discuss several of these practices in more detail below.

In addition to the techniques mentioned above, chapter 2 describes various benefits of the PSA: increased compliance of the project with the EA, a swift start of the project since several fundamental decisions have already been taken, and alignment with other projects. In reporting the action research findings, chapter 3 concludes that the PSA was not used as a rigid set of instructions, and that this project artifact cannot be expected to be sufficient to ensure project compliance with EA. However, the PSA did result in increased architectural awareness, i.e. a richer and more tangible understanding of the EA. These results of the action research presented in chapter 3 are consistent with the statistical results. In chapter 7 it is shown that, after controlling for other techniques and factors, the PSA does not significantly increase project compliance with EA. However, increased awareness of and insight into the EA and the organization does result in projects being able to better deal with complexity and risks. Another finding of chapter 7 is that conforming projects tend to start up slower than non-conforming projects. Regarding the PSA, in short, the empirical findings of the action research and statistical study are consistent, but they contradict two of the hypothesized benefits mentioned in chapter 2 and the literature.

Observation 2 in chapter 3 states that EA introduces additional project complexity. This is the result of: high-level architectures (EA and DA) defining an ideal solution without considering practical problems, large numbers of requirements for projects to conform to, project members having to learn and understand the EA, and translating generic EA prescriptions to specific project situations. As stated in chapter 3, all these issues took time and effort. This is consistent with the statistical finding of chapter 7 that projects conforming to EA tend to start up significantly slower. It should also be noted that the other finding of chapter 7, the fact that projects seem to be able to deal with complexity better, is not at odds with the above. In addition to EA being only one part of a project's environment potentially introducing complexity, having to deal with additional complexity and the ability to deal with it are simply two separate aspects.

The participative research presented in chapters 2, 3 and 6 found that EA prescriptions are often quite ambiguous. This was due to their abstract nature, the norms being codified in natural language, and the personal and contextual knowledge used in interpreting them. Chapter 7 confirms prescriptions being open to multiple interpretations, albeit not as convincingly as we would have expected considering the previous chapters. One reason might be that the EA

studied initially was particularly ambiguous, but that prescriptions in most organizations are only moderately so. A related reason could be that the ambiguity was in part a result of the EA being relatively new to the organization. Alternatively, compliance assessments may in most organizations be carried out in a collaborative fashion, automatically resulting in reduced disagreement. People might also implicitly assume agreement, with disagreement only manifesting itself when being explicitly confronted with it. This may especially be the case with compliance assessments as detailed as the one described in chapter 6. In order to scientifically assess compliance, it is likely that this study is more fine-grained than regular practitioner compliance tests are, thereby exposing more disagreement amongst testers.

A final consistency issue to discuss concerns one of the key assumptions of this dissertation and of working with EA in general. Chapters 2 to 6 assume, and by means of participatory research make it likely, that project compliance with EA is a crucial issue. The empirical research of chapter 7 confirms this convincingly, as project compliance is shown to be a central, mediating factor in between frequently-used techniques for working with EA on the one side and several benefits at the organizational and project levels on the other.

Research Methods

As we have conducted mixed-method research, we also consider a short methodological discussion to be of value. We have used action research, statistical analysis, a structured literature review and focus groups to gather and analyze data. Action research and focus groups both served to explore the field, to extract knowledge from real-life daily practice and to generate hypotheses. Focus group interviews proved to be a valuable way to discuss and get feedback on the action research findings. Statistical analyses, in particular the survey research of chapter 7, were used to test hypotheses and expand on theory. The multidisciplinary literature review enriched our view on compliance. In general, this mixed-method approach worked quite satisfactorily and can thus be recommended for large research projects, such as a PhD study.

With regard to the statistical analyses, we have experienced first hand that taking sufficient time to design and test a good questionnaire more than pays itself back with a high-quality and consistent dataset. However, some remarks should be made regarding the regression analysis. Although explicitly taking into account the ordinal nature of survey data and thus methodologically sound, ordinal regression yields parameter estimates that are relatively hard to interpret. Not only is a separate regression coefficient calculated for each category of each ordinal variable, but the coefficients do not have a readily interpretable meaning. We therefore suggest complementing ordinal regression with other

techniques capable of handling ordinal data. For example, regression analyses with PLS (partial least squares) and optimal scaling (categorical regression) have their own shortcomings, but yield parameter estimates that are more easily interpretable (e.g. calculating one standardized coefficient per association).

9.3 Contributions

In addition to the added knowledge and conclusions described in the previous sections, this research project has yielded the following concrete contributions.

Framework of architectures. Chapter 2 presents a framework that defines and interrelates several types of architecture. The types of architecture described are: Enterprise Architecture, Domain Architecture, Project Architecture, Project Start Architecture and Software Architecture. Figure 3.2 of chapter 3 presents a compact overview of these concepts.

Artifact and process model for projects conforming to EA. We have developed a layered artifact and process model for projects that have to comply with EA. The overall model is presented in chapter 4 and its detailed sub-models are presented in chapter 5. The model, offering practitioners a (semi-)structured way to deal with EA, is based in part on the observations and best practices presented in chapter 3. One component of the model, compliance assessments of EA-related projects, is described in much more depth in chapter 6.

Dimensions of compliance. In chapters 6 and 8 we have defined and motivated four dimensions of compliance. These dimensions represent the different aspects that should be taken into account when the aim is to achieve or to measure compliance with norms (i.e. prescriptions).

- *Correctness*: A norm should be applied in accordance with its intended meaning, rationale and usage.
- *Justification*: The application of a given norm – or the lack thereof – should be justified, depending on its relevance and priority in the specific situation.
- *Consistency*: A given norm and the norms to which it relates should be applied in a coherent way.
- *Completeness*: All (mandatory) norms should be adhered to, as opposed to adhering only to a convenient subset.

Explanatory model for EA conformance and benefits. Chapter 7 presents a theoretically motivated and empirically supported explanatory model for achieving EA benefits. The model shows that achieving these benefits can be

explained in part by project conformance to Enterprise Architecture, which is determined to a large degree by compliance assessments, management propagation and assisting projects. Conformance, in turn, affects many goals at both the enterprise and the project level.

Typology of compliance tactics. Chapter 8 presents an overview of compliance tactics, based on insights from various academic disciplines. This typology can be used for developing a compliance strategy. As a supplement to this overview, several insights for combining tactics into a coherent strategy are presented.

9.4 Implications and Suggestions for Further Research

This section presents the most important implications and suggestions for further research. See the conclusion sections of the separate chapters for more detailed overviews. Starting with the implications for practice, it follows from the research that organizations should invest more effort in EA-related projects. This consists of two important aspects. First, the Enterprise Architecture and the EA practice should pay sufficient attention to *making it easier for projects to work in the context of EA*. This entails having a compact set of EA prescriptions, written and modeled as unambiguously as possible, explicitly stating which prescriptions are relevant for projects and addressing them directly (e.g. "Projects should…"), and updating prescriptions based on review and practitioner feedback. In addition, enterprise architects should actively assist projects in their attempts to work with EA. In order to increase compliance, organizations should use compliance assessments, management propagation and assisting projects.

Second, the results show that projects are crucial means by which enterprise-level benefits can be achieved, but also that they benefit relatively little from EA themselves. It should be prevented that projects grow unmotivated by the significant efforts of working in the context of EA. Organizations should therefore try and *increase the EA-related benefits obtained by projects*. Projects should not only benefit from improved insights into and management of complexity and risks, but should also be able to see their deadlines and budget overruns decreased. In addition, benefits achieved should be communicated regularly, as this may motivate future compliance attitudes. Moreover, as projects represent local goals and sustain some disadvantages as a result of EA – in terms of additional complexity and a relatively slow initialization – this also entails not bothering projects unnecessarily with adherence to less crucial prescriptions. In other words, in focusing on the essentials, the EA function should be able to balance between local and enterprise-level interests.

Considering the implications for science, future research should focus on the challenges for practice mentioned above. Academia can contribute to improved practices for effectively complying with Enterprise Architecture and increasing the benefits obtained from it. A second implication of this dissertation is that future research on Enterprise Architecture should involve both EA creators and EA users. The subjectivity and differences in perception identified in chapter 7 make it clear that a study cannot rely solely on one type of stakeholder. A third implication concerns incorporating the role of projects and their compliance with enterprise-wide standards and other norms in research on organization-wide goals. Although the role of projects has been neglected hitherto, this dissertation has made clear that they have an important role in this regard, implementing the processes and systems directly or indirectly related to the organization's strategic goals. Research can therefore not be restricted to the organizational and strategic level. The role of compliance should also be explicitly included. Future empirical research could utilize more sophisticated conceptualizations of compliance. In a statistical study, for example, this concept could be measured as a formative construct comprised of the four aspects of compliance identified in chapters 6 and 8: correctness, justification, consistency and completeness. These four dimensions of compliance will provide a richer measurement of the concept. Regardless of the exact focus of new research, this dissertation has clearly shown that organization-wide and strategic endeavors cannot afford to neglect the lower organizational levels of projects, programs and organizational units.

References

Abdullah, S.N., Indulska, M., Sadiq, S. (2009). *A Study of Compliance Management in Information Systems Research*. In: Proceedings of the 17th European Conference on Information Systems (ECIS 2009), Verona, Italy.

Agrawal, R., Johnson, C., Kiernan, J., Leymann, F. (2006). *Taming Compliance with Sarbanes-Oxley Internal Controls Using Database Technology*. In: Proceedings of ICDE06, the 22nd International Conference on Data Engineering.

Alter, S., Wright, R. (2010). *Validating Work System Principles for Use in Systems Analysis and Design*. In: Proceedings of the 31st International Conference on Information Systems (ICIS 2010), St. Louis, USA.

Ambler, S.W., Nalbone, J., Vizdos, M.J. (2005). *The Enterprise Unified Process: Extending the Rational Unified Process*. Upper Saddle River: Prentice Hall.

Amer, T., Hackenbrack, K., Nelson, M. (1994). *Between-Auditor Differences in the Interpretation of Probability Phrases*. Auditing: A Journal of Practice and Theory, Vol. 13, No. 1, pp. 126-136.

Arjoon, S. (2006). *Striking a Balance Between Rules and Principles-based Approaches for Effective Governance: A Risks-based Approach*. Journal of Business Ethics, Vol. 68, pp. 53-82.

Armour, F.J., Kaisler, S.H., Liu, S.Y. (1999). *A Big-picture Look at Enterprise Architectures*. IT Professional, Vol. 1, No. 1, pp. 35-42.

Ayres, I., Braithwaite, J. (1992). *Responsive Regulation: Transcending the Deregulation Debate*. New York: Oxford University Press.

Badea, L., Pana, N.A. (2010). *The Role of Empathy in Developing the Leader's Emotional Intelligence*. Theoretical and Applied Economics, Vol. XVII, No. 2(543), pp. 69-78.

Bandara, W., Indulska, M., Chong, S., Sadiq, S. (2007). *Major Issues in Business Process Management: An Expert Perspective*. In: Proceedings of the 15th European Conference on Information Systems (ECIS 2007).

Bardram, J. (1998). *Designing for the dynamics of cooperative work activities*. In: Proceedings of the 1998 ACM Conference on Computer Supported Cooperative Work, pp. 89-98.

Baresi, L., Pezzè, M. (2006). *An Introduction to Software Testing*. Electronic Notes in Theoretical Computer Science, Vol. 148, No. 1, pp. 89-111.

Barr, M.S., Miller, G.P. (2006). *Global Administrative Law: The View from Basel*. The European Journal of International Law, Vol. 17, No. 1, pp. 15-46.

Barthelmess, P., Anderson, K.M. (2002). *A View of Software Development Environments Based on Activity Theory*. Computer Supported Cooperative Work, Vol. 11, No. 1-2.

Bartlett, C.A., Goshal, S. (1994). *Changing the Role of Top Management: Beyond Strategy to Purpose*. Harvard Business Review, Vol. 72, No. 6, pp. 79-88.

Baskerville, R.L. (1999). *Investigating Information Systems with Action Research*. Communications of the AIS, Vol. 2, Article 19.

Baskerville, R., Wood-Harper, A. (1996). *A Critical Perspective on Action Research as a Method for Information Systems Research*. Journal of Information Technology, Vol. 11, No. 3, pp. 235-246.

Bernus, P. (2003). *Enterprise models for enterprise architecture and ISO9000:2000*. Annual Reviews in Control, Vol. 27, No. 2, pp. 211-220.

Bertelsen, O.W. (2000). *Design Artefacts: Towards a Design-oriented Epistemology*. Scandinavian Journal of Information Systems, Vol. 12, No. 1, pp. 15-28.

Bhaskar, R. (1997). *On the Ontological Status of Ideas*. Journal for the Theory of Social Behaviour, Vol. 27, No. 2/3, pp. 139-147.

Binder, R.V. (2000). *Testing Object-Oriented Systems: Models, Patterns, and Tools*. Reading, MA: Addison-Wesley.

Blaikie, N. (1993). *Approaches to Social Enquiry*. Cambridge: Polity Press.

Bloor, M., Frankland, J., Thomas, M., Robson, K. (2001). *Focus Groups in Social Research*. London: Sage Publications.

Boar, B.H. (1999). *Constructing Blueprints for Enterprise IT Architectures*. John Wiley & Sons, Inc.

Boh, W.F., Yellin, D. (2007). *Using Enterprise Architecture Standards in Managing Information Technology*. Journal of Management Information Systems, Vol. 23, No. 3, pp. 163-207.

Bommel, P. van, Buitenhuis, P.G., Hoppenbrouwers, S.J.B.A., Proper, H.A. (2007). *Architecture Principles: A Regulative Perspective on Enterprise Architecture*. In: Proceedings of the EMISA 2007 workshop: Vol. 119. Lecture Notes in Informatics, pp. 47-60.

Bommel, P. van, Hoppenbrouwers, S.J.B.A., Proper, H.A., Weide, Th.P. van der (2006). *Giving Meaning to Enterprise Architectures: Architecture Principles with ORM and ORC*. In: Proceedings of the OTM Workshops 2006, LNCS 4278, pp. 1138–1147.

Bond, R., Smith, P.B. (1996). *Culture and Conformity: A Meta-Analysis of Studies Using Asch's (1952b, 1956) Line Judgment Task*. Psychological Bulletin, Vol. 119, No. 1, pp. 111-137.

Boss, S.R., Kirsch, L.J., Angermeier, I., Shingler, R.A., Boss, R.W. (2009). *If Someone Is Watching, I'll Do What I'm Asked: Mandatoriness, Control, and Information Security*. European Journal of Information Systems, Vol. 18, pp. 151–164.

Botha, H., Boon, J.A. (2003). *The Information Audit: Principles and Guidelines*. Libri, Vol. 53, pp. 23-38.

Box, S., Platt, K. (2005). *Business Process Management: Establishing and Maintaining Project Alignment*. Business Process Management Journal, Vol. 11, No. 4, pp. 370-387.

Bradley, R.V., Pratt, R.M.E., Byrd, T.A., Outlay, C.N., Wynn, D.E. (2011). *Enterprise Architecture, IT Effectiveness and the Mediating Role of IT Alignment in US Hospitals*. Information Systems Journal, Vol. 22, No. 2, pp. 97-127.

Braganza, A., Franken, A. (2007). *SOX, Compliance, and Power Relationships*. Communications of the ACM, Vol. 50, No. 9, pp. 97-102.

Braithwaite, V. (2007). *Responsive Regulation and Taxation: Introduction*. Law & Policy, Vol. 29, No. 1, pp. 3-10.

Braun, C., Winter, R. (2005). *A Comprehensive Enterprise Architecture Metamodel and Its Implementation Using a Metamodeling Platform*. In: Proceedings of the EMISA Workshop in Klagenfurt, pp. 64-79.

Breaux, T.D., Antón, A.I., Spafford, E.H. (2009). *A Distributed Requirements Management Framework for Compliance and Accountability*. Computers & Security, Vol. 28, No. 1-2, pp. 8-17.

Brekke, K.A., Kverndokk, S., Nyborg, K. (2003). *An Economic Model of Moral Motivation*. Journal of Public Economics, Vol. 87, pp. 1967-1983.

Brereton, P., Kitchenham, B.A., Budgen, D., Turner, M., Khalil, M. (2007). *Lessons From Applying the Systematic Literature Review Process Within the Software Engineering Domain*. The Journal of Systems and Software, Vol. 80, No. 4, pp. 571-583.

Bruls, W.A.G, Steenbergen, M. van, Foorthuis, R.M., Bos, R., Brinkkemper, S. (2010). *Domain Architectures as an Instrument to Refine Enterprise Architecture*. Communications of the Association for Information Systems, Vol. 27, No. 1, Article 27.

Bucher, T., Fischer, R., Kurpjuweit, S., Winter, R. (2006). *Enterprise Architecture Analysis and Application. An Exploratory Study*. In: Proceedings of EDOC Workshop TEAR. URL: http://tear2006.telin.nl [Accessed: March 2nd 2008]

Bulgurcu, B., Cavusoglu, H., Benbasat, I. (2010). *Information Security Policy Compliance: An Empirical Study of Rationality-Based Beliefs and Information Security Awareness*. MIS Quarterly, Vol. 34, No. 3, pp. 523-548.

Burditt, G.M. (1996). *Corporate Compliance Audits*. Food and Drug Law Journal, Vol. 51, pp. 217-220.

Burgemeestre, B., Hulstein, J., Tan, Y. (2009). *Agent Architectures for Compliance*. In: Proceedings of ESAW 2009.

Caballero, I., Verbo, E., Calero, C., Piattini, M. (2007). *A Data Quality Measurement Information Model Based on ISO/IEC 15939*. In: Proceedings of the 12th International Conference on Information Quality, MIT, Cambridge.

Caldwell, F., Eid, T. (2007). *Magic Quadrant for Finance Governance, Risk and Compliance Management Software*. Gartner.

Capgemini (2006). *Architecture and the Integrated Architecture Framework*. URL: http://www.capgemini.com/services/soa/ent_architecture/?d=4C418BF7-2926-B6FF-8A63-7FAED70CCF8B [Accessed: October 20th 2006]

Capgemini. (2007). *Enterprise, Business and IT Architecture and the Integrated Architecture Framework*. URL: http://www.capgemini.com/m/en/tl/Enterprise__Business_and_IT_Architecture_and_the_Integrated_Architecture_Framework.pdf [Accessed: October 27th 2007]

Capgemini Academy (2007). *IAF Essentials*. Material of the course "IAF Essentials", Capgemini.

Chayes, A., Chayes, A.H. (1993). *On Compliance*. International Organization, Vol. 47, No. 2, pp. 75-205.

Chen, C.K., Hughes Jr., J. (2004). *Using Ordinal Regression Model to Analyze Student Satisfaction Questionnaires*. IR Applications, Vol. 1.

Choo, C.W. (2006). *The Knowing Organization*. Second Edition. New York: Oxford University Press.

Chopra, A.K., Singh, M.P. (2006). *Producing Compliant Interactions: Conformance, Coverage, and Interoperability*. In: Proceedings of DALT 2006, Lecture Notes in Computer Science, Volume 4327, pp, 1-15, Springer.

Chung, P.W.H., Cheung, L.Y.C., Machin, C.H.C. (2008). *Compliance Flow: Managing the Compliance of Dynamic and Complex Processes*. Knowledge-Based Systems, Vol. 21, No. 4, pp. 332-354.

Cialdini, R.B. (1987). *Compliance Principles of Compliance Professionals: Psychologists of Necessity*. In: Zanna, M.P., Olson, J.M., Herman, C.P. (eds.). Social Influence: The Ontario Symposium, Vol. 5. Hillsdale: LE Associates.

Cialdini, R.B., Goldstein, N.J. (2004). *Social Influence: Compliance and Conformity*. Annual Review of Psychology, Vol. 55, pp. 591-621.

CIO Council (2001). *A Practical Guide to Federal Enterprise Architecture*. Version 1.0 2001.

Cleven, A., Winter, R. (2009). *Regulatory Compliance in Information Systems Research: Literature Analysis and Research Agenda*. In: Halpin, T., Krogstie, J., Nurcan, S., Proper, E., Schmidt, R., Soffer, P, Ukor, R. (eds.). Enterprise, Business-Process and Information Systems Modeling, pp. 174-186.

COSO. (1994). *Internal Control - Integrated Framework*. Jersey City: Committee of Sponsoring Organizations of the Treadway Commission.

Cuppens-Boulahia, N., Cuppens, F. (2008). *Specifying Intrusion Detection and Reaction Policies: An Application of Deontic Logic*. Proceedings of the 9th International DEON Conference, Luxembourg, July 15-18, 2008, LNCS, Vol. 5076, pp. 65-80, Springer.

Currie, W. (2008). *Institutionalization of IT Compliance: A Longitudinal Study*. Proceedings of the 29th International Conference on Information Systems (ICIS 2008).

Daniel, B., Schwier, R.A., McCalla, G. (2003). *Social Capital in Virtual Learning Communities and Distributed Communities of Practice*. Canadian Journal of Learning and Technology, Vol. 29, No, 3, pp. 113-139.

Daniel, F., Casati, F., D'Andrea, V., Mulo, E., Zdun, U., Dustdar, S., Strauch, S., Schumm, D., Leymann, F., Sebahi, S., Marchi, F. de, Hacid, M. (2009). *Business Compliance Governance in Service-Oriented Architectures*. Proceedings of the International Conference on Advanced Information Networking and Applications, pp. 113-120.

Davison, R., Martinsons, M., Kock, N. (2004). *Principles of canonical action research*. Information Systems Journal, Vol. 14, No. 1, pp. 65-86.

Dawson, M.A. (2008). *Integrating Compliance Risk Management into Enterprise Risk Management*. Bank Accounting & Finance, Vol. 21, No. 5, pp. 36-39.

Department of Defense. (2009). *DoDAF: DoD Architecture Framework*. Version 2, Volume 1. Washington: Defense Pentagon.

Dess, G.G., Robinson, R.B. (1984). *Measuring Organizational Performance in the Absence of Objective Measures: The Case of thePrivately-Held Firm and Conglomerate Business Unit*. Strategic Management Journal, Vol. 5, No. 3, pp. 265-273.

DiMaggio, P.J., Powell, W.W. (1983). *The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields*. American Sociological Review, Vol. 48, No. 2, pp. 147-160.

Dobson, P.J. (2001). *The Philosophy of Critical Realism – An Opportunity for Information Systems Research*. Information Systems Frontiers, Vol. 3, No. 2, pp. 199-210.

Doty, D.H., Glick, W.H. (1994). *Typologies as a Unique Form of Theory Building: Toward Improved Understanding and Modeling*. The Academy of Management Review, Vol. 19, No. 2, pp. 230-251.

Downs, G.W, Rocke, D.M., Barsoom, P.N. (1996). *Is The Good News About Compliance Good News About Cooperation?* International Organization, Vol. 50, No. 3, pp. 379-406.

Drew, M. (2007). *Information Risk Management and Compliance: Expect the Unexpected*. BT Technology Journal, Vol. 25, No. 1, pp. 19-29.

El Kharbili, M., Stein, S. Markovic, I., Pulvermüller, E. (2008). *Towards a Framework for Semantic Business Process Compliance Management*. In: Proceedings of GRCIS 2008, CAiSE Workshop on Governance, Risk and Compliance of Information Systems.

Ellis, D., Barker, R., Potter, S., Pridgeon, C. (1993). *Information Audits, Communication Audits and Information Mapping: A Review and Survey*. International Journal of Information Management, Vol. 13, No. 2, pp. 134-151.

Emmerich, W., Finkelstein, A., Montangero, C., Stevens, R. (1997). *Standards Compliant Software Development*. In: Proceedings of the ICSE Workshop on Living with Inconsistency.

Emmerich, W., Finkelstein, A., Montangero, C., Antonelli, S., Armitage, S., Stevens, R. (1999). *Managing Standards Compliance*. IEEE Transactions on Software Engineering, Vol. 25, No. 6, pp. 836-851.

Engeström, Y. (1987). *Learning by Expanding: An Activity-Theoretical Approach to Developmental Research*. Helsinki: Orienta-Konsultit Oy.

Engeström, Y. (1991). *Developmental Work Research: Reconstructing Expertise Through Expansive Learning*. In: Nurminen, M.I., Weir, G.R.S. (Eds.). Human Jobs and Computer Interfaces. Amsterdam: Elsevier Science Publishers B.V.

Engeström, Y., Brown, K., Christopher, L.C., Gregory, J. (1997). *Coordination, Cooperation, and Communication in the Courts: Expansive Transitions in Legal Work*. In: Cole, M., Engeström, Y., Vasquez, O. (Eds.). Mind, culture, and activity. Cambridge: Cambridge University Press.

Falkl, J. (2005). *Service Oriented Architecture Compliance: Initial Steps in a Longer Journey*. IBM Developerworks.

Farenhorst, R., De Boer, R.C. (2009). *Architectural Knowledge Management: Supporting Architects and Auditors*. PhD thesis, Vrije Universiteit Amsterdam.

Faure, M., Lefevere, J. (2005). *Compliance with Global Environment Policy*. In: R.S. Axelrod, D.L. Downie, N.J. Vig (eds.). The Global Environment: Institutions, Law, and Policy. Second Edition, pp. 163-180. Washington DC: CQ Press.

Florida Department of Transportation. (2006). *ITS/APTS Architecture Guide: To Help Florida Transit Systems Comply with the National ITS Architecture Consistency Policy*. Tallahassee, Florida: FDoT 2006. URL: http://www.floridaits.com/PDFs/RAPTS/Final-ITS-APTS_Arch_Guide.pdf [Accessed: May 7th 2008]

Foorthuis, R.M., Brinkkemper, S. (2007). *A Framework for Local Project Architecture in the Context of Enterprise Architecture*. Journal of Enterprise Architecture, Vol. 3, No. 4, pp. 51-63. URL: http://www.foorthuis.nl/

Foorthuis, R.M., Brinkkemper, S. (2008a). *Best Practices for Business and Systems Analysis in Projects Conforming to Enterprise Architecture*: Enterprise Modelling and Information Systems Architectures, Vol. 3, No. 1, pp. 36-47.

Foorthuis, R.M., Brinkkemper, S., Bos, R. (2008b). *An Artifact Model for Projects Conforming to Enterprise Architecture*. In: Stirna, J., Persson, A. (Eds.). The Practice of Enterprise Modeling. Proceedings of PoEM 2008, IFIP WG 8.1 Working Conference, LNBIP 15, pp. 30-46. Berlin: Springer.

Foorthuis, R.M., Steenbergen, M. van, Mushkudiani, N., Bruls, W., Brinkkemper, S., Bos, R. (2010). *On Course, But Not There Yet: Enterprise Architecture Conformance and Benefits in Systems Development*. Proceedings of the Thirty First International Conference on Information Systems (ICIS 2010), St. Louis, Missouri, USA.

Foorthuis, R.M., Bos, R. (2011). *A Framework for Organizational Compliance Management Tactics*. In: C. Salinesi and O. Pastor (Eds.), CAiSE 2011 Workshops (GRCIS 2011), LNBIP 83, pp. 259–268. Berlin: Springer-Verlag.

Foorthuis, R.M., Hofman, F., Brinkkemper, S., Bos, R. (2012). *Compliance Assessments of Projects Adhering to Enterprise Architecture*. Journal of Database Management, Vol. 23, No. 2, pp. 44-71.

French, S. (2009). *Critiquing the Language of Strategic Management*. Journal of Management Development, Vol. 28, No. 1, pp. 6-17.

Gammelgård, M. Simonsson, M., Lindström, Å. (2007). *An IT Management Assessment Framework: Evaluating Enterprise Architecture Scenarios*. Information Systems and e-Business Management, Vol. 5, No. 4, pp. 415-435.

Garner, B.A. (2004). *Black's Law Dictionary*. Eight Edition. Eagan: Thomson Reuters.

Garson, G.D. (2010). *Ordinal Regression (Statnotes from North Carolina State University)*. URL: http://faculty.chass.ncsu.edu/garson/PA765/ordinalreg.htm [Accessed: August 30th 2010]

Gaunt, N. (1998). *Installing an Appropriate Information Security Policy*. International Journal of Medical Informatics, Vol. 49, pp. 131-134.

Gauthier, D. (1991). *Why Contractarianism?* In: Vallentyne, P. (Ed.), Contractarianism and Rational Choice: Essays on David Gauthier's Morals by Agreement (pp. 15-30). Cambridge: Cambridge University Press.

Geva, A. (2006). *A Typology of Moral Problems in Business: A Framework for Ethical Management*. Journal of Business Ethics, Vol. 69, pp. 133-147.

Goedvolk, J., de Bruin, H., Rijsenbrij, D.B.B. (1999). *Integrated Architectural Design of Business and Information Systems*. In: Proceedings of The Second Nordic Workshop on Software Architecture (NOSA'99).

Goncalo, J.A., Staw, B.M. (2006). *Individualism–Collectivism and Group Creativity*. Organizational Behavior and Human Decision Processes, Vol. 100, No. 1, pp. 96–109.

Goodhue, D.L, Kirsch, L.J., Quillard, J.A., Wybo, M.D. (1992). *Strategic Data Planning: Lessons from the Field*. MIS Quarterly, Vol. 16, No. 1, pp. 11-34.

Governatori, G., Milosevic, Z., Sadiq, S. (2006). *Compliance Checking Between Business Processes and Business Contracts*. In: Proceedings of the 10th International Enterprise Distributed Object Computing Conference (EDOC 2006), pp. 221-232.

Greefhorst, D., Koning, H., Vliet, H. van. (2006). *The Many Faces of Architectural Descriptions*. Information Systems Frontiers, Vol. 8, No. 2, pp. 103-113.

Green, L.W. (2001). *From Research to "Best Practices" in Other Settings and Populations*. American Journal of Health Behavior, Vol. 25, No. 3, pp. 165-178.

Gregor, S., Hart, D., Martin, N. (2007). *Enterprise Architectures: Enablers of Business Strategy and IS/IT Alignment in Government*. Information Technology & People, Vol. 20, No. 2, pp. 96-120.

Grossman, D., Zaelke, D. (2005). *An Introduction to Theories of Why States and Firms Do (and Do Not) Comply with Law*. Seventh International Conference on Environmental Compliance and Enforcement.

Hallier, J., James, P. (1999). *Group Rites and Trainer Wrongs in Employee Experiences of Job Change*. Journal of Management Studies, Vol. 36, No. 1, pp. 45-67.

Hamilton, R.A. (1995). *Compliance Auditing*. Internal Auditor, Vol. 52, No. 6, pp. 42-45.

Harmon, P. (2004). *Evaluating an Organization's Business Process Maturity*. Business Process Trends, Vol. 2, No. 3.

Harris, J., Cummings, M. (2007). *Compliance Issues and IS Degree Programs*. Journal of Computing Sciences in Colleges, Vol. 23, No. 1, pp. 14-20.

Hartman, E.M. (1996). *Organizational Ethics and the Good Life*. New York: Oxford University Press.

Hayes, R.S., Schilder, A., Dassen, R., Wallage, P. (2005). *Principles of Auditing: An International Perspective*. Berkshire, England: Hill International Publishing.

Healy, M., Iles, J. (2002). *The Establishment and Enforcement of Codes.* Journal of Business Ethics, Vol. 39, pp. 117-124.

Henderson, J., Venkatraman, N. (1993). *Strategic alignment: Leveraging information technology for transforming organizations*. (Reprint). IBM Systems Journal, 1999, Vol. 38, No 2/3, pp. 472-484.

Hefner, D., Malcolm, C. (2002). *15 Essential Steps of IT Project Management*. Healthcare Financial Management, Vol. 56, No. 2, pp. 76-78.

Hevner, A.R., March, S.T., Park, J., Ram, S. (2004). *Design Science in Information Systems Research*. MIS Quartlerly, Vol. 28, No. 1, pp. 75-105.

Heyes, A. (2000). *Implementing Environmental Regulation: Enforcement and Compliance*. Journal of Regulatory Economics, Vol. 17, No. 2, pp. 107-129.

Hollis, M. (1994). *The Philosophy of Social Science: An Introduction*. Cambridge: Cambridge University Press.

Hoogervorst, J.A.P., Dietz, J.L.G. (2008). *Enterprise Architecture in Enterprise Engineering*. Enterprise Modelling and Information Systems Architectures, Vol. 3, No. 1, pp. 3-13.

Hurley, J. (2004). *The Struggle to Manage Security Compliance for Multiple Regulations*. White Paper, Symantec. URL: http://www.infoworld.com/pdf/whitepaper/StruggleToManage.pdf [Accessed: February 2nd 2011]

IFAC. (2003). *International Framework for Assurance Engagements, Exposure Draft*. New York: IFAC.

IIA. (1997). *Auditing Compliance with Policies, Plans, Procedures, Laws, Regulations, and Contracts*. The Internal Auditor, Vol. 54, No. 4.

IIBA. (2006). *A Guide to the Business Analysis Body of Knowledge*. Release 1.6. URL: http://www.theiiba.org/content.asp?contenttype=Body%20of%20Knowledge [Accessed: July 6th 2007].

IEEE. (1990). *IEEE St. 610.12-1990: IEEE Standard Glossary of Software Engineering Terminology*. New York: The Institute of Electrical and Electronics Engineers.

IEEE Computer Society. (2000). *IEEE Recommended Practice for Architectural Description of Software-Intensive Systems*. IEEE Standard 1471-2000, Sept. 21, 2000.

ILRI. (1995). *Livestock Policy Analysis, ILRI Training Manual 2*. International Livestock Research Institute.

Islam, G., Zyphur, M.J. (2009). *Rituals in Organizations: A Review and Expansion of Current Theory*. Group & Organization Management, Vol. 34, No. 1, pp. 114-139.

IT Governance Institute. (2000). *COBIT, Control Objectives*. Third Edition. Rolling Meadows, IL: Information Systems Audit and Control Foundation (ISACF).

Johnson, P., Ekstedt, M., Silva, E., Plazaola, L. (2004). *Using Enterprise Architecture for CIO Decision-Making: On the Importance of Theory*. In: Proceedings of the Second Annual Conference on Systems Engineering Research.

Jones, T.M. (1991). *Ethical Decision Making by Individuals in Organizations: An Issue-Contingent Model*. The Academy of Management Review, Vol. 16, No. 2, pp. 366-395.

Jonkers, H., Lankhorst, M.M., Buuren, R. van, Hoppenbrouwers, S.J.B.A., Bonsangue, M., Torre, L.W.N. van der. (2004). *Concepts for Modeling Enterprise Architectures*. International Journal of Cooperative Information Systems, Vol. 13, pp. 257-288.

Jonkers, H., Lankhorst, M.M., Doest, H.W.L. ter, Arbab, F., Bosma, H., Wieringa, R.J. (2006). *Enterprise architecture: Management Tool and Blueprint for the Organisation*. Information Systems Frontiers, Vol. 8, No. 2, pp. 63-66.

Jourdan, C., Oehler, K. (2005). *Flexible Global Compliance Architecture: What Does It Mean To Chief Financial Officers?* PriceWaterhouseCoopers White Papers Series, Germany.

Joyce, E.J. (1974). *Expert Judgment in Audit Program Planning*. Journal of Accounting Research, Vol. 14, pp. 29-60.

Kagal, L., Finin, T., Joshi, A. (2003). *A Policy Language for a Pervasive Computing Environment*. In: Proceedings of POLICY 2003, IEEE 4th International Workshop on Policies for Distributed Systems and Networks.

Kaisler, S.H., Armour, F., Valivullah, M. (2005). *Enterprise Architecting: Critical Problems*. In: Proceedings of the 38th Hawaii International Conference on System Sciences.

Kappelman, L., Pettite, A., McGinnis, T., Sidorova, A. (2008). *Enterprise Architecture: Charting the Territory for Academic Research*. In: Proceedings of AMCIS 2008, Americas Conference on Information Systems.

Kerrigan, S., Heenan, C., Wang, H., Law, K.H., Wiederhold, G. (2003). *Regulatory Information Management and Compliance Assistance*. National Conference on Digital Government Research, Boston, MA, May 18-21, 2003.

Kim, S. (2007). *IT Compliance of Industrial Information Systems: Technology Management and Industrial Engineering Perspective*. The Journal of Systems and Software, Vol. 80, No. 10, pp. 1590-1593.

Kim, H.M., Fox, M.S., Sengupta, A. (2007). *How to Build Enterprise Data Models to Achieve Compliance to Standards or Regulatory Requirements (and Share Data)*. Journal of the Association for Information Systems, Vol. 8, No. 2, pp. 105–128.

Kitchenham, B., Brereton, O.P., Budgen, D., Turner, M., Bailey, J., Linkman, S. (2009). *Systematic Literature Reviews in Software Engineering – A Systematic Literature Review*. Information and Software Technology, Vol. 51, No. 1, pp. 7-15.

Kluger, A.N, DeNisi, A. (1996). *The Effect of Feedback Interventions on Performance: A Historical Review, a Meta-Analysis, and a Preliminary Feedback Intervention Theory*. Psychological Bulletin, Vol. 119, No. 2, pp. 254-284.

Koning, H., Bos, R., Brinkkemper, S. (2009). *A Lightweight Method for the Modeling of Enterprise Architectures*. In: Proceedings of the ICSOC 2008 Workshop, LNCS 5472, pp. 375–387. Berlin: Springer.

Kozina, M. (2006). *Evaluation of ARIS and Zachman Frameworks as Enterprise Architectures*. Journal of Information and Organizational Sciences, Vol. 30, No. 1.

Kraus, J.S., Coleman, J.L. (1987). *Morality and the Theory of Rational Choice*. Ethics, Vol. 97, No. 4, pp. 715-749.

Kruchten, P. (1995). *Architectural Blueprints—The "4+1" View Model of Software Architecture*. IEEE Software, Vol. 12, No. 6, pp. 42-50.

Kruchten, P. (2003). *The Rational Unified Process. An Introduction*. Third Edition. Boston: Addison-Wesley.

Kump, L., Rose, L. (2004). *A Matter of Trust*. Forbes, Vol. 174, No. 8, pp. 67-70.

Kuutti, K. (1995). *Activity Theory as a Potential Framework for Human-Computer Interaction Research*. In: Nardi, B. (ed.). Context and Consciousness: Activity Theory and Human Computer Interaction, pp. 17-44. Cambridge: MIT Press.

Kuutti, K. (1991). *The Concept of activity as a basic unit of analysis for CSCW research*. In: Proceedings of the European Conference on CSCW, pp. 249-264. Dordrecht: Kluwer.

Landis, J.R., Koch, G.G. (1977). *The Measurement of Observer Agreement for Categorical Data*. Biometrics, Vol. 33, No. 1, pp. 159-174.

Lankhorst, M. et al. (2005). *Enterprise architecture at work. Modelling, communication and analysis*. Berlin: Springer.

Leech, N.L, Barrett, K.C., Morgan, G.A. (2005). *SPSS for Intermediate Statistics: Use and Interpretation*. Second Edition. Mahwah, New Jersey: Lawrence Erlbaum Association.

Levine, J.M., Resnick, L.B. (1993). *Social Foundations of Cognition*. Annual Review of Psychology, Vol. 44, pp. 585-612.

Li, H., Sarathy, R., Zhang, J. (2010). *Understanding Compliance with Use Policy: An Integrative Model Based on Command-and-Control and Self-Regulatory Approaches*. In: Proceedings of the 31st International Conference on Information Systems (ICIS 2010), St. Louis, USA.

Lin, K.Z., Fraser, A.M., Hatherly, D.J. (2003). *Auditor Analytical Review Judgement: A Performance Evaluation*. The British Accounting Review, Vol. 35, No. 1, pp. 19-34.

Lindström, Å. (2006). *On the Syntax and Semantics of Architectural Principles*. In: Proceedings of the 39th Hawaii International Conference on System Sciences.

Lines, M. (2007). *Ensuring process compliance with the RUP Development Case and Review Record*. The Rational Edge, February Fourteenth 2007. URL: http://www.ibm.com/developerworks/rational/library/feb07/lines/index.html [Accessed: May 7th 2007]

Luthy, D., Forcht, K. (2006). *Laws and Regulations Affecting Information Management and Frameworks for Assessing Compliance*. Information Management & Computer Security, Vol. 14, No. 2, pp. 155-166.

Ly, L.T, Göser, K., Rinderle-Ma, S., Dadam, P. (2008). *Compliance of Semantic Constraints – A Requirements Analysis for Process Management Systems*. In: Proceedings of GRCIS 2008, Workshop on Governance, Risk and Compliance of Information Systems.

Macaulay, A. (2004). *Enterprise Architecture Design and the Integrated Architecture Framework*. Microsoft Architects Journal, Vol. 1, pp. 4-9.

MacLean, T.L., Behnam, M. (2010). *The Dangers of Decoupling: The Relationship Between Compliance Programs, Legitimacy Perceptions, and Institutionalized Misconduct*. Academy of Management Journal, Vol. 53, No.6, pp. 1499-1520.

Maes, R. (2003). *On the Alliance of Executive Education and Research in Information Management at the University of Amsterdam*. International Journal of Information Management, Vol. 26, No. 3, pp. 249-257.

Maes, R., Rijsenbrij, D., Truijens, O., Goedvolk, H. (2000). *Redefining Business - IT Alignment Through a Unified Framework*. Landelijk Architectuur Congres, Amsterdam.

Mair, W.C. (2002). *Systems Assurance and Control (SAC): Executive Summary*. The Institute of Internal Auditors Research Foundation (IIA).

Malloy, T.F. (2003). *Regulation, Compliance and the Firm*. Temple Law Review, Vol. 76, No. 3, pp. 451-531.

Malone, T.W., Crowston, K. (1994). *The Interdisciplinary Study of Coordination*. ACM Computing Surveys, Vol. 26, No. 1.

March, J.G., Olsen, J.P. (1998). *The Institutional Dynamics of International Political Orders*. International Organization, Vol. 52, No. 4, pp. 943-969.

March, S.T., Smith, G.F. (1995). *Design and Natural Science Research on Information Technology*. Decision Support Systems, Vol. 15, No. 4, pp. 251-266.

Marradi, A. (1990). *Classification, Typology, Taxonomy*. Quality & Quantity, Vol. 24, pp. 129-157.

Massacci, F., Prest, M., Zannone, N. (2005). *Using a Security Requirements Engineering Methodology in Practice: The Compliance with the Italian Data Protection Legislation*. In: Computer Standards & Interfaces, Vol. 27, No. 5, pp. 445-455.

Meeuwisse, R. (2010). *Standardizing Terminology for Integrated Governance, Risk Management & Compliance (gRc)*. URL: http://www.integrated-grc.com/Terminology.php [Date of access: June 12th 2011]

Merriam-Webster. (2011). *Merriam-Webster Online Dictionary*. URL: http://www.merriam-webster.com/dictionary/ [Date of access: January 22nd 2011].

Merton, R.K. (1957). *Social Theory and Social Structure*. New York: Free Press.

Meschke, M., Baumoel, U. (2010). *Architecture Concepts for Value Networks in the Service Industry*. Proceedings of the Thirty First International Conference on Information Systems (ICIS 2010), St. Louis, Missouri, USA.

Meyer, J.W., Rowan, B. (1977). *Institutionalized Organizations: Formal Structure as Myth and Ceremony*. The American Journal of Sociology, Vol. 83, No. 2, pp. 340-363.

Miles, M.B., Huberman, A.M. (1994). *Qualitative Data Analysis*. Second Edition. Thousand Oaks: Sage Publications.

Mingers, J. (2004). *Real-izing Information Systems. Critical Realism as an Underpinning Philosophy for Information Systems*. Information and Organization, Vol. 14, pp. 87-103.

Mintzberg, H. (1987). *The Strategy Concept I: Five Ps for Strategy*. California Management Review, Vol. 30, No. 1, pp. 11-24.

Mitchell, R. B. (1996). *Compliance Theory: An Overview*. In: Cameron, J., Werksman, J., Roderick, P. (eds.). Improving Compliance with International Environmental Law. London: Earthscan.

Morgan, D.L. (1996). *Focus Groups*. Annual Review of Sociology, Vol. 22, pp. 129-152.

Morganwalp, J.M., Sage, A.P. (2004). *Enterprise architecture measures of effectiveness*. International Journal of Technology, Policy and Management, Vol. 4, No. 1, pp. 81-94.

Mulholland, A., Macaulay, A.L. (2006). *Architecture and the integrated architecture framework*. URL: http://www.au.capgemini.com/resources/solution_material/architecture_and_the_integrated_architecture_framework/?d=1 [Accessed: October 20th 2006]

Namiri, K., Stojanovic, N. (2007). *A Formal Approach for Internal Controls Compliance in Business Processes*. In: Proceedings of BPMDS 2007, 8th CAiSE Workshop on Business Process Modeling, Development and Support.

Niemi, E. (2006). *Enterprise Architecture Benefits: Perceptions from Literature and Practice*. In: Proceedings of the 7th IBIMA Conference on Internet, Information Systems in the Digital Age, Brescia, Italy.

Norušis, M.J. (2008). *SPSS Statistics 17.0 Guide to Data Analysis*. Upper Saddle River, NJ: Prentice Hall.

Norušis, M.J. (2009). *SPSS 17.0 Advanced Statistical Procedures Companion*. Upper Saddle River, NJ: Prentice Hall.

Nouwt, S. (2008). *Reasonable Expectations of Geo-Privacy?* SCRIPTed, Vol. 5, No. 2, pp. 375-403.

Obitz, T., Babu K., M. (2009). *Enterprise Architecture Expands its Role in Strategic Business Transformation*. Infosys Enterprise Architecture Survey 2008/2009.

OCEG. (2009). *GRC Capability Model, "Red Book" 2.0. Basic Member Edition*. Open Compliance & Ethics Group.

O'Dell, C., Grayson, C.J. (1998). *If Only We Knew What We Know: Identification and Transfer of Internal Best Practices*. California Management Review, Vol. 40, No. 3, pp. 154–174.

Ogbonna, E., Harris, L.C. (1998). *Managing Organizational Culture: Compliance or Genuine Change?* British Journal of Management, Vol. 9, pp. 273–288.

Op 't Land, M., Proper, H.A. (2007). *Impact of Principles on Enterprise Engineering*. In: Proceedings of the 15th European Conference on Information Systems (ECIS 2007).

Pahnila, S., Siponen, M., Mahmood, A. (2007). *Employees' Behavior Towards IS Security Policy Compliance*. In: Proceedings of the 40th Hawaii International Conference on System Sciences.

Panitz, J.C., Wiener, M., Amberg, M. (2010). *A Balanced Scorecard for Compliance – Requirements of a Comprehensive Compliance-Reporting*. In: Proceedings of Americas Conference on Information Systems (AMCIS 2010), paper 160.

Paternoster, R., Simpson, S. (1996). *Sanction Threats and Appeals to Morality: Testing a Rational Choice Model of Corporate Crime*. Law & Society Review, Vol. 30, No. 3, pp. 549-583.

Patton, M.Q. (2002). *Qualitative Research and Evaluation Methods*. Third Edition. Thousand Oaks: Sage Publications.

Persson, A., Stirna, J. (2001). *An Exploratory Study into the Influence of Business Goals on the Practical Use of Enterprise Modelling Methods and Tools*. In: Proceedings of the International Conference on Information Systems Development (ISD2001).

Peterson, Z.N.J., Burns, R. (2006). *Building Regulatory Compliant Storage Systems*. In: Proceedings of the International Conference on Digital Government Research, San Diego, California, pp. 442-443.

Pfleeger, S.L., Fenton, N., Page, S. (1994). *Evaluating Software Engineering Standards*. IEEE Computer, Vol. 27, No. 9, pp. 71-79.

Philippe, D., Durand, R. (2011). *The Impact of Norm-conforming Behaviors on Firm Reputation*. Strategic Management Journal, Vol. 32, No. 9, pp. 969-993.

Pipino, L.L., Lee, Y.W., Wang, R.Y. (2002). *Data Quality Assessment*. Communications of the ACM, Vol. 45, No. 4, pp. 211-218.

Project Management Institute. (2004). *A Guide to the Project Management Body of Knowledge: PMBOK Guide*. Third Edition. Pennsylvania: Project Management Institute, Inc.

Puhakainen, P., Siponen, M. (2010). *Improving Employees' Compliance Through Information Systems Security Training: An Action Research Study*. MIS Quarterly, Vol. 34, No. 4, pp. 757-778.

Pulich, M., Tourigny, L. (2004). *Workplace Deviance: Strategies for Modifying Employee Behavior*. The Health Care Manager, Vol. 23, No. 4, pp. 290–301.

Pulkkinen, M., Hirvonen, A. (2005). *EA Planning, Development and Management Process for Agile Enterprise Development*. In: Proceedings of the 38th Hawaii International Conference on System Sciences, pp. 223.3.

Pulkkinen, M. (2006). *Systemic Management of Architectural Decisions in Enterprise Architecture Planning. Four Dimensions and Three Abstraction Levels*. In: Proceedings of the 39th Annual Hawaii International Conference on System Sciences (HICSS'06), Track 8, p. 179a.

Pupke, C. (2008). *Compliance and Corporate Performance: The Impact of Compliance Coordination on Corporate Performance*. Norderstedt: Books on Demand.

Quinn, J.B. (1996). *Strategies for Change*. In: Mintzberg, H., Lampel, J., Quinn, J.B., Ghoshal, S. (Eds.) The Strategy Process: Concepts, Contexts, Cases, pp. 10-16. Upper Saddle River: Prentice Hall.

Raadt, B. van der, Soetendal, J., Perdeck, M., Vliet, H. van. (2004). *Polyphony in Architecture*. In: Proceedings of the 26th International Conference on Software Engineering (ICSE'04).

Racz, N., Panitz, J., Amberg, M., Weippl, E., Seufert, A. (2010). *Governance, Risk & Compliance (GRC) Status Quo and Software Use: Results from a Survey among Large Enterprises*. In: Proceedings of ACIS 2010.

Rational. (2003). *Rational Unified Process*. Version 2003.06.00.65. Rational Software Corporation.

Rich, P. (1992). *The Organizational Taxonomy: Definition and Design*. The Academy of Management Review, Vol. 17, No. 4, pp. 758-781.

Richardson, G.L., Jackson, B.M., Dickson, G.W. (1990). *A Principles-Based Enterprise Architecture: Lessons from Texaco and Star Enterprise*. MIS Quarterly, Vol. 14, No. 4, pp. 385-403.

Riempp, G., Gieffers-Ankel, S. (2007). *Application Portfolio Management: A Decision-oriented View of Enterprise Architecture*. Information Systems and e-Business Management, Vol. 5, No. 4, pp. 359-378.

Ross, J.W., Weill, P., Robertson, D. (2006). *Enterprise Architecture as Strategy: Creating a Foundation for Business Execution*. Boston, Massachusetts: Harvard Business School Press.

Rossouw, G.J., Van Vuuren, L.J. (2003). *Modes of Managing Morality: A Descriptive Model of Strategies for Managing Ethics*. Journal of Business Ethics, Vol. 46, pp. 389-402.

Rowe, F. (2005). *Are Decision Support Systems Getting People to Conform? The Impact of Work Organization and Segmentation on User Behaviour in a French Bank*. Journal of Information Technology, Vol. 20, pp. 103-116.

Sadiq, S., Governatori, G., Naimiri, K. (2007). *Modeling Control Objectives for Business Process Compliance*. In: Proceedings of the 5th International Conference on BPM. Berlin: Springer.

Sadiq, S., Indulska, M. (2008). *The Compliance Enabled Enterprise: Process is the Product*. Compliance and Regulatory Journal, Vol. 5, pp. 27-31.

Schapiro, T. (2003). *Compliance, Complicity, and the Nature of Nonideal Conditions*. The Journal of Philosophy, Vol. C, No. 7, pp. 329-355.

Schneiberg, M., Bartley, T. (2008). *Organizations, Regulation and Economic Behavior: Regulatory Dynamics and Forms from the Nineteenth to Twenty-First Century*. Annual Review of Law and Social Science, Vol. 4, pp. 31–61.

Schraaf, A.A.A. van der. (2005). *The Compliance Strategy in the Netherlands*. Seventh International Conference on Environmental Compliance and Enforcement.

Scott, W.R. (2003). *Organizations: Rational, Natural, and Open Systems*. Fifth Edition. Upper Saddle River: Prentice Hall.

Short, J.L., Toffel, M.W. (2010). *Making Self-Regulation More Than Merely Symbolic: The Critical Role of the Legal Environment*. Administrative Science Quarterly, Vol. 55, No. 3, pp. 361-396.

SIA. (2005). *White Paper on the Role of Compliance*. Albany, NY: Securities Industry Association, Compliance and Legal Division, October 2005.

Slot, R., Dedene, G., Maes, R. (2009). *Business Value of Solution Architecture*. In: E. Proper, F. Harmsen, J.L.G. Dietz (eds.). Advances in Enterprise Engineering II, LNBIP (28), pp. 84-108. Berlin: Springer.

Smith, K.B. (2002). *Typologies, Taxonomies, and the Benefits of Policy Classification*. Policy Studies Journal, Vol. 30, No. 3, pp. 379-395.

So, Y. (1993). *A tutorial on logistic regression*. In: Proceedings of the 18th SAS Users Group International Conference, 1290-1295.

Solms, S.H. von. (2005). *Information Security Governance: Compliance management vs operational management*. Computers & Security, Vol. 24, pp. 443-447.

Sousa, P., Marques Pereira, C., Alves Marques, J. (2004). *Enterprise Architecture Alignment Heuristics*. Microsoft Architects Journal, Vol. 4, pp. 34-39.

SPSS. (2008). *SPSS 16.0 Help File*. SPSS Inc.

Srinidhi, B.N., Vasarhelyi, M.A. (1986). *Auditor Judgment Concerning Establishment of Substantive Tests Based on Internal Control Reliability*. Auditing: A Journal of Practice & Theory, Vol. 5, No. 2.

Stajkovic, A.D., Luthans, F. (1997). *A Meta-Analysis of the Effects of Organizational Behavior Modification on Task Performance, 1975-95*. The Academy of Management Journal, Vol. 40, No. 5, pp. 1122-1149.

Stanton, J.M., Stam, K.R., Mastrangelo, P., Jolton, J. (2005). *Analysis of End User Security Behaviors*. Computers & Security, Vol. 24, pp. 124-133.

Star, S.L., Griesemer, J.R. (1989). *Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39*. Social Studies of Science, Vol. 19, No. 3, pp. 387-420.

Steenbergen, M., Brinkkemper, S. (2008). *Modeling the Contribution of Enterprise Architecture Practice to the Achievement of Business Goals*. In: Proceedings of the 17th International Conference on Information Systems Development (ISD2008), Paphos, Cyprus.

Steenbergen, M. van, Brinkkemper, S. (2009). *The Architectural Dilemma: Division of Work versus Knowledge Integration*. In: H. Weigand, H. Werthner, G. Gal (eds.), Proceedings of the Third International Workshop on Business/IT Alignment and Interoperability (BUSITAL'09), pp. 46-60.

Steenbergen, M. van, Schipper, J., Bos, R., Brinkkemper, S. (2010). *The Dynamic Architecture Maturity Matrix: Instrument Analysis and Refinement*. In: A. Dan, F. Gittler, and F. Toumani (Eds.), ICSOC/ServiceWave 2009, LNCS 6275, pp. 48-61. Berlin: Springer-Verlag.

Steenbergen, M. van (2011). *Maturity and Effectiveness of Enterprise Architecture*. PhD thesis, Utrecht University, Utrecht.

Straub, D.W. (1990). *Effective IS Security: An Empirical Study*. Information Systems Research, Vol. 1, No. 3, pp. 255-276.

Straub, D.W, Welke, R.J. (1998). *Coping with Systems Risk: Security Planning Models for Management Decision Making*. MIS Quarterly, Vol. 22, No. 4, pp. 441-469.

Szulanski, G. (1996). *Exploring Internal Stickiness: Impediments to the Transfer of Best Practice Within the Firm*. Strategic Management Journal, Vol. 17, pp. 27-43.

Tashakkori, A., Teddlie, C. (1998). *Mixed Methodology: Combining Qualitative and Quantitative Approaches*. California: Sage Publications.

Tewarie, W.N.B. (2010). *Model Based Development of Audit Terms of Reference: A Structured Approach to IT Auditing*. PhD thesis, Vrije Universiteit Amsterdam.

The Open Group. (2003). *TOGAF Version 8.1 "Enterprise Edition"*. TOG. URL: http://www.open group.org/architecture/togaf8-doc/arch/ [Accessed: December 13th 2006]

The Open Group. (2009). *TOGAF Version 9: The Open Group Architecture Framework*. TOG. URL: http://www.opengroup.org/togaf/ [Accessed: November 13th 2009]

Thiroux, J.P. (1977). *Ethics: Theory and Practice*. Encino: Glencoe Publishing Co., Inc.

Thralls, C. (1992). *Rites and Ceremonials: Corporate Video and the Construction of Social Realities in Modern Organizations*. Journal of Business and Technical Communication, Vol. 6, No. 4, pp. 381-402.

Tranfield, D., Denyer, D., Smart, P. (2003). *Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review*. British Journal of Management, Vol. 14, pp. 207-222.

Treviño, L.K., Weaver, G.R., Reynolds, S.J. (2006). *Behavioral Ethics in Organizations: A Review.* Journal of Management, Vol. 32, No. 6, pp. 951-990.

Trotman, K.T., Yetton, P.W. (1985). *The Effect of the Review Process on Auditor Judgments*. Journal of Accounting Research, Vol. 23, No. 1, pp. 256-267.

Tyler, T.R., Blader, S.L. (2005). *Can Businesses Effectively Regulate Employee Conduct? The Antecedents of Rule Following in Work Settings*. The Academy of Management Journal, Vol. 48, No. 6, pp. 1143-1158.

USDA (United States Department of Agriculture). (2007): *Governance of the Universal Telecommunications Network (UTN)*. URL: http://www.ocio.usda.gov/directives/doc/DN3300-022.pdf [Accessed: May 7th 2007]

Venkatraman, N., Ramanujam, V. (1987). *Measurement of Business Economic Performance: An Examination of Method Convergence*. Journal of Management, Vol. 13, No. 1, pp. 109-122.

Versteeg, G., Bouwman, H. (2006). *Business Architecture: A New Paradigm to Relate Business Strategy to ICT*. Information Systems Frontiers, Vol. 8, No. 2, pp. 91-102.

Volonino, L., Gessner, G.H., Kermis, G.F. (2004). *Holistic Compliance with Sarbanes-Oxley*. Communications of the AIS, Vol. 14, No. 1, pp. 219-233.

Vries, E.J. de. (2007). *Rigorously Relevant Action Research in Information Systems*. In: Proceedings of the 15th European Conference on Information Systems (ECIS 2007).

Vroom, C., Solms, R. von. (2004). *Towards Information Security Behavioural Compliance*. Computers & Security, Vol. 23, pp. 191-198.

Wagner, E.L., Scott, S.V., Galliers, R.D. (2006). *The Creation of 'Best Practice' Software: Myth, Reality and Ethics*. Information and Organization, Vol. 16, No. 3, pp. 251-275.

Wagter, R., Berg, M. van den, Luijpers, J., Steenbergen, M. van. (2005). *Dynamic Enterprise Architecture: How to Make It Work. Hoboken*. New Jersey: John Wiley & Sons.

Wall, T.D., Michie, J., Patterson, M., Wood, S.J., Sheehan, M., Glegg, C.W., West, M. (2004). *On the Validity of Subjective Measures of Company Performance*. Personnel Psychology, Vol. 57, No. 1, pp. 95-118.

Ward, J., Peppard, J. (2002). *Strategic Planning for Information Systems*. Third Edition. Chichester: John Wiley & Sons Ltd.

Wasserman, C.E. (2009). *An Overview of Compliance and Enforcement in the United States: Philosophy, Strategies, and Management Tools*. URL: http://www.inece.org/1stvol1/wasserman.htm [Accessed: Oct 11th 2009].

Weaver, G.R., Treviño, L.K., Cochran, P.L. (1999a). *Corporate Ethics Programs as Control Systems: Influences of Executive Commitment and Environmental Factors*. Academy of Management Journal, Vol. 42, No. 1, pp. 41-57.

Weaver, G.R., Treviño, L.K., Cochran, P.L. (1999b). *Corporate Ethics Practices in the Mid-1990's: An Empirical Study of the Fortune 1000*. Journal of Business Ethics, Vol. 18, pp. 283-294.

Webster, J., Watson, R.T. (2002). *Analyzing the Past to Prepare for the Future: Writing a Literature Review*. MIS Quarterly, Vol. 26, No. 2.

Weerd, I. van de, Brinkkemper, S. (2008). *Meta-modeling for Situational Analysis and Design Methods*. In M.R. Syed and S.N. Syed (Eds.). Handbook of Research on Modern Systems Analysis and Design Technologies and Applications, pp. 38-58. Idea Group Publishing, Hershey.

Weisburd, D., Britt, C. (2007). *Multivariate Regression with Multiple Category Nominal or Ordinal Measures: Extending the Basic Logistic Regression Model*. In: Statistics in Criminal Justice, Third Edition, pp. 579-606. New York: Springer.

Welcomer, S.A. (2002). *Firm-Stakeholder Networks: Organizational Response to External Influence and Organizational Philosophy*. Business & Society, Vol. 41, No. 2, pp. 251-257.

Wenger, E. (2000). *Communities of Practice and Social Learning Systems*. Organization, Vol. 7, No. 2, pp. 225-246.

Winter, R., Fischer, R. (2007). *Essential Layers, Artifacts, and Dependencies of Enterprise Architecture*. Journal of Enterprise Architecture, Vol. 3, No. 2, pp. 1-12.

Youngs, R., Redmond-Pyle, D., Spaas, P., Kahan, E. (1999). *A Standard for Architecture Description*. IBM Systems Journal, Vol. 38, No. 1, pp. 32-50.

Zachariadis, M., Scott, S., Barrett, M. (2010). *Designing Mixed-Method Research Inspired by a Critical Realism Philosophy: A Tale From the Field of IS Innovation*. In: Proceedings of the Thirty First International Conference on Information Systems (ICIS 2010), St. Louis, Missouri, USA.

Zachman, J.A. (1987). *A Framework for Information Systems Architecture*. IBM Systems Journal, Vol. 26, No. 3, pp. 276-292.

Zachman, J.A. (1996). *Enterprise Architecture: The Issue of the Century*. Zachman International.

Zaelke, D., Kaniaru, D., Kružíková, E. (2005). *Making Law Work: Environmental Compliance & Sustainable Development, Vol. I & II*. London: Cameron May Ltd.

Zaelke, D., Stilwell, M., Young, O. (2005). *Compliance, Rule of Law & Good Governance*. In: Zaelke, D., Kaniaru, D., Kružíková, E. (Eds.). Making Law Work: Environmental Compliance & Sustainable Development, Vol. I & II. London: Cameron May Ltd.

Zeist, R.H.J. van, Hendriks, P.R.H. (1996). *Specifying Software Quality with the Extended ISO Model*. Software Quality Journal, Vol. 5, No. 4, pp. 273-284.

Zimbardo, P.G., Leippe, M.R. (1991). *The Psychology of Attitude Change and Social Influence*. New York: McGraw-Hill.

zur Muehlen, M., Indulska, M., Kamp, G. (2007). *Business Process and Business Rule Modeling Languages for Compliance Management: A Representational Analysis*. In: Proceedings of the 26th International Conference on Conceptual Modeling, Auckland, New Zealand.

Publication List

This dissertation is based on the following publications:

Foorthuis, R.M., Brinkkemper, S. (2007). *A Framework for Local Project Architecture in the Context of Enterprise Architecture*. In: Journal of Enterprise Architecture, Vol. 3, No. 4, pp. 51-63, November 2007.

Foorthuis, R.M., Brinkkemper, S. (2008). *Best Practices for Business and Systems Analysis in Projects Conforming to Enterprise Architecture*. In: Enterprise Modelling and Information Systems Architectures, Vol. 3, No. 1, pp. 36-47, July 2008.

Foorthuis, R.M., Brinkkemper, S., Bos, R. (2008). *An Artifact Model for Projects Conforming to Enterprise Architecture*. In: Stirna, J., Persson, A. (Eds.). The Practice of Enterprise Modeling. Proceedings of PoEM 2008, IFIP WG 8.1 Working Conference, LNBIP 15, pp. 30-46. Berlin: Springer-Verlag.

Foorthuis, R.M., Brinkkemper, S. (2008). *A Process Model for Project Members Conforming to Enterprise Architecture*. Technical Report, Utrecht University, ISSN 0924-3275. URL: http://www.cs.uu.nl/research/techreps/repo/CS-2008/2008-023.pdf

Foorthuis, R.M., Steenbergen, M. van, Mushkudiani, N., Bruls, W., Brinkkemper, S., Bos, R. (2010). *On Course, But Not There Yet: Enterprise Architecture Conformance and Benefits in Systems Development*. In: Proceedings of the Thirty First International Conference on Information Systems (ICIS 2010), St. Louis, Missouri, USA.

Foorthuis, R.M., Bos, R. (2011). *A Framework for Organizational Compliance Management Tactics*. In: C. Salinesi and O. Pastor (Eds.), CAiSE 2011 Workshops (GRCIS 2011), LNBIP 83, pp. 259–268. Berlin: Springer-Verlag.

Foorthuis, R.M., Hofman, F., Brinkkemper, S., Bos, R. (2012). *Compliance Assessments of Projects Adhering to Enterprise Architecture*. In: Journal of Database Management, Vol. 23, No. 2, pp. 44-71. DOI: 10.4018/jdm.2012040103.

Foorthuis, R.M., Brinkkemper, S., Bos, R. (submitted). *Tactics for Internal Compliance: A Literature Review*.

Other peer reviewed publications:

Foorthuis, R.M., Brinkkemper, S. (2007). *A Framework for Project Architecture in the Context of Enterprise Architecture*. In: Lankhorst, M.M., Johnson, P. (Eds.). Proceedings of the Second Workshop on Trends in Enterprise Architecture Research (ECIS 2007 Workshop TEAR 2007), pp. 51-60.

Foorthuis, R.M., Hofman, F., Brinkkemper, S., Bos, R. (2009). *Assessing Business and IT Projects on Compliance with Enterprise Architecture*. In: Proceedings of GRCIS 2009, CAiSE Workshop on Governance, Risk and Compliance of Information Systems.

Bruls, W.A.G, Steenbergen, M. van, Foorthuis, R.M., Bos, R., Brinkkemper, S. (2010). *Domain Architectures as an Instrument to Refine Enterprise Architecture*. In: Communications of the Association for Information Systems, Vol. 27, No. 1, Article 27.

Foorthuis, R.M., Steenbergen, M. van, Mushkudiani, N., Bruls, W., Brinkkemper, S., Bos, R. (2010). *On Enterprise Architecture Conformance and Benefits*. In: Proceedings of the Fifth SIKS/BENAIS Conference on Enterprise Information Systems (EIS 2010), Eindhoven, The Netherlands.

Steenbergen, M. van, Foorthuis, R.M., Mushkudiani, N., Bruls, W., Brinkkemper, S., Bos, R. (2011). *Achieving Enterprise Architecture Benefits: What Makes the Difference?* In: Proceedings of the 15th IEEE International EDOC Workshops, TEAR 2011.

Non-peer reviewed publications:

Foorthuis, R.M., Brinkkemper, S. (2008). *Best practices voor projecten onder enterprise architectuur*. In: Hendriks, C.M., Oosterhaven, J.A. (Eds.). Architectuur maakt de toekomst mogelijk: LAC boek 2008, pp. 147-155. Den Haag: Academic Service, SDU Uitgevers bv.

Foorthuis, R.M., Hofman, F., Brinkkemper, S., Bos, R. (2009). *Toetsen van Projecten op Enterprise Architectuur*. In: Hendriks, C.M., Oosterhaven, J.A. (Eds.). Architectuur móet bijdragen: LAC boek 2009, pp. 159-168. Den Haag: Academic Service, SDU Uitgevers bv.

Summary

This research project set out to identify effective practices and models for working with projects that are required to comply with Enterprise Architecture (EA), and investigate the benefits and drawbacks brought about by compliance. During the first phase of the research, the domain was explored and relevant concepts were described. In this context, Enterprise Architecture, Domain Architecture (DA), Project Architecture, Project Start Architecture (PSA) and Software Architecture were defined and interrelated. EA is a high-level and somewhat abstract architecture providing solution guidelines and constraints, similar to mid-level Domain Architectures. A Project Architecture, on the other hand, is focused on actual implementation of more or less local solutions, which need to be compliant with the EA and any DAs. Project Start Architecture and Software Architecture can be regarded as constituents of the Project Architecture.

By means of Canonical Action Research and Focus Groups, several EA-related candidate best practices and observations from practice were identified. *Best practices* found during this phase are: providing projects with advice, having architects participate actively in projects, using a (phase-dependent) PSA and encouraging conformance by means of artifact templates. Notable *observations* are: the ambiguity of EA prescriptions, the added project complexity of working with EA and the awareness and knowledge stimulating role of the PSA.

These observations and best practices subsequently formed the basis for a layered artifact and process model for EA-related projects. Examples of important new EA-related project artifacts are the EA Conformance Report, the PSA template and the EA Feedback Report. The model's first layer specifies by which processes these artifacts are created and what the relationships between the processes are. Each process is described in detail at the second layer.

One process in particular has been worked out in detail, viz. assessing projects on compliance with EA. Important concepts in this regard are the *EA* itself, which amongst others consists of project prescriptions (i.e. architectural norms with which projects should comply). These prescriptions may take the form of principles, models or policy statements. Another crucial element is the *project*, which delivers the local solution that should ultimately yield business results. During its lifetime, a project will create project artifacts (i.e. deliverables such as Software Architecture Documents and Use Case Models). These are typically the items which should be assessed on compliance by using

compliance checks. As part of the *assessment process*, four such checks can be used when verifying compliance. These *compliance checks* are the Correctness Check (is the prescription applied in accordance with its intended meaning, rationale and usage?), the Justification Check (is the application – or lack thereof – of a given prescription justified, depending on its relevance and priority in the specific situation?), the Consistency Check (given a prescription, are related prescriptions applied in a coherent way?) and the Completeness Check (are all prescriptions applied?).

In the second phase of the research, both the hypotheses (practices) of the first phase and the claims of practitioners and academics were tested by means of a *survey study* (n=293). Furthermore, theory was expanded upon by creating a statistical causal model. The empirical study showed that most of the identified techniques are used in practice. Relevant compliance tactics in this respect are: knowledge exchanges, providing advice, working with a PSA, conducting compliance assessments, using document templates, and having management propagate EA. Financial sanctions and disincentives proved to be barely used in organizational practice. The results also showed that projects benefit in several ways from working with EA. These benefits are delivering the desired quality more often, being better equipped to deal with risk and being able to manage complexity more effectively. Several of the hypothesized project benefits could not be confirmed, however, such as exceeding deadlines and budgets less often, and delivering the required functionality more frequently. EA simply did not have a significant effect on these aspects. The results also showed that EA has a downright negative impact on the speed of initializing projects. This is probably due to one of the observations found during the Canonical Action Research and Focus Groups of the first phase, namely EA introducing additional project complexity: getting acquainted with abstract and non-practical EA prescriptions, dealing with additional stakeholders, balancing possible conflicts of interests and undergoing compliance assessments. The results furthermore demonstrated that several organization-wide benefits are achieved due to EA. Important benefits are accomplishing enterprise goals, gaining insight into organizational complexity, achieving integration, standardization and deduplication of related processes and systems, depicting a clear image of the future situation and providing a communicational frame of reference. Hypothesized benefits not confirmed are achieving business/IT alignment and agility, controlling costs and complexity, and co-operating with other organizations effectively and efficiently. All of these latter claims were rejected because EA does not seem to have a significant impact on these goals, not because EA has a negative effect.

The results also showed that EA creators and EA users generally agree in their evaluations, in the sense that both are positive (and in some cases negative). However, with regard to various benefits, both at the enterprise and

the project level, EA creators are significantly and consistently more positive than EA users. This is on the one hand probably due to the creators' involvement and commitment, the binding effect of which results in them possessing a relatively positive attitude. On the other hand, EA users arguably have a relatively negative attitude as a result of their inability to see the overall picture (due to their local focus) and of them having to deal with additional complexity and effort. Because of the subjectivity of these two groups, it is of paramount importance to take both perspectives into account for attaining a balanced view.

The results furthermore showed that most techniques identified are used in practice. However, after controlling for other effects using a regression analysis, only three tactics prove to have a significant impact on compliance with EA: compliance assessments, management propagation and assisting projects. Compliance of projects subsequently results in an increased ability to achieve EA-related benefits. At the organizational level, conformance has significant effects on achieving business/IT alignment, accomplishing enterprise-wide goals and integrating, standardizing and deduplicating processes and systems. At the project level, conformance is shown to have significant effects on the ability to manage project complexity, delivering the desired quality and delivering the desired functionality. Interestingly, project compliance with EA has the strongest effects on organization-wide benefits, whereas projects themselves benefit to a lesser extent and in more subtle ways. In any case, the project level plays an important part in achieving organization-wide goals, which is one of the key goals of EA. Projects should therefore not be neglected.

During the third phase of the research the insights regarding organizational compliance were enriched and broadened by focusing on compliance in general (i.e. also compliance with laws, regulations, industrial standards, internal policies, et cetera). An extensive multidisciplinary literature review studying 134 publications revealed that no less than 45 compliance tactics exist for stimulating conformance to norms. These tactics differ in their nature (enforcement, inducement, assessment or management) and their application level (enterprise, collective or individual). Using these two dimensions, the 45 techniques can be presented in the form of a *typology of compliance tactics*. Several guidelines have also been provided for moving from compliance tactics to compliance strategy.

Nederlandse Samenvatting

Dit promotieonderzoek heeft als doel effectieve technieken en modellen voor projecten onder Enterprise Architectuur (EA) te identificeren en te onderzoeken, alsmede de voor- en nadelen van het daadwerkelijk aan EA conformeren. Tijdens de eerste onderzoeksfase is het domein verkend en zijn de relevante concepten beschreven. In dit kader zijn Enterprise Architectuur, Domein Architectuur (DA), Project Architectuur, Project Start Architectuur (PSA) en Software Architectuur in onderlinge samenhang beschreven. Enterprise Architectuur is de hoog-niveau en enigszins abstracte architectuur die oplossingsrichtlijnen en kaders voorschrijft, vergelijkbaar met Domein Architecturen. Een Project Architectuur richt zich daarentegen op daadwerkelijke implementatie van min of meer lokale oplossingen, welke conform aan de EA en DA's dienen te zijn.

Door middel van Canonical Action Research en Focus Group onderzoek zijn verschillende EA-gerelateerde kandidaat best practices en observaties uit de praktijk geïdentificeerd. Onder andere de volgende *best practices* zijn tijdens deze fase gevonden: projecten assisteren met advies, architecten actief laten participeren in projecten, een (fase-afhankelijke) PSA gebruiken en conformiteit stimuleren middels templates van artefacten (documenten en modellen). Onder andere de volgende *observaties* zijn gedaan: ambiguïteit van EA-voorschriften, toegenomen projectcomplexiteit als gevolg van het werken onder EA en de PSA als bron van bewustwording en kennis.

Deze observaties en best practices zijn vervolgens als basis gebruikt voor een gelaagd artefacten- en procesmodel voor projecten onder architectuur. Voorbeelden van belangrijke nieuwe EA-gerelateerde projectartefacten zijn het EA Conformance Report, de PSA-template en het EA Feedback Report. Het model schrijft voor door welke processen deze artefacten worden gecreëerd en wat de relaties tussen de processen zijn. Elk proces wordt in de tweede laag van het model in meer detail beschreven.

Meer specifiek is een van de processen in een hoge mate van detail uitgewerkt, namelijk het toetsen van projecten op architectuur. Een belangrijk concept in dit kader is de *Enterprise Architectuur* zelf, die onder meer bestaat uit de voorschriften waar projecten zich aan dienen te houden. Deze EA-voorschriften kunnen de vorm aannemen van principes, modellen of

beleidsuitspraken. Een ander belangrijk concept is het *project*, dat de lokale oplossing creëert die de uiteindelijke bedrijfsresultaten moet opleveren. Een project brengt ook projectartefacten voort (tussentijdse resultaten zoals een Software Architectuur Document en Use Case Modellen). Dit zijn typisch de items die getoetst moeten worden op conformiteit met de EA. Als deel van het *toetsproces* kunnen vier *compliance checks* ingezet worden. Dit zijn de Correctness Check (is het voorschrift toegepast zoals bedoeld?), de Justification Check (is de toepassing van het principe – of het achterwege laten ervan – gerechtvaardigd, gezien de relevantie en prioriteit ervan in de specifieke situatie?), de Consistency Check (gegeven een voorschrift, zijn alle gerelateerde voorschriften op een coherente wijze toegepast?), en de Completeness Check (zijn alle voorschriften toegepast?).

In de tweede onderzoeksfase zijn zowel de eerder opgestelde hypothesen (de best practices) als de claims van academici en professionals *statistisch getoetst* door middel van een vragenlijst (n=293). Daarnaast is er aan theorieontwikkeling gedaan door middel van het creëren van een statistisch causaal model. Dit empirisch onderzoek toont aan dat het grootste deel van de eerder geïdentificeerde practices in de praktijk wordt gebruikt. Relevante technieken in dit kader zijn: kennisuitwisseling, het geven van advies, werken met een PSA, het toetsen of projecten conform zijn aan de EA, het gebruiken van artefact templates, en het door het management laten uitdragen dat EA belangrijk is. Opvallend is het feit dat financiële prikkels en sancties in de praktijk nauwelijks gebruikt worden. De resultaten tonen ook aan dat projecten op verschillende manieren profiteren van het werken onder EA. Voordelen zijn het vaker kunnen leveren van de gewenste kwaliteit en het beter kunnen managen van risico's en complexiteit. Verschillende veronderstelde voordelen worden in de praktijk echter niet behaald, waaronder het minder overschrijden van deadlines en budgetten, en het vaker kunnen leveren van de gewenste functionaliteit. EA heeft hier simpelweg geen invloed. De resultaten tonen echter ook aan dat EA wel een negatief effect heeft op de snelheid waarmee projecten opgestart kunnen worden. Dit is waarschijnlijk te wijten aan een aantal zaken die reeds in het Canonical Action Research en Focus Group onderzoek van de eerste fase zijn gevonden, namelijk dat EA resulteert in additionele complexiteit in het project: bekend moeten worden met abstracte en niet altijd even praktische EA-voorschriften, om moeten gaan met meer stakeholders, moeten balanceren tussen belangentegenstellingen en het moeten ondergaan van conformiteitstoetsen. De resultaten laten verder zien dat diverse organisatiebrede voordelen wel kunnen worden behaald dankzij EA. Belangrijke voordelen in dit kader zijn het kunnen behalen van doelstellingen op organisatieniveau, het integreren, standaardiseren en ontdubbelen van verwante processen en systemen, het verkrijgen van inzicht in organisatorische complexiteit, het neerzetten van een

duidelijk beeld van de toekomstige situatie en het bieden van een referentiekader om de verschillende belanghebbenden effectief met elkaar te laten communiceren. Veronderstelde voordelen op organisatieniveau die in de praktijk niet behaald worden zijn het bereiken van business/IT alignment en flexibiliteit ('agility'), het beheersen van kosten en complexiteit en het goed samenwerken met andere organisaties. Deze voordelen werden verworpen als hypothesen omdat EA hier geen effect blijkt te hebben, niet omdat EA hier een negatieve impact heeft.

De resultaten tonen ook aan dat EA-makers (onder andere enterprise architecten) en EA-gebruikers (onder andere projectleden) vaak gedeelde evaluerende percepties hebben, in de zin dat ze beide positief (en op sommige vlakken negatief) zijn. Echter, ten aanzien van diverse van de bovengenoemde EA-voordelen, zowel op organisatie- als op projectniveau, zijn EA-makers significant positiever dan EA-gebruikers. Dit is aan de ene kant waarschijnlijk het gevolg van de betrokkenheid en het 'commitment' van de EA-makers, hetgeen door de bindende werking resulteert in een relatief positieve attitude. Aan de andere kant zullen EA-gebruikers mogelijk een relatief negatieve attitude hebben als gevolg van het feit dat ze door hun lokale blikveld het geheel niet kunnen overzien. Ook zal meespelen dat gebruikers juist als gevolg van het werken onder EA te maken krijgen met toegenomen projectcomplexiteit en een grotere hoeveelheid aandachtspunten. Vanwege bovengenoemde subjectiviteit van de twee groepen, is het belangrijk om beide perspectieven in ogenschouw te nemen teneinde een gebalanceerd inzicht in EA te verkrijgen.

De resultaten tonen aan dat de meeste technieken in de praktijk gebruikt worden. Een statistische regressieanalyse, waarbij wordt gecorrigeerd voor andere invloeden, laat echter zien dat maar drie van deze tactieken een significante impact op het behalen van conformiteit met EA hebben: toetsen op conformiteit, uitdragen van het belang van EA door het management en het assisteren van projecten. Conformiteit van projecten, op haar beurt, leidt vervolgens vaker tot het behalen van EA-gerelateerde voordelen. Op organisatieniveau heeft projectconformiteit significante positieve effecten op het kunnen behalen van organisatiebrede doelstellingen en op het kunnen integreren, standaardiseren en ontdubbelen van processen en systemen. Op projectniveau heeft conformiteit significante positieve gevolgen voor het kunnen beheersen van projectcomplexiteit en het kunnen leveren van de gewenste kwaliteit en functionaliteit. Met name opvallend is het feit dat conformiteit van projecten met de EA een sterk effect heeft op organisatiebrede voordelen, terwijl de projecten in kwestie zelf in mindere mate profiteren. Projecten spelen in elk geval een centrale rol in het behalen van bedrijfsbrede doelstellingen, hetgeen een van de kerndoelen van EA is.

Tijdens de derde onderzoeksfase zijn de opgedane inzichten in organisatorische conformiteit met voorschriften verrijkt en verbreed door te kijken naar conformiteit in het algemeen (dus ook het voldoen aan wetten, regels, industriële standaarden, intern beleid, et cetera). Middels een uitgebreide multidisciplinaire literatuurreview van 134 publicaties werden 45 'compliance tactics' geïdentificeerd voor het stimuleren van conformiteit met normen. Deze tactieken verschillen qua aard (straffen, belonen, meten en managen) en hun toepassingsniveau (organisatiebreed, collectief en individueel). Met behulp van deze twee dimensies zijn de 45 technieken ingebed in een *typologie van compliance tactics*. Verder zijn diverse aanwijzingen gegeven voor het combineren van de tactieken tot een coherente compliance strategie.

Curriculum Vitae

Ralph Foorthuis was born on 7 December 1974 in Amsterdam, The Netherlands. In 1999 he received his master's degree in Communication Science cum laude at the Faculty of Social and Behavioral Sciences of the University of Amsterdam. Two years later he earned his master's degree, also cum laude, in Social Science Informatics at the Faculty of Science of the University of Amsterdam. He also holds a propaedeusis in Sociology.

After graduating, he worked as a developer of dialogue scripts at the call center of ING. From 2002 he worked for Statistics Netherlands (CBS) as a database designer, developer, systems analyst and business redesign architect. In these roles he was involved in improving and automating many of this institute's key statistical products – including the Consumer Price Index and the Energy and Demographic statistics – and in creating large time-oriented data registers. Late 2009 Ralph obtained a position as Senior IT Architect at UWV Business Services. At UWV he has been actively involved in several initiatives, including the organization's web portal for data services, security and privacy measures, and policies and systems for generating data products.

He started his doctoral research as an external researcher at Utrecht University at the end of 2006. In this context he published multiple articles on enterprise architecture and compliance. His research interests include enterprise and project architecture, compliance, business and systems analysis, and the value of architecture. He finished his PhD research in 2012. Ralph has been a member of the program committee of GRCIS (Governance, Risk and Compliance of Information Systems) several times, and has functioned as a peer reviewer for various journals and conferences, including MIS Quarterly (Management Information Systems Quarterly) and ECIS (The European Conference on Information Systems).