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Negin Banaeianjahromi

ON THE ROLE OF ENTERPRISE ARCHITECTURE IN ENTERPRISE INTEGRATION

LUT
Lappeenranta
University of Technology

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Abstract

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In the current business era, it is crucial for an organization to understand the rapidly changing environment of today. To swiftly respond to the changing environment, an organization must provide enterprise integration (EI) not only internally, but also externally, with its customers and suppliers. Many approaches and technologies have been proposed to facilitate EI; however, due to its complexity, integration has remained a continuous challenge in organizations. One of the major integration obstacles is maintaining architectural descriptions of the organization. Architectural descriptions, or Enterprise Architecture (EA), provides a comprehensive view of all the organizational entities and their relationships to achieve an organization's strategic goals.

Many studies have referred to EA as a solution to facilitate EI in organizations. However, developing EA is not easy to achieve. This dissertation aims to facilitate integration projects by approaching EA obstacles from a social and organizational perspective. The main research question is *What is the role of EA and its obstacles in EI?*

A qualitative and interpretive research approach is applied in this dissertation. The data was collected through interviews with practitioners from 17 large organizations and analyzed using the Grounded Theory method. The study first investigates the EI obstacles and identifies EA maintenance as a major obstacle in EI projects. After identifying the EA obstacles, the dissertation further investigates them to understand the issues in EA development that prevent EA from being efficient.

By investigating the obstacles in EA development, this research shows that if not addressed properly beforehand, the obstacles follow EA through the development process. Most of the identified obstacles are social and organizational issues. The results indicate a 'lack of communication and collaboration' as the root obstacle in EA development that can address most of the other obstacles. Revisiting the data from a communication and collaboration point of view, the results reveal 'organizational culture' and 'clarity in EA development process' as additional causes of the lack of communication and collaboration in EA development. Furthermore, 'personnel's distrust' and 'organization loses its competitive edge' are identified as additional effects of the lack of communication and collaboration in EA development. Finally, this study provides some recommendations to facilitate EA development for researchers and practitioners.

Keywords: Enterprise Architecture, Enterprise Integration, Enterprise Architecture development, obstacles, communication and collaboration, grounded theory, large enterprises.

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Negin Banaeianjahromi
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Helsinki, Finland

To my sister Neda, who is in Heaven

Contents

List of publications

I. Banaeianjahromi, N. and Smolander, K. (2016). What Do We Know About the Role of Enterprise Architecture in Enterprise Integration? A Systematic Mapping Study. Journal of Enterprise Information Management: Volume 29, Issue 1, 140-164.

II. Banaeianjahromi, N., Kähkönen, T., Alanne, A. and Smolander, K. (2016). Integration Obstacles during ERP Development. In 2016 49th Hawaii International Conference on System Sciences (HICSS), 4697–4706. IEEE.

III. Banaeianjahromi, N. and Smolander, K. (2016). Understanding Obstacles in Enterprise Architecture Development. In 2016 European Conference on Information Systems (ECIS) 2016.

IV. Banaeianjahromi, N. and Smolander, K. (2017). Lack of Communication and Collaboration in Enterprise Architecture Development. Information Systems Frontiers, 1-32. Published online: 15 Aug 2017.

In this dissertation, the publications are referred to as *Publication I, Publication II, Publication III, and Publication IV.*

Author's contribution

I. The candidate participated in the planning and execution of data collection, data analysis, and reporting as the main responsible person.

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IV. The candidate participated in the planning and execution of data collection, data analysis, and reporting as the main responsible person.

Abbreviations

ARIS	Architecture of Integrated Information Systems
AT	Architectural Thinking
CEN	European Standardization Committee
CEO	Chief Executive Officers
CIO	Chief Information Officer
DoDAF	Department of Defense Architecture Framework
e-	electronic-
EA	Enterprise Architecture
EAM	Enterprise Architecture Management
EI	Enterprise Integration
ERP	Enterprise Resource Planning
FEAF	Federal Enterprise Architecture Framework
GTM	Grounded Theory Method
IS	Information Systems
IT	Information Technology
NC	Numerical Control
PLC	Programmable Logic Controller
SMS	Systematic Mapping Study
TOGAF	The Open Group Architecture Framework
Q&A	Question and answer
XML	EXtensible Markup Language

1 Introduction

To respond to the changing market demands and technological advancements, enterprise systems should be able to adapt to the pace of environmental and technological changes smoothly and constantly. Enterprises not only should seamlessly share information internally but should also be able to connect with their suppliers and customers. The idea of having highly integrated systems began to hold shape already over thirty years ago (Barki and Pinsonneault, 2002). According to Kosanke et al. (1999), enterprise integration can *"provide the right information at the right place and at the right time and thereby enable communication between people, machines and computers and their efficient co-operation and co-ordination".* One third of an organization's IT budget is spent to provide integration to share data (Brosey et al., 2001). Enterprise integration (EI) is not an easy task to accomplish (Ho and Lin, 2004; Lim et al., 1998), and many obstacles may appear in the way of an integration project.

Many studies have pointed out challenges in integration (Lee et al., 2003; Hitt et al., 1993; Romero and Vernadat, 2016; Lam, 2005). Linthicum (2003) mentioned integration as a complex and difficult problem. Usually, hundreds or even thousands of information systems exist in the large organizations, and the adoption of different technologies during different times has led to heterogeneous environments. These heterogeneous environments introduce challenges for integration (Linthicum, 2003).

In order to integrate enterprise systems, different kinds of technologies have been introduced. These integration technologies have become more complex, and the scope of integration is expanding continuously (Singletary et al., 2003). This situation has brought more complexity into the organizational environment. To address the complexities brought on by these expanding integration projects, scholars have introduced Enterprise Architecture (EA) as the ultimate solution to tackle this issue (Anaya and Ortiz, 2005; Chen et al., 1997; Erol, Mansouri, et al., 2009; Kang et al., 2010; Noran, 2013; Panetto et al., 2012; Peristeras and Tarabanis, 2000; Vernadat, 2007; Chen et al., 2008; Hoogervorst, 2004; Lam, 2005).

Based on a survey result conducted by Infosys (Obitz and Babu, 2009), integration was mentioned as one of the key focus areas for EA. There are multiple definitions of EA in literature, but a general definition would be: an approach to manage organizational, structural, and technological complexity by providing a holistic view of the organization (Kaisler et al., 2005; Kamoun, 2013; Niemi and Pekkola, 2013). According to Proper (2013), organizations are increasingly adopting EA to manage organizational changes and complexities. EA has also been realized as a city map that describes infrastructure technologies, databases, and the standards and policies of application design (Goodhue et al., 1992).

Lam (2005) considers EA as one of the perspectives when approaching EI, mentioning that EA can address functional overlap, duplication, and redundancy in large organizations. Lam (2005) pointed out that EA *"encompasses the interconnectedness of*

IS applications, and the degree to which individual IS applications need to be integrated". Furthermore, Lankhorst (2004) and Chalmeta et al. (2001) referred to EA as an instrument that can address EI issues.

In this dissertation, after investigating EI obstacles, inefficient architectural descriptions are realized as a potential challenge in EI projects. EA is inefficient when it is not up to date, complete, understandable, or in detail. The issue of inefficient EA not only hinders the integration projects but also puts the organization in chaos, as there is no guideline or plan to determine the consequences of actions in the organization. Therefore, it is crucial to have an efficient EA in the organization. However, EA development is not an easy task to accomplish. Despite the popularity of EA in the last decades, it is not easy to find a successfully developed EA in an organization. Not all EA developments lead to a reduction of complexity. To be successful in EA, it is also crucial to understand the issues that hinder EA development. When reviewing the relevant literature in the intersection of EA and EI, it becomes clear that there is a relationship between them, which – to the knowledge of author – has not been studied before.

In this dissertation, EA obstacles are explored in order to provide practitioners with guidelines to develop EA efficiently, while avoiding EI obstacles. This leads us to the research question: *What is the role of EA and its obstacles in EI?* The objective of this dissertation is twofold. First, the EI obstacles are studied to identify the role of EA in integration projects. The dissertation aims to improve the understanding of integration by studying the EI obstacles and the role that EA plays in EI. The second objective of this dissertation is to provide EA practitioners with related concepts to address EA development issues and develop EA efficiently. EA is most efficient when it is up to date, complete, understandable, and sufficiently detailed.

This dissertation investigates the integration obstacles in five large enterprises and studies data regarding EA obstacles from fifteen large enterprises. During the time of data collection for this dissertation (2014-2015), all of the interviewed organizations had finished at least one round of EA development from pre-development to post-development, and some of them were in the stage of updating their EA. This dissertation utilizes a qualitative and interpretive research approach.

This dissertation is divided in two parts: an introduction and an appendix, including four scientific publications. The introduction consists of six chapters. Chapter 2 presents the literature review on key concepts required to follow the logic and the methods of this dissertation. Chapter 3 describes the research problem, research methods, and the research process. Chapter 4 provides an overview of the publications, consisting of results and relating to the whole for each publication. Publications are presented in Appendix 1. Chapter 5 discusses the theoretical and practical contributions and implications of this research as well as the validity and limitations of the research. Chapter 6 summarizes the contribution of this research and proposes future research ideas.

2 Background

The aim of this chapter is to define the scope of this study and describe the concepts related to this dissertation. Based on the literature, the concepts used in this dissertation will be defined in this chapter. First, different definitions of enterprise integration are presented, and enterprise integration obstacles are discussed. In section 2.2, different definitions of enterprise architecture (EA) are presented, followed by a discussion on different EA frameworks and layers. Finally, this chapter investigates the obstacles and social aspects of EA.

2.1 Enterprise integration

The examination of the literature for the definition of enterprise integration reveals various definitions for the meaning of integration. Integration has been defined in different contexts. Merriam-Webster dictionary defines integration as *"the act or process of uniting different things"*.

In the context of an organization, integration often refers to a combination of different parts, which can be organizational units, departments and business partners as well as business processes, people, and technology (Oh et al., 2007). Betha (2007) gives a comprehensive definition of integration in the organizational context as the action of bringing two entities together in order to unify and coordinate their computing resources, strategies, processes, and organization. It is important to mention that "*integration is a never ending process"*, firstly because it is a goal, and secondly, because the enterprise is changing constantly (Vernadat, 2002).

In association with enterprise systems, integration is vague and obscure. For example, according to Rodon (2006), in the Information Systems (IS) field, integration has been attributed a diversity of meanings:

1) Integration as the interoperability of systems
2) Integration as developing a whole new system
3) Integration when combining existing systems into one logical system
4) Integration as establishing communication between systems
5) Integration as inter-organizational process reengineering
6) Integration as standardizing existing systems
7) Integration as becoming a natural extension of the users or a routine
8) Integration as the adoption or diffusion of a system.

Multiple names exist for integration in the IS literature, for instance, system integration (Umapathy et al., 2008), intra- and inter-organization integration (Ngeru et al., 2009), enterprise application integration (Linthicum, 2000), organizational integration (Ettlie and Reza, 1992), information systems integration (Giacomazzi et al., 1997), supply chain

integration (Gunasekaran and Ngai, 2004), infrastructure integration (Ruh et al., 2002), and enterprise integration (Chen et al., 2008).

Brosey et al. (2001) posited that *"Enterprise Integration connects and combines people, processes, systems, and technologies to ensure that the right people and the right processes have the right information and the right resources at the right time."* This definition of EI is similar to Kosanke et al.'s (1999) definition, where integration is always a matter of networks with different contents.

In this thesis, the term 'enterprise integration' (EI) was used and was defined based on Chen et al.'s (2008) definition of EI: *"Enterprise integration is the process of ensuring the interaction between enterprise entities necessary to achieve domain objectives".* According to Chen et al., (2008), EI can be approached in various ways, for example: (1) physical integration, (2) application integration, and (3) business integration.

2.1.1 Enterprise integration frameworks

Enterprise integration (EI) facilitates information flows, systems interoperability, and knowledge-sharing among organizations (Vernadat, 2003). EI reflects the capability of integrating different system functionalities (Lee et al., 2003). It has promised to deal with the pace of technological changes (Betha, 2007).

EI is not only dealing with artefacts but also roles, places, and people. Figure 1 illustrates the views of Kosanke et al. (1999) on EI. In this figure, enterprise engineering is concerned with inter- and intra-enterprise operations to enhance their efficiency and effectiveness through communication infrastructure engineering between involved elements and their coordination and cooperation (Kosanke et al., 1999).

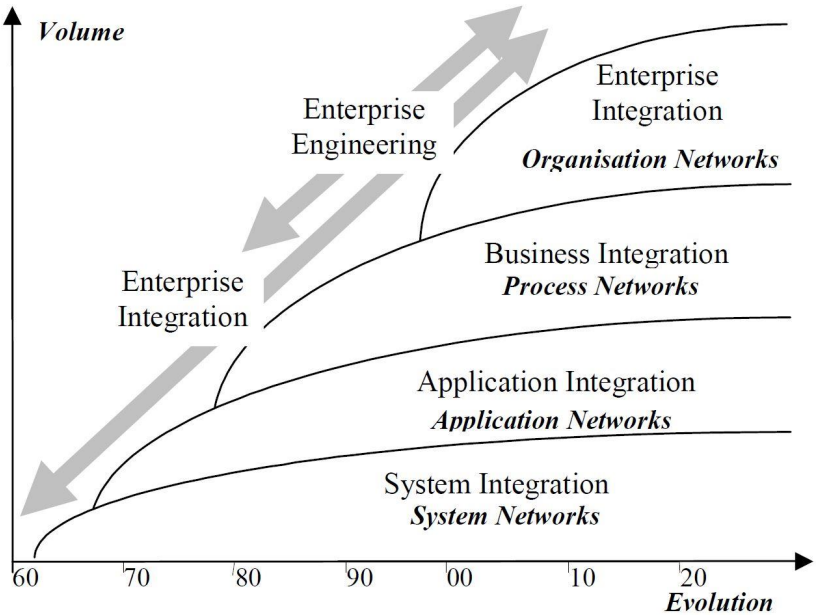

Figure 1 Kosanke et al. 's (1999) view on enterprise integration

Technical integration is not the only aspect of integration (Lee and Lee, 2000). According to Lee et al. (2003), behavioral integration is a bigger challenge than technical integration. Proper distribution of roles and responsibilities, change management, and organizational transformation are the behavioral issues critical to the success of EI (Lee et al., 2003).

EI enables organizations with more agility and flexibility to enhance communication, coordination, and cooperation not only among human actors but also between information systems (Lee et al., 2003). Aiming to consolidate and coordinate databases and applications, EI is concerned with strategies, methods, models, and tools (Romero and Vernadat, 2016). According to Panetto and Whitman (2016), EI, interoperability, and networking can effectively improve communication and collaboration in companies.

Themistocleous and Irani (2002) divided EI into two types of loose integration and tight integration. Loose integration means that integration is focused on sharing data among partners, a low degree of process dependence, a low degree of integration, and asynchronous communication. On the other hand, tight integration focuses on integrating cross-enterprise business processes and systems, a high degree of processes dependency, a high degree of integration, and synchronous communication. In addition, Romero and Vernadat (2016), extended this EI taxonomy by adding another gradation of integration as interfaced systems integration, which is the weakest form of integration, because data exchange between systems is only possible through a predefined exchange protocol.

IE can be approached in various ways (Vernadat, 2002). Three levels of integration are recognized by the European Standardization Committee CEN TC310/WG1: (1) Physical Integration (interconnection of devices, NC machines, PLCs via computer networks), (2) Application Integration (dealing with interoperability of software applications and database systems in heterogeneous computing environments), and (3) Business Integration (co-ordination of functions that manage, control, and monitor business processes) (Bick and Pawlowski, 2006; Panetto and Whitman, 2016). Similarly, Hasselbring (2000) categorized integration into three levels of business, application, and software platform.

Giachetti (2004) divided integration into four levels: network/platform level, data level, application level, and process level. Figure 2 illustrates Giachetti's (2004) enterprise information integration framework.

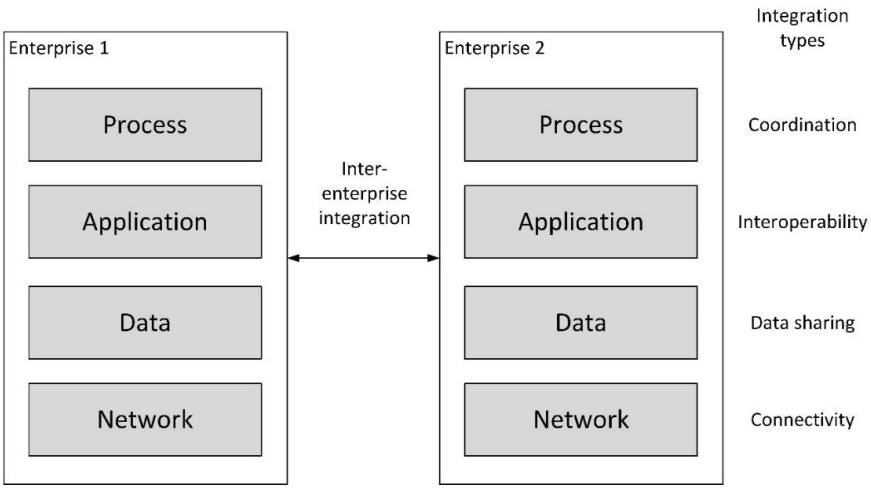

Figure 2 Giachetti's (2004) enterprise information integration framework

In this framework, the network level has to do with the integration of physical elements of an enterprise such as hardware, machines, devices, and their operating systems. The goal in this level is connectivity between systems, applications, and modules provided to ensure that data can be sent from one system to another. In the data level, the goal of integration is to share data among two or more subsystems or organizational units for exchanging data. An example of integration approaches in this level are shared data schema, federated databases XML, and data warehouses. In the application level, applications are information systems that provide a service. Each application tends to utilize locally defined data and message formats, which causes fragmentation in the enterprises. To tackle this issue, interoperability is desired. Giachetti (2004) defines interoperability as *"the ability of one software application to access/use data generated by another software system"*. Examples of integration approaches at the application level are middleware and mediators. In the business process level, applications support

business tasks, which are a part of a larger business process. In this level, different functional units in the supply chain carry out the tasks and the issue of aligning the goals of each functional unit with the overall organizational goal. To address the issue of alignment, coordination has been defined as the *"management of the dependencies that arise between business tasks"* (Malone and Crowston, 1994). Examples of integration approaches in the process level are computer-supported collaborative work, workflow management systems, and ERP systems.

Furthermore, to improve integration in enterprises, various architectures, such as enterprise service bus, service-oriented architecture, messaging, and many more, have been proposed (Avgeriou and Zdun, 2005; Panetto and Molina, 2008; Buschmann et al., 2007; Papazoglou and Heuvel, 2007; Shen et al., 2007; Tragatschnig and Zdun, 2013).

2.1.2 Enterprise integration obstacles

EI has been described in literature as a complex and very expensive task to achieve (Ho and Lin, 2004; Lim et al., 1998). According to Romero and Vernadat (2016), EI is firstly an organizational challenge and then a technical one. Technical integration (software and hardware integration) is one of EI perspectives, while behavioral integration is the most critical challenge (Lee et al., 2003). Change management and transformation in enterprises are critical issues to the success of enterprise integration. According to Lee et al. (2003), to get maximum benefit from EI, organizations need to consider both technical and behavioral integration.

According to Hitt et al. (1993), three main barriers of integration are (1) the inability to achieve overall understanding, coordination, and effective communication of information across the organization, (2) having different levels of knowledge among people in an organization, which makes communication and coordination more difficult, and (3) certain considerations regarding power and political issues.

Lam (2005) proposed a list of integration challenges in the context of e-Government. He mentioned that these challenges can hinder integration projects in other contexts as well. Table 1 presents the integration challenges mapped by Lam (2005).

Table 1 Integration obstacles according to Lam (2005)

Themes	Obstacles
Strategy	Lack of shared e-Government goals and objectives Over-ambitious e-Government milestones Lack of ownership and governance Absence of implementation guidance Funding issues
Technology	Lack of architecture interoperability Incompatible data standards Incompatible data standards Different security models Inflexibility of legacy systems Incompatible technical standards
Policy	Concerns over citizen privacy Data ownership E-Government policy evolution
Organization	Lack of agency readiness Slow pace of government reform Absence of an e-Government champion Legacy government processes Lack of relevant in-house management and technical expertise

2.2 Enterprise architecture

Over the past decade, IS in the organizations grabbed enormous attention and investments. Although this increase in IS investments had a significant impact on the performance of organizations, these investments brought complexity to the IS architecture. In this situation, IS architecture was faced with a large and ever-growing number of heterogeneous IS, which are expensive to maintain, tightly interrelated, and lack flexibility in the ever-changing business environment. Over time, many organizations have lost control of their architecture as its complexity increased. To address this challenge, Enterprise Architecture (EA) has been broadly advised and employed by scholars and practitioners for aligning IS investments with enterprise objectives (Winter, 2014).

EA lacks a universally accepted definition (Rohloff, 2005). In the IS literature EA scholars have approached EA with variation, for instance, as a complex approach (Narman et al., 2007), a complex phenomenon (Bricknall et al., 2006), a helpful tool to understand the complexity and manage change (Hinkelmann et al., 2016), a valuable instrument for aligning IT and the business processes (Foorthuis et al., 2016), a description of an enterprises organizational structure, business processes, information systems, and infrastructure (Lankhorst, 2013), a process concerned with translating business strategy to enterprise change (Korhonen et al., 2016), a strategic discipline that can be used in defining and realizing the IT strategies and roadmaps (Ross, Weill, and D.

Robertson, 2006), a description of an enterprise from an integrated business and IT perspective (Kotusev et al., 2015), a framework to develop, coordinate, and a means to align all activities and elements in an organization in order to achieve the organization's strategic goals (Akbarifar and Hamdi, 2016).

Gartner defined EA as *"a discipline for proactively and holistically leading enterprise responses to disruptive forces by identifying and analysing the execution of change towards desired business vision and out-comes"* (Gartner, 2017). EA provides a common vision of the main resources (people, processes, and technology) and how they integrate to provide the main drivers of the enterprise (strategy) (Anaya and Ortiz, 2005). EA has been defined as an approach to manage organizational, structural, and technological complexity by providing a holistic view of the organization (Kaisler et al., 2005; Kamoun, 2013; Niemi and Pekkola, 2013). Also, EA has been defined as the organizing logic for business processes and for IT infrastructure of a company (Ross, Weill, and Robertson, 2006), where "*as-is*" (current) and "*to-be*" (target) statuses are employed, connected by a migration plan from the current to the target situation in an organization (Josey, 2011).

Bernard (2012) defines EA as *"the analysis and documentation of an enterprise in its current and future states from an integrated strategy, business, and technology perspective".* In this dissertation, I use a general definition of EA: an approach to manage organizational, structural, and technological complexity by providing a holistic view of the organization to achieve the organization's strategic goals (Kaisler et al., 2005; Kamoun, 2013; Niemi and Pekkola, 2013; Ross, Weill, and Robertson, 2006). Moreover, in this thesis, EA development refers to the development of an EA description and model.

Torre and Zee (2017) identified the most important characteristics of EA based on a questionnaire containing both qualitative and quantitative questions. They targeted the enterprise architects around the world in order to identify the most important characteristics of EA in terms of decision-making. The following are the most important characteristics of EA, as defined by Torre and Zee (2017):

(1) Translating strategic goals into an IT strategy
(2) Communicating plans of action
(3) Explaining decisions instead of making them
(4) Qualitative before quantitative data
(5) Stronger business focus than other disciplines
(6) Politics, emotions, and soft skills play a bigger role than in other disciplines
(7) Large number of stakeholders with conflicting views
(8) Highly uncertain plans in a changing environment

EA can be considered the basis for enterprise engineering that can assist in managing changes and systems engineering. EA is, first of all, an organizational and strategic challenge and only then an IT issue (Chen et al., 2008). Thus, EA is similar to a city plan that explains the rules and standards for the design of infrastructure technologies, databases, and applications (Goodhue et al., 1992).

The frameworks and models of EA provide solutions to address complexities, including work (who, where), function (how), information (what), and infrastructure (how to) (Ross, 2003). According to Armour and Kaisler (2001), architecture creates a structure for a chaotic environment by applying systematic approaches. Although it has been said to be difficult, organizations should continuously maintain their EA in order to meet the current and future needs of their customers to remain competitive (Hansen and Hacks, 2017).

According to Anaya and Ortiz (2005), EA can be used either as a tool for engineering or as a management tool. As a tool for engineering, EA defines guidelines of the required information and methodologies. As a management tool, EA provides visualization for the manager to see the relationships between any artifacts in the organization. In this respect, it is important to define relationships between different architectures and artifacts involved in an EA effort in advance. Performing as a mediator to improve integration, EA minimizes the gap between business and IT (Wu, 2007). According to Tamm et al. (2011), EA is placed between IT and business strategy in organizations, and EA is responsible for translating the strategic principles, capabilities, and goals into the systems and processes.

According to Winter (2014), the EA discipline has matured over the past decades by (1) expanding its scope from software architecture to application architecture and from process architecture to business architecture, (2) broadening the focus of EA from single solutions to intra- and inter-enterprise architecture, (3) expanding its influence from a single architectural layer to different interdependencies over the whole business and IT area, (4) demonstrating not only the current and future status of architecture entities, but also roadmaps to cover the whole EA lifecycle.

2.2.1 EA frameworks

Zachman (1987), the creator of Zachman Framework, defines an EA framework as *"a logical structure used to categorize and organize the various descriptions of an organization which are important for the management and the development of their systems"*. Bernus et al. (2015) define EA framework as *"a means of sensemaking in the complex world of change, in the domain of EA"*. Another definition of an EA framework to be used in this dissertation would be the Borbinha (2007) definition, in which he defines an EA framework as *"a communication tool to support the enterprise architecture process"*. According to Borbinha (2007), an EA framework consists of a set of concepts that must be employed to guide the EA process. According to Gartner (2005), *"frameworks are important because they provide a context within which the organizational thinking can be structured, and consistent use of a framework in all components of an enterprise architecture program is a best practice."*

EA frameworks consist of a set of building blocks to describe a method for designing information systems (Shah and Kourdi, 2007). Many EA frameworks have been proposed, and most of the organizations adopt these EA frameworks to guide them in

developing EA. According to Franke et al. (2016), EA frameworks and models provide a better understanding of the organization to the stakeholders.

EA frameworks contain a list of recommendations and standard products for implementing an information system. EA frameworks simplify the development of the architecture and ensure complete coverage of all the architectural dimensions of the designed solutions through unified terminology. Being language-independent, EA frameworks provide a common understanding of terminologies among stakeholders (Shah and Kourdi, 2007). According to Shah and Kourdi (2007), EA frameworks play dual roles: (1) serve as documentation and component-specification tools and (2) facilitate enterprise planning and problem-solving.

EA consists of a huge number of artifacts and in order to reduce the number of artifacts, most EA frameworks contain several layers and views of architecture (Winter and Fischer, 2006); for example, five hierarchical layers of EA proposed by Winter and Fischer (2006). Most other proposed EA frameworks also consist of these layers, but with different names and presentations (Aier et al., 2007; Josey, 2011; IFIP-IFAC, 1999; Saha, 2004).

The five layers of EA based on Winter and Fischer's (2006) study are: (1) business architecture, which represents the organization of the enterprise from a business strategy perspective; (2) process architecture, representing the organization of service development, service creation, and service distribution in the enterprise context; (3) integration architecture, representing the organization of information system components in the enterprise context; (4) software architecture, representing the organization of software artifacts such as software services and data structures; (5) technology architecture, representing the organization of hardware and networks.

Similar to the Winter and Fischer (2006) layers of EA framework, Hoogervorst (2009) proposed four main design domains and identified four main architecture layers (business, organization, information, and IT layers). Figure 3 presents these main enterprise design domains.

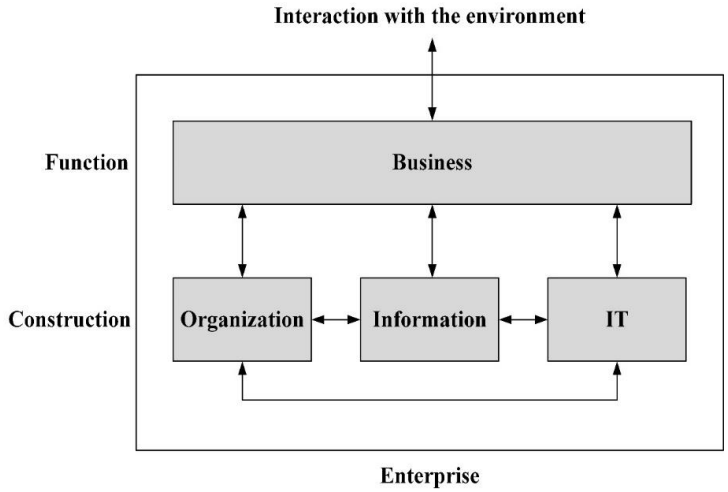

Figure 3 Main enterprise design domains proposed by Hoogervorst (2009)

In the Hoogervorst (2009) framework, which considers business architecture as a functional design domain, consisting of the environmental elements of the enterprise (for instance customers, suppliers, partners, or stakeholders), products, and services of the enterprise, and the relationships between them. Business architecture guides the enterprise function design through a set of principles and standards. Organization architecture, as the main constructional design aspect, concerns the internal enterprise arrangement for delivering the products and services of the enterprise, including sub design domains like processes, employee and management behavior, enterprise culture, and management/leadership practices. In the information architecture, different informational aspects, such as the structure and quality of information, the management of information, and the utilization of information, have a role to play. Being technology-independent, information architecture differs from IT architecture. IT architecture (technology) is necessary for organizational and informational support, and it is a crucial aspect of enterprise construction. This sub-architecture of the enterprise construction architecture is concerned with the IT network, application, storage, data communication, et cetera.

According to (Gartner, 2005), *"a good framework will define the components of an enterprise architecture and the relationships between them, providing the architecture team and the organization a set of shared semantics and concepts with which to describe their architecture".* EA is either developed based on a specific architectural framework

or adapted and customized from a previously defined framework (Plazaola et al., 2008). The EA outcome is a set of artefacts, often presented graphically, which describe what a business does, how it operates and what resources it requires (Lankhorst, 2009; Ross, Weill and Robertson, 2006; Zachman, 1987).

2.2.2 Enterprise architecture obstacles

Despite the popularity and the benefits that EA brings to organizations, it is still hard to find examples of successful EA development. Several frameworks and methodologies have been proposed to assist architects in developing EA (Lankhorst, 2013; Zachman, 1987; Hoogervorst, 2004); however, practitioners still encounter several challenges during EA development. Some of these obstacles are critical enough to cause project termination and failure. Furthermore, although EA has matured over the past decades, it is still struggling with some challenges. Thus, to become successful in EA development, it is crucial to identify and address the obstacles in this process. In this dissertation, EA obstacles are defined as factors that negatively influence the progress of EA projects, cause loss of resources, and may cause the termination of an EA project.

Many studies have identified EA obstacles employing surveys, interviews, or literature reviews (Bricknall et al., 2006; Chuang and van Loggerenberg, 2010; Hauder et al., 2013; Hjort-Madsen, 2006; Isomäki and Liimatainen, 2008; Iyamu, 2009; Jahani et al., 2010; Kaisler et al., 2005; Lucke et al., 2010; Nikpay et al., 2013; Roth, Hauder, Farwick, et al., 2013; Saarelainen and Hotti, 2011; Seppänen et al., 2009). Based on an extensive literature review, Lucke et al. (2010) proposed a taxonomy of EA issues by categorizing 14 EA obstacles into five categories of management, semantic, education and experience, knowledge management, and extent and dynamics. Another study was by Roth et al. (2013), who conducted a survey to identify EA challenges by focusing on EA documentation. Among 140 responses, *"huge effort of data collection"* and *"bad quality of EA model data"* were identified as the most reported issues. Additionally, *"insufficient tool support"*, *"no management support"*, and *"low return on investment"* were among the other important reported challenges.

Investigating EA challenges in the government sector, Isomäki and Liimatainen (2008) divided the most important EA challenges into three main categories of shared understanding and implementation ability, business-IT alignment, and governance. Furthermore, they mentioned legislative boundaries and professionalism as structural issues and also the lack of shared IT infrastructure as other obstacles that hinder an EA project. Management, scope, and content are three categories of EA issues proposed by Bricknall et al. (2006). Although, in literature, EA obstacles have been categorized differently, management commitment, shared understanding, governance, communication and coordination, the enterprise architect's skills, complexity, insufficient tools, and inadequate resources are the most frequent categories common in the literature.

Management buy-in is a critical factor in keeping up the EA project (Bricknall et al., 2006), and insufficient management commitment during EA development is mentioned as a major issue in the literature (Lucke et al., 2010; Seppänen et al., 2009; Valtonen et al., 2011; Ylimäki, 2008). According to Senge (1996), top-management 'buy-in' is *"a poor substitute for genuine commitment at many levels in an organization, and in fact, if management authority is used unwisely, it can make such commitment less rather than more likely".*

Another frequently reported EA obstacle is a lack of shared understanding (Hjort-Madsen, 2006; Iyamu, 2009; Saarelainen and Hotti, 2011; Seppänen et al., 2009; Ylimäki, 2008), which is related to the communication in organizations (Saarelainen and Hotti, 2011). Communication and shared understanding affect group work and decision-making, which facilitate information exchange among EA stakeholders (Nikpay et al., 2013). Communication and collaboration are important and necessary components in EA development (Bricknall et al., 2006), which are constantly required across different organizational levels and functions (Hjort-Madsen, 2006). Hope et al. (2017) identified communication and consultation as one of the most cited key critical success factors in EA development through a thematic review. From the perspective of the architects, communication, obtaining buy-in from the stakeholders, ownership, perceptions of the enterprise architect, and organizational politics are the most important EA development challenges (Chuang and van Loggerenberg, 2010).

Managing EA, or enterprise architecture management (EAM), is one of the most pressing and most time-consuming concerns, according to CIOs (Luftman and Zadeh, 2011). According to Aier et al. (2011), the difference between EA and EAM is that EA describes the fundamental structures of an organization and enables its transformation by bridging between business and IT, while EAM is about the establishment and continued development of EA.

Large organizations employ EAM as a management tool to guide implementation, to align business and IT, to provide the basis for organizational assessment, to manage technology, and to corporate strategic management (Ross, Weill, and Robertson, 2006; Henderson and Venkatraman, 1993; Foorthuis et al., 2012; Boh and Yellin, 2007; Simon et al., 2014). Although EAM has become popular as a management tool in business and IT over the last decade, it faces several challenges. Looking for solutions to overcome EAM challenges, Löhe and Legner (2014) identified four general EA development challenges:

(1) Great effort relating to the initial collection as well as EA artifacts being outdated and of low quality
(2) Low usage of existing EA artifacts in day-to-day work and decision-making
(3) Lack of EAM acceptance in the (IT) organization and difficulties to enforce EA policies and standards

(4) Coordination problems because the EAM initiative sets up processes for managing the EA lifecycle parallel to established IT processes

Winter (2014) identified the following two functional challenges of EA: (1) although architects try to position themselves between management, business, and IT, their backgrounds and competency profiles usually keep them close to the IT functions; (2) developing EA as a centralized mechanism to coordinate IS development and to align local projects with the organization-wide policies and priorities is the opposite of local and un-coordinated IS projects. In this situation, from the perspective of the local stakeholders, EA has restricted their freedom, and consequently, this issue hinders EA acceptance by local stakeholders.

2.2.3 Social aspect of EA

EA manages the complexity of an organization by providing a structured description of an enterprise and its relationships. For several years, EA has been considered a way to guide IS projects toward consistent solutions in enterprises. However, as current research has pointed out, the impact of EA on the organization remains limited in IT projects by assigning only 5-10 % of the commitment resources to it (Gardner et al., 2012).

Conventional and popular EA frameworks (such as TOGAF, Zachman, ARIS, FEAF, and DoDAF) convey the message that in order to have successful EA, it is enough to follow the steps described in those approaches to achieve the desired state. However, these approaches do not take into consideration the huge influence of the social aspect on the organizations in EA development and the current EA frameworks missing integration of stakeholders in their process (Roth, Hauder, and Matthes, 2013; Guerreiro et al., 2016).

Recent studies have indicated people to be a major problem in EA development (Van Der Raadt et al., 2008; Janssen, 2012). These studies suggested that a lack of attention on the social aspect or people in EA development could be the reason why organizations are still struggling with EA development. According to Bente et al. (2012), EA deals with *"social elements such as collaborative business processes, organizational leadership, political dynamics and work culture…"*, and thus, the role of people needs careful consideration in EA development, because *"the people element brings complex behavioural attributes into the functioning of an enterprise…"*.

In practice, most EA developments do not result in the desired effects. This is because EA practitioners still look at EA as something that is related to the IT functions of the organizations, which only covers 10 % of an organization, and the remaining 90 % unrelated to IT are disregarded (Gardner et al., 2012). It is crucial to move the attention away from traditional EA (IT functions) to the other non-IT related aspects of enterprises in EA development.

Winter (2014) identified EA acceptance by local stakeholders as a major issue of EA complexity. Addressing the issue, he suggests that the focus of EA should shift from an

enforcement-centric view to an influence-centric view. This suggestion highlights the aforementioned *"other 90 % of the enterprise"* (Gardner et al., 2012).

The term Architectural Thinking (AT) is used by Ross and Quaadgras (2012) to describe the way of thinking and acting in which the day-to-day decision-making of the local and individual actors takes into consideration both the fundamental design principles and the organization-wide and long-term concerns of the enterprise. There are major differences between traditional EAM and AT that have been mentioned by Winter (2014). Table 2 is from a study by Aier et al. (2015), comparing EA and AT.

Table 2 Differences between EA and AT (Aier et al., 2015)

Differentiating characteristics	**Traditional EAM**	**Architectural thinking**
Driver/owner	Architects	Individual decision-makers
Hosting organizational unit	Primarily IT; sometimes corporate center	Business lines
Addressed stakeholders	Various (IT, corporate management, business lines)	Individual decision-maker (= owner)
Benefit type	Enterprise-wide, long-term: "what's in it for the enterprise"	Local utility, medium-term: "what's in it for me, and why is it beneficial for all of us"
Threats for benefit realization (and solution strategy)	"ivory tower" → engage architects in changing projects	"local" architectures →bottom-up consolidation
Method support	Dedicated, sophisticated methods and tools: expert users!	Lightweight, pragmatic (e.g., principle catalogues, calculation templates, charts): users are no architecture experts!

2.3 Summary

This chapter covered the background of this dissertation by describing the concepts and literature related to the definition of Enterprise Architecture and Enterprise Integration as well as their obstacles. The business environment today is a collaborative but still competitive environment, in which EA and EI are two important concepts. Integration is a never-ending process, as enterprises must adapt to the constantly changing business environment. Integration happens in different levels: physical, application, and business. EI is much more than application integration within an organization; it is the integration of entities in order to unify and coordinate their computing resources, strategies, processes, and organization. EA can be defined as an approach to manage organizational, structural, and technological complexity by providing a holistic view of the organization.

3 The research problem and methodology

This chapter presents the research problem and the research perspective of this dissertation. This chapter includes descriptions of the research methods, the reasoning for the selection of those methods, and a description of the data collection and analysis process.

3.1 The research problem

Due to its complexity and importance for the survival of enterprises, EI has always been one of their major concerns. EI facilitates communication, cooperation, and collaboration within an enterprise (Vernadat, 2009). Despite the importance of EI, highlighted in the literature as a way to enhance agility, communication, and interoperability (Chalmeta et al., 2001; Chen et al., 2008; Lee et al., 2003; Ngeru et al., 2009; Umapathy et al., 2008; Vernadat, 2009), many challenges still remain in the way of EI implementation in enterprises (Hitt et al., 1993; Lam, 2005; Romero and Vernadat, 2016). These challenges initiated the primary motivation for this research, which was to explore and to find a solution to facilitate the process of integration in enterprises.

During the preparation phase of this research, it became clear that excessive architectural descriptions of systems was an obstacle or a critical factor in EI. An initial stage of research revealed that literature frequently mentions the improvement of integration as one of the many benefits of EA development in enterprises (Boh and Yellin, 2007; Tamm et al., 2011). Furthermore, some studies were found to refer to EA as a solution to solve EI issues (Erol, Sauser, et al., 2009; Goethals et al., 2006; Kang et al., 2010; Kim et al., 2006), but no reasoning for these statements was explicitly given. An investigation of the literature showed that no previous study had previously explicitly studied the role of architecture in integration, and it became clear that this was an area worthy of further research.

The goal of this dissertation is to increase empirical knowledge about the obstacles during EA and EI development in organizations and to find the possible relationship between EA and EI. In particular, the research focused more on the social and organizational aspects of EA development in organizations in order to facilitate EI obstacles.

The research questions (RQ) of this dissertation are addressed in detail in the *Publication I – IV*. Table 3 presents the research questions addressed in each publication.

RQ1: What do we know about the role of EA in EI from literature?

This main research question addresses how the role of EA in EI is discussed in the literature. This question is answered in *Publication I* by conducting a systematic mapping study to understand the research focus, research methods, and publication types and trends over time. The study concluded that there are gaps in this continuum of research.

RQ2: What issues hinder integration?

This main research question addresses the integration obstacles during ERP development. The answers to the question are provided by employing analysis based on literature as well as empirical data from 52 interviews in 5 large enterprises. The aim is to investigate EI obstacles in actual projects. Integration projects during ERP development were selected.

RQ3: What are the EA development obstacles?

This main research question aims to identify the obstacles during EA development by interviewing 20 experts from 14 large enterprises. The answers on how to reduce EA development challenges based on the advice of the managers are also discussed.

RQ4: How are different obstacles related to each other, and is there a core obstacle that explains most of the others?

The aim of the above research question is to understand the relationship between EA obstacles and to find a core obstacle that can explain most of the other obstacles. To answer this question, three rounds of data collection, including analyzing interviews and organizational documents, are conducted.

Table 3 Research questions and related publications

Publication	**Research Questions**	**RQ 1**	**RQ 2**	**RQ 3**	**RQ 4**
I	What do we know about the role of EA in EI from literature?	×			
II	What issues hinder integration?		×		
III	What are the EA development obstacles?			×	
IV	How are different obstacles related to each other, and is there a core obstacle that explains most of the others?				×

3.2 Research perspective

Research methods can be broadly divided into qualitative and quantitative methods (Lee and Hubona, 2009; Myers and Avison, 2002). Quantitative methods of research rely on observable, measurable – *quantifiable* – data, and the production of numerical descriptions of said data, answering a social or human problem by testing hypotheses that yield themselves to quantifiable observation-making (Creswell, 2013); whereas quantitative methods rely on a numerical output of analysis, qualitative methods are, as defined by Strauss and Corbin (1998), *"any type of research that produces findings not arrived at by statistical procedures or other means of quantification"*. This study relies on qualitative methods of investigating the research problems at hand. Qualitative

research methods and the interpretive perspective have been very popular in IS research (Dubé and Paré, 2003; Kaplan and Duchon, 1988), and as Benbasat and Weber (1996) explain, *"research methods shape the language we use to describe the world, and language shapes how we think about the world"*.

Another classification of research methods is proposed by Järvinen (2004), in which research methods are categorized into mathematical approaches and approaches that study reality. The category of research methods concerned with reality is further divided into the research steering utility of innovation, which is itself categorized into approaches of evaluating and building. Another division in the study of reality is studying what reality is. This division is further categorized into the analytical and empirical approaches. The empirical approaches of study are further categorized into approaches of testing and creating a theory. Figure 4 presents Järvinen's taxonomy of research methods. Considering Järvinen's classification, this dissertation falls under the type of research which studies reality by employing empirical approaches to create a theory.

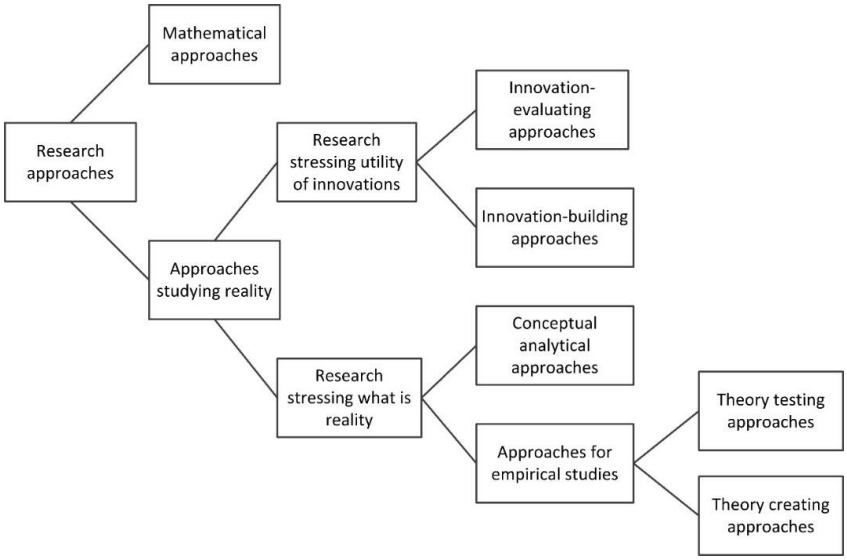

Figure 4 Taxonomy of research methods (Järvinen 2004)

3.3 Research philosophy

In this section, a brief description of the philosophical foundation of the research is presented. Commonly, research philosophical perspectives are classified into four paradigms of positivism, constructivism, critical theory, and pragmatism (Easterbrook et al., 2008).

Positivism: Knowledge in positivism is based on logical inference from a set of basic observable facts. Positivists believe that knowledge is constructed incrementally from verifiable observations, which is why a positivist studies things by breaking them down to simpler components (Easterbrook et al., 2008 p. 291). According to Hirschheim (1985),

the positivist approach is comprised of five pillars: the unity of the scientific methods, the search for causal relationships, the belief in empiricism, and the foundation of science upon logic and mathematics. Over the past century, positivism has been criticized due to the unreliability of our observations of the world, which can provide false positives and negatives in our conclusions. Although positivism is still the most common paradigm in the natural sciences, there is a group of positivists, who are described as post-positivist (Easterbrook et al., 2008). Post-positivism puts forth the argument that it is more productive to reject hypotheses than to provide direct evidence for them, resulting in a paradigm of theory-testing, where confidence in a theory increases with each failure to reject it. Positivism has thus become associated with controlled experiments, in which viable hypotheses are tested in isolation from outside factors. However, case studies and survey research are frequently carried out with a positivist perspective (Easterbrook et al., 2008; Orlikowski and Baroudi, 1991).

Constructivism: Constructivism, referred to as interpretivism (Klein and Myers, 1999), concentrates on how people understand a phenomenon, making scientific knowledge and human context inseparable in the perspective of constructivism (Easterbrook et al., 2008; Orlikowski and Baroudi, 1991), and so, *"constructivists concentrate less on verifying theories, and more on understanding how different people make sense of the world, and how they assign meaning to actions"* (Easterbrook et al., 2008). Constructivists avoid making generalizations, since theories are always tied to the context of study. Constructivism is often adopted in the social sciences, where the positivist does not have much to say about the richness of the social interactions (Easterbrook et al., 2008). Constructivists prefer qualitative methods, including interviews, case studies, ethnography, and action research (Stol et al., 2016).

Critical theory: According to Easterbrook et al. (2008), from the perspective of critical theory, *"research is a political act, because knowledge empowers different groups within society, or entrenches existing power structures"*. Choosing what research to conduct, critical theorists improve different groups in society by gaining knowledge through research or by drawing attention to things that need changing (Easterbrook et al., 2008). Action research reflects the philosophy of critical theorists (Easterbrook et al., 2008).

Pragmatism: Pragmatists believe that knowledge is incomplete, and the value of knowledge is judged by how useful it is for solving practical problems using whatever research methods that are suitable in order to gain practical knowledge (Easterbrook et al., 2008). Pragmatism includes a degree of relativism, in which the usefulness of knowledge or truth is relative to the observer. Pragmatists prefer to employ mixed methods of research to gain several views of the issue under investigation.

The methods of this dissertation are those of the constructivist school of methodological thought. According to Easterbrook et al. (2008), constructivists use methods that collect qualitative data about human activities and how different people understand the world. In this dissertation, qualitative research methods are employed, and data is collected through interviewing persons of interest, using questions designed to probe their opinions and

expertise on the issues under investigation. Furthermore, constructivists' concentration is not on verifying theories but on understanding phenomena (Easterbrook et al., 2008); it is possible that theories emerge during research, but they are tied to the context being studied. This dissertation does not formulate any hypotheses, or does it verify any theories (Stol et al., 2016; Easterbrook et al., 2008).

3.4 Research methods

In this section, the research methods applied in this study are introduced and discussed.

3.4.1 Systematic mapping study

To identify the gaps in the current continuum of research, a Systematic Mapping study (SMS) was employed. SMS is a type of literature review study that complements a systematic literature review (Kitchenham, 2004; Kitchenham and Charters, 2007). Despite the systematic literature review in SMS, it is not necessary to physically read through all relevant articles (Kitchenham and Charters, 2007). By creating a map of the research conducted in the field, an SMS study describes the field of research from a higher level (Brereton et al., 2007; Budgen et al., 2008; Petersen et al., 2008), instead of investigating the research questions in detail. An SMS study forms a descriptive narrative of the field of study, producing an overview of a specific topic (Brereton et al., 2007; Kitchenham et al., 2011).

The process suggested by Petersen et al. (2008) was used to conduct the SMS study illustrated in Figure 5. In this process, the first step is to define research questions based on which keywords are created. These keywords are then used to conduct searches of specified databases, journals, and conference articles. In the next phase, the articles are filtered out based on defined criteria. The most relevant remaining articles are then categorized, and the SMS study is formed based on these articles.

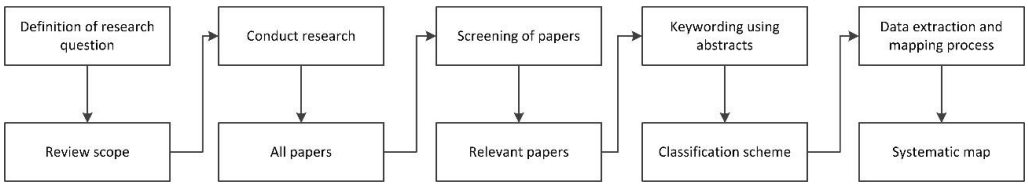

Figure 5 The systematic mapping process (Petersen et al., 2008)

3.4.2 Case studies

Benbasat et al. (1987) state that a case study *"examines a phenomenon in its natural setting, employing multiple methods of data collection to gather information from one or a few entities (people, groups, or organizations)"*. According to Yin (2013), a case study is an empirical inquiry that studies a current phenomenon in a real-life context.

Case studies are suitable for exploration, classification, description, hypothesis development, and testing (Benbasat et al., 1987; Gable, 1994). When the study uses more than a single case, the study has used a multiple-case design (Yin, 2013). According to Yin (2013), interviews are the main source of gathering case study information.

Case studies are useful in answering the *"why"* and *"how"* questions and examining contemporary events rather than frequency and incidence (Benbasat et al., 1987; Yin, 2013). For case studies, there are five important components of research design (Yin, 2013): (1) the question of a study, (2) its propositions, (3) its units of analysis, (4) the logic linking the data to the proposition, and (5) the criteria for interpreting the findings.

Case study research is most effective when the topic is broad and complex, and when an in-depth investigation is required (Benbasat et al., 1987; Dubé and Paré, 2003; Feagin et al., 1991; Yin, 2013). According to Dubé and Paré (2003), case studies are popular in the field of IS for a multitude of reasons. The first reason is that organizational, rather than technical, issues are investigated; and the second is that reporting on real-life IT experience in case study research allows both researchers and practitioners to cope with the rapid changes of IT in the organizations. The third reason is that the ability to collect both qualitative and quantitative data brings richness to the study, and makes it suitable for studying complex phenomena. Fourthly, in-depth case studies allow for a better understanding of the challenges, opportunities, and issues regarding IT in the organizations. Finally, case studies can be used both for the generation and the testing of hypotheses.

3.4.3 Grounded theory

The Grounded Theory Method (GTM) was first introduced by Glaser and Strauss (1967). GTM aims to generate empirically grounded theory based on a systematic exploration of data collected on a phenomenon (Strauss and Corbin, 1990; Urquhart and Fernández, 2013). This implies that the development of the theory happens through an interactive process of collecting and analyzing data. GTM has been adopted in diverse fields of research, including information systems (IS).

There are two perspectives of GTM: Glaserian and Straussian (Glaser, 1992; Strauss and Corbin, 1990). According to Glaser (1992), Strauss and Corbin's approach forces the development of a theory instead of allowing the theory to emerge from data. In response to Glaser, Strauss and Corbin claim that their approach does not force data but allows it to speak. The Glaserian approach tends to be more open and flexible in the analytical steps, while the Straussian approach tends to lean towards formal elaboration of procedures (Matavire and Brown, 2008). This is evident in the work of Strauss and Corbin (1990), where they suggest a detailed line-by-line analysis of data.

In this dissertation, the Straussian approach is employed, because it allows formulating the research problem before launching the grounded theory study and has predefined steps to follow. There are three major types of coding in the Straussian approach: open, axial, and selective coding (Strauss and Corbin, 1998; Strauss and Corbin, 1990).

Open coding is defined as 'the analytic process through which concepts and categories are identified and their properties and dimensions are discovered in data' (Strauss and Corbin, 1998). The key activities of this phase are naming, comparing, and memo writing (Locke, 2001). Axial coding is 'the process of relating the categories to their subcategories; it is termed *"axial"* because coding occurs around the axis of a category, linking the category at the level of properties and dimensions (Strauss and Corbin, 1990). Open coding and axial coding processes happen in parallel. The final step of the analysis process is selective coding. Determining the central category that all other major categories are related to is a part of selective coding (Strauss and Corbin, 1998). The major focus of a study is represented by the core category *"that appears to have the greatest explanatory relevance and highest potential for linking all of the other categories together"* (Corbin and Strauss 2008).

In GTM, the researcher should aim at gathering data that helps in the development of the emerging theory (Strauss and Corbin, 1998). This means that in order to have meaningful results, theoretical sampling should be employed. Strauss and Corbin (1990 p. 176) define theoretical sampling as *"sampling on the basis of concepts that have proven theoretical relevance to the evolving theory"*. In theoretical sampling, the researcher does not seek generalizability or representativeness, and the focus is more on sampling adequacy rather than sample size (Bowen, 2008). Theoretical sampling involves iteration between sample selection, fieldwork, and analysis until no new insights emerge by expanding the sample further; this is called theoretical saturation (Ritchie et al., 2013; Strauss and Corbin, 1998). Theoretical saturation has occurred when (1) no new data emerged regarding a category; (2) all the dimensions of a category are fully developed; (3) the relationships among categories are well-established and validated (Strauss and Corbin, 1998). In GTM, knowing when saturation has occurred is a point of confusion. According to Suddaby (2006), saturation is not always obvious, since iteration is applied in GTM to collect and analyze data, and thus, there is no clear boundary between data collection and analysis. According to Glaser and Strauss (1967 p. 62), *"the criteria for determining saturation<…> are a combination of the empirical limits of the data, the integration and density of the theory and the analyst's theoretical sensitivity."* The indication of saturation includes the repetition of information and confirmation of existing conceptual categories depending on the context and the experience of the researcher (Suddaby, 2006).

3.5 Research process

The research process began by conducting a systematic mapping study (SMS) to get a better understanding of the intersection of Enterprise Architecture (EA) and Enterprise Integration (EI) (*Publication I*). The goal was to survey and analyze the available literature on determining the role of EA in EI and to identify existing gaps in research. The result of this study provided insight on research focus, research method, and publication types in this area. As it became evident that there was a need for empirical

research in this area, confirmed by *Publication I*, the Grounded Theory method was chosen for consequent phases of research.

For the next step, as my colleagues had already collected data regarding integration projects, we collaborated and collected more data on EI challenges and any issues regarding EA in the organizations. The data collection and analyses in this step led us to *Publication II*. We investigated EI obstacles during ERP development and realized that architectural descriptions are among the major concerns during integration projects (*Publication II*). We searched for this issue in literature and discovered that the reason behind the architectural problems was because of the obstacles that happen during EA development. If architects do not address EA development obstacles, the obstacles will remain throughout all the phases of EA development and will perpetually hinder EA projects. In some cases, EA development obstacles have even terminated the project. Therefore, it is crucial to understand these obstacles and to address them properly in order to have intact architectural descriptions of the enterprise (*Publications III and IV*). Figure 6 presents the research process and phases. The dashed boxes in Figure 6 represent the step which is not published in any of the scientific papers attached to this dissertation but realized during this research.

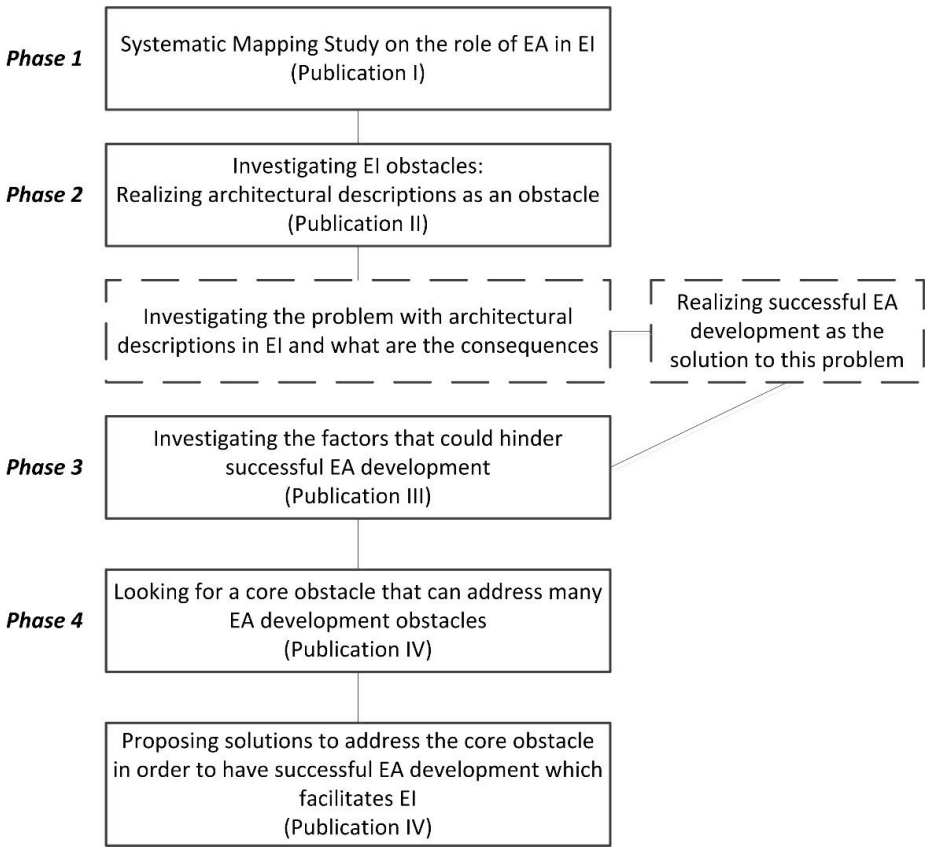

Figure 6 Research process and phases

3.5.1 Data collection

The first publication (*Publication I*) was written based on 50 papers from the literature, selected based on certain steps suggested by Petersen et al. (2008). The rest of the publications were based on empirical data obtained through interviews and organizational documents.

Table 4 illustrates the three rounds of data collection. Round 0 of the data collection was conducted by my colleagues from three cases (A, B, C) in the period from February 2013 to May 2014 (Kähkönen, Smolander, et al., 2017; Kähkönen, Alanne, et al., 2017). The interviewees included stakeholders from client organizations, the vendors and third parties such as middleware vendors and offshore departments. No strict interview protocol was used, but instead, the questions focused on general challenges in ERP development. In total, 45 interviews using the snowball technique with the average duration of one hour were made in the round 0.

Round 1 of data collection was carried out by my colleague and I, which was considered the main dataset for *Publication II* because of its focus on integration issues; the first round of data collection serves more as supporting material. In round 1 of interviews, data was collected from three cases, P, K, and M, in May and June 2014. A total of 9 experts were interviewed using the snowball technique with an average duration of 1 hour and 15 minutes. In addition to asking questions regarding integration issues, in round 1 of interviews, the interviewees' feedback on the definition of EA, the utilization of EA in their work, the influence of EA in their company, and any general concerns regarding EA development and maintenance were also collected.

In round 2 of data collection, data from 14 organizations (cases A to N) was gathered with purposeful sampling (Patton, 2005) in the period from May to July 2015. In total, 20 experts were interviewed, with the average duration of the interviews being 1 hour and 10 minutes. The interviewed companies were large, ranging from 600 to 35,000 employees. All of these organizations had finished at least one round of EA development from pre-development to post-development, and some of them were in the stage of updating their EA. Semi-structured interviews were deemed to be suitable for data collection. This way, the interviewer could ensure that all of the pre-planned themes were covered, and the interviewees could think about and reflect on the topics as well as bring their experience and perceptions to the discussion (Lange and Mendling, 2011).

Purposeful sampling was initiated in the beginning of May 2015, when an email was sent to an EA specialist group with 335 members to request qualified members of the group to assist with interviews. A total of 38 replies were received, and all were answered with a telephone call, informing them of the method and theme of the interviews. The initial call also included questions regarding the interviewees' background, including their experience with EA development projects. Of these 38 responses, experts heavily involved in EA development projects in large organizations were selected for further interviews. The further interviews included 20 experts – chief executive officers (CEO),

chief information officers (CIO), project managers, IT managers, and heads of related departments. All of the interviews took place in the interviewees' workplaces. The main questions addressed the obstacles, missions, and goals of the EA project in different EA development stages as well as the results and outcomes of the project. Data collected in round 2 was utilized in *Publications III* and *IV*. Round 1 and 2 interview questions can be found in the appendix section of *Publication IV*.

Table 4 Data collected and used in the publications

Cases	**Industry**	**No. of employees**	**No. of interviews**	**Roles of interviewees**	**Publication**
Round 0					
P	Global manufacturing enterprise	30,000	17	Different roles representing the client organization, the vendor and third-party organizations	II
Q	Large & global service provider in retail business	1000	16	Different roles representing the client organization, the vendor and third-party organizations	
R	Large and global manufacturing enterprise	20,000	10	Different roles representing the client organization	
Round 1					
P	Global manufacturing enterprise	30,000	6	Business-IT negotiator IT manager of business area Manager of E-business and integration Head of E-business and integration Business support manager of a business area Director of business process development	II, IV

K	Automotive industry	1570	2	CIO Head of IT department	
M	Automotive industry	1,600	1	Head of systems analysis and design	
Round 2					
A	Governmental organization	1,500	1	CIO	III, IV
B	Banking industry	800	1	CIO	
C	Consulting industry	2,000	1	Project manager	
D	Governmental organization	20,000	1	IT manager	
E	Cement industry	720	1	CIO	
F	Consulting industry	600	1	Project manager	
G	Governmental organization	10,000	3	CIO Head of systems analysis and design Head of business process development	
H	Automotive industry	9,700	3	CEO R&D director Head of business process development	
I	Automotive industry	35,000	1	CIO	
J	Automotive industry	11,000	2	CIO Head of R&D	
K	Automotive industry	1,570	1	CIO	
L	Banking industry	1,000	2	Head of software development IT manager	
M	Automotive industry	1,600	1	Head of systems analyze & design	
N	Governmental organization	1,860	1	IT manager	

In addition to the data collected during the three rounds of interviews, data collected from organizational documents were utilized. The organizational documents were received

from the interviewees in round 2, after a request to send EA documents available. Out of 14 organizations, five organizations (cases A, G, I, K, and L) sent documents regarding their EA development project. In total, nine documents were chosen for analysis (329 pages).

3.5.2 Data analysis

The first publication was a systematic mapping study, in which existing studies on the subject were read and analyzed. For this mapping study, no special analytical tools were used, other than spreadsheets.

For *Publications II*, *III*, and *IV*, the data was analyzed by adopting the interpretivist paradigm (Easterbrook et al., 2008). All of the interviews were transcribed into text format and then analyzed with the qualitative data analysis tool Atlas.ti. Also, the organizational documents were imported to Atlas.ti for analysis. Based on 'open coding', 'axial coding', and 'selective coding' principles from the Grounded Theory Method (Strauss and Corbin, 1998), datasets were analyzed upon collection.

After an analysis of the data from round 1, architectural descriptions were revealed as a major issue in integration projects. The problems with the architectural descriptions were not being up to date, not being in detail, not being understandable by the integration team, and not being complete.

Reviewing the literature revealed that architects faced many obstacles, which affects the final EA performance, and sometimes, entire EA projects are terminated due to those obstacles. As architectural descriptions were one of the critical issues during integration projects, another round (round 2) of interviews was conducted to improve understanding of the obstacles that practitioners face during EA development.

The first step was to open code the interview transcripts, all of which were read, and words, sentences, and paragraphs were conceptually labeled through constant comparison (Strauss and Corbin, 1998). Then, conceptually similar ones were grouped to form categories and subcategories using theoretical comparison (Strauss and Corbin, 1998). For example, the code 'high costs of losing trained personnel' was assigned to the following interview quotation: *"When you lose your trained human resource, it is harmful for the organisation because the organisation is losing its knowledge and potential"* –Case B, CIO. The interview questions and themes were used to lead us to conceptually categorizing the data.

Furthermore, a categorization level to increase the understandability of the codes during the coding process was provided. For example, 'high costs of losing trained personnel' was identified as a post-development EA obstacle, which was coded as 'Obstacle::Post-development::High costs of losing trained personnel'. During open coding, codes were constantly compared and merged with similar ones. For instance, 'Lack of innovation by EA consultant', 'EA consultant being inflexible', 'inexperienced EA consultant', and 'EA

consultant became inefficient' were merged into one category: 'EA consultant-related issues'. The result of this phase was a list of obstacles that practitioners faced during EA development. The result of this phase is presented in *Publication III*.

Axial coding is the process of relating categories to their subcategories. The term *"axial"* is used because coding occurs around the axis of a category, linking the category at the level of properties and dimensions (Strauss and Corbin, 1990). In this step, the data was scrutinized to identify the relationships, such as the conditions, cause-and-effect relationship, and interactions, between the categories and subcategories. For instance, it was noted that confusion in the government is associated with the political changes of the country that have a direct impact on the management of governmental organizations, which results in the constant change of management. Open coding and axial coding processes happened in parallel.

The final step of the analysis process was selective coding. Determining the central category that all other major categories are related to is a part of selective coding (Strauss and Corbin, 1998). The major focus of a study is represented by the core category *"that appears to have the greatest explanatory relevance and highest potential for linking all of the other categories together"* (Corbin and Strauss 2008). Figure 7 is an example of a network diagram that was drawn during the axial and selective coding processes.

Analysis of the categories revealed that communication and collaboration are major obstacles which can explain other obstacles. Looking for approaches to facilitate communication and collaboration during EA development identified EI as the action in question.

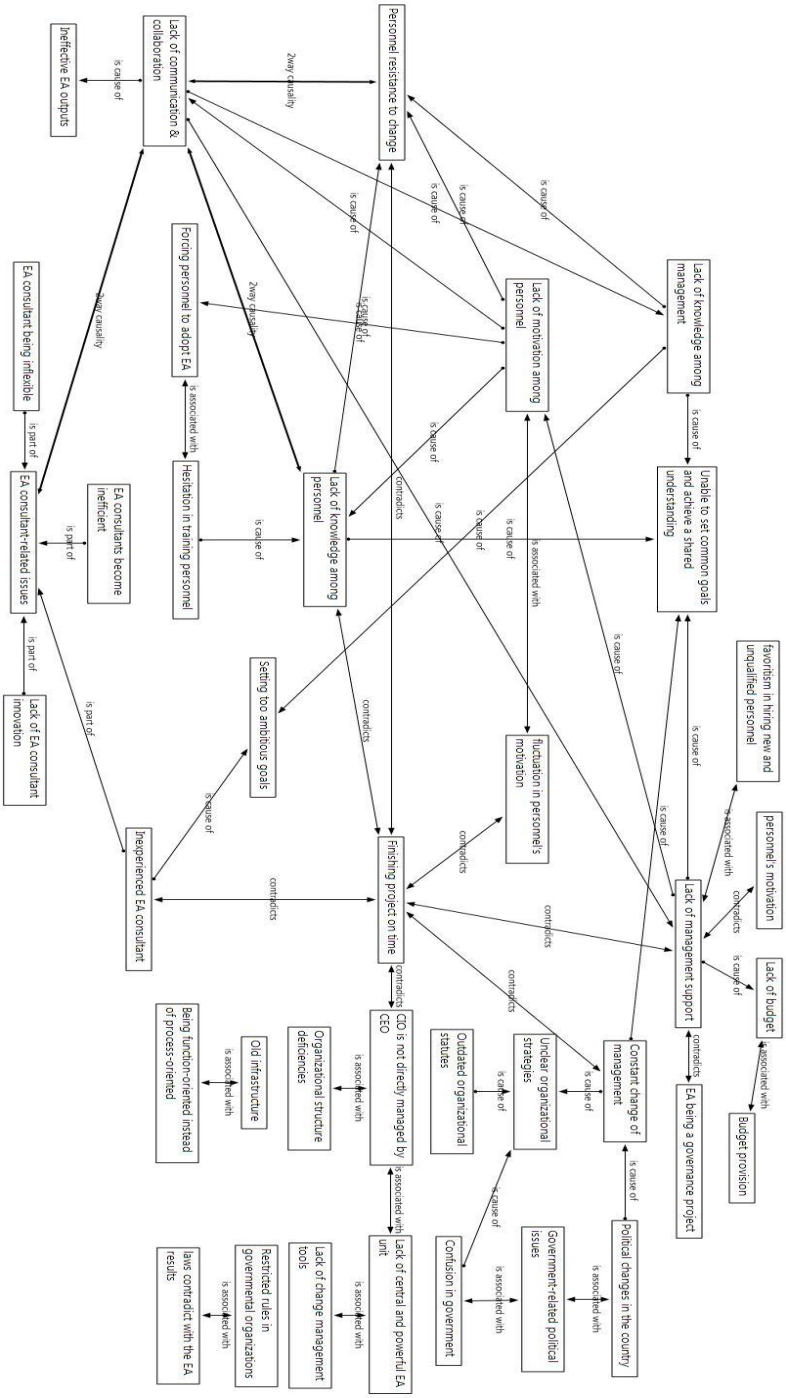

Figure 7 Network diagram of the identified obstacles and their relationships

3.6 Summary

This chapter described the research problem and methods used to accomplish the research in this dissertation. Table 5 presents the phases of this study.

Table 5 Summary of research phases

Phase	**Phase 1**	**Phase 2**	**Phase 3**	**Phase 4**
Research questions	-What is the role of EA in EI?	-What issues hinder integration?	-What are the obstacles in EA development?	-How are different obstacles related to each other, and is there a core obstacle that explains most of the others?
Data collection method	-Systematic literature review	-Theme-based interviews	-Theme-based interviews	-Use of existing semi-structured and theme-based interviews from two previous studies. -Organizational documents
Interview round	No interview data	Rounds 0 and 1	Round 2	Rounds 1 and 2
Data analysis method	-Systematic mapping study	-Grounded theory analysis	-Multiple case study -Grounded theory analysis	-Grounded theory analysis
Reporting	*Publication I*	*Publication II*	*Publication III*	*Publication IV*

4 Overview of publications

This chapter presents the most important results of this study contained in four publications. The four publications, attached as an appendix to this dissertation, comprise the results in detail. All of the publications (*Publications I, II, III, and IV*) are published in peer-reviewed scientific journals and conference proceedings. This chapter provides an overview of the publications and their objectives, results, and how each relates to the larger theme of the dissertation.

4.1 Publication I: What do we know about the role of enterprise architecture in enterprise integration? A systematic mapping study

4.1.1 Research objectives

The objective of this study was to survey and analyze the existing literature on the intersection area of EA and EI and to identify the gaps and state-of-the-art research. Through this study, the following research questions were answered: What are the main research foci in the literature about the role of EA in EI? What are the most common research methods and publication types applied? How has the number of publications changed over time?

4.1.2 Results

This paper provided a comprehensive overview on the intersection of EA and EI. In this study, 50 articles regarding the role of EA in EI were investigated. Applying *"enterprise architecture" AND ("enterprise integration" OR "enterprise interoperability" OR "enterprise coordination" OR "enterprise coherence" OR "integration of enterprise" OR "coordination of enterprise")* as the search string, inquiries were made from the following databases: ACM Digital Library, Citeseer, Business Source Complete and Academic Search Elite of EBSCO, Emerald Insight, IEEEXplore Digital Library, ScienceDirect, and SpringerLink.

When conducting this study, it became apparent that almost two thirds of the studies focused on frameworks and conceptual models. Furthermore, studies rarely focused on the experiences of the persons involved in EA and EI, and most of the studies focused on evaluation research, emphasizing the development and implementation of EA and EI in practice (Banaeianjahromi and Smolander, 2016). Additionally, the Delphi-method, surveys, or Grounded theory were not widely used in the field.

In this publication, selected literature was categorized based on their research focus into the following categories: EA framework, EI framework, enterprise interoperability, Service-Oriented Architecture (SOA), and enterprise engineering. Articles included in the

EA framework category focus on different EA frameworks, models, and tools to implement and develop EA in order to achieve integration. For instance, Richardson et al. (1990) state that EA interrelates data, hardware, software, and communication resources to support business functions and manage decision-making. Kim et al. (2006) referred to EA as a solution that enterprises take to address integration issues. Moreover, several studies have developed EI frameworks to support integration (Chen et al., 1997; Noran, 2013). Enterprise modeling is another approach to achieve EI (Moynihan, 1997; Ni et al., 2007).

A number of studies in the intersection of EA and EI distinguish integration from interoperability (Chen and Doumeingts, 2003; Kosanke, 2006; Panetto and Molina, 2008; Vernadat, 2003). According to Chen and Doumeingts (2003), two integrated systems may be interoperable but not necessarily integrated. SOA has been widely employed as a solution to integration issues (Erol, Mansouri, et al., 2009). In the literature, EA is considered the foundation of enterprise engineering, and EI is treated as an essential part of it (Cuenca et al., 2010; Kosanke and Nell, 1999; Kosanke et al., 1999).

Investigating the number of publications per year in the intersection area of EA and EI, a downward trend in the number of publications from 2010 to 2013 was discovered. According to Mayall (2009), this decline in the number of publications could be due to the economic recession, during which, management considered EA development a costly, low-priority task and chose to postpone it. It was concluded that there was a need for empirical research in this area. Figure 8 illustrates the publication timeline based on the number of articles published per year.

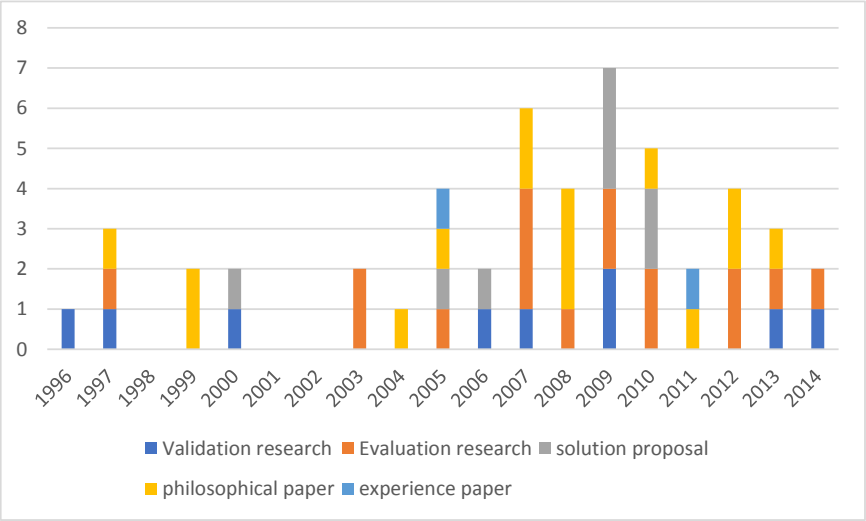

Figure 8 Publication timeline based on the number of articles per year

4.1.3 Relation to the whole

The answer to the main research question of this publication (What is the role of EA in EI?) provided the path for further studies. There was a relationship between EA and EI as reported in several studies. However, no article had investigated the role of EA and EI explicitly. Based on this SMS study, enterprises adopt EA (1) to support business functions and manage decision-making by interrelating data, hardware, software, and communications resources (Richardson et al., 1990), (2) to design and maintain enterprises for their entire life-cycle and to organize existing EI knowledge in the frequently changing environments (Kim et al., 2006), and (3) to achieve EI (Goethals et al., 2006; Bernus and Nemes, 1996; Erol et al., 2010; Hoogervorst, 2004; Kilpeläinen, 2007; Anaya and Ortiz, 2005; Kang et al., 2010; Toh et al., 2009; Zheng and Zheng, 2013).

The results of this study indicated that EA and EI frameworks and conceptual models have been thoroughly studied in the literature, and so it was deemed redundant to continue in that direction with further research. The decision was made to conduct research using empirical data using the Grounded theory method as the main research method.

4.2 Publication II: Integration obstacles during ERP development

4.2.1 Research objectives

The aim of this publication was to provide a better understanding of integration in the context of the ERP (Enterprise Resource Planning) system. The purpose was to investigate the issues that hinder integration projects. The research questions for this study were (1) *what issues hinder integration?* and (2) *how do issues hindering integration relate to general ERP development challenges?* The study was an explorative, qualitative study, with data collected from 5 large organizations via theme-based interviews.

4.2.2 Results

The research was continued by employing empirical data to understand the integration obstacles (*Publication II)*. This study mapped the integration challenges from literature into the integration obstacles found in the data. The identified obstacles were categorized into 4 themes of environmental, technical, managerial, and organizational obstacles.

The findings reveal that integration should not only be considered a purely technical challenge, but other perspectives of integration, such as environmental, managerial and organizational, should be considered as well. The interrelationship between the identified obstacles derived from data and general ERP challenges in the literature shows that integration should not be considered a separate task while developing ERP.

4.2 Publication II: Integration obstacles during ERP development

This article contributed to the field of EI by comparing our findings with literature and identifying new challenges that had not been widely covered in the ERP literature before such as political sanctions, management of product licenses, a lack of measurements for integration projects, discovering a way to satisfy customers by integrating, a lack of previous experience on integration projects, and a lack of company-wide policies for integration. Several enterprise application integration challenges and barriers have been studied before by Hung et al. (2015), Lam (2005), and Themistocleous (2004). The findings of *Publication II* can be considered an extension to the previous list of integration challenges in literature.

Furthermore, the study shows that it is crucial to maintain architectural descriptions of the interconnected systems to facilitate the identification of integration needs and requirements. Table 6 presents the identified integration obstacles and their relations with the ERP challenges obtained from the literature. Table 6 provides an answer to the main research question of this publication (What issues hinder integration?).

Table 6 Main themes, literature categories and integration obstacles

Main themes	**Categories of general ERP challenges from the literature** (Finney and Corbett, 2007; Nah et al., 2001; Aloini et al., 2007; Momoh et al., 2010; Ngai et al., 2008; Shaul and Tauber, 2013; Dezdar and Sulaiman, 2009)	**Integration obstacles derived from data**	**Cases**
Environmental obstacles	**Intra-organizational environment** Issues related to organizational culture as well as organization's experience in ERP projects	Complicated end product	P
		Inexperience in integration projects	P, M
		Heterogeneous operating environment	R
		Different strategic interests of business units	P
	Inter-organizational environment Issues related to external environment such as conflicts between the organizations, poor management of partnerships with these organizations and underperformance of either vendor or consultant	Sanctions in licensing	M
		Competitors taking new technologies into use	P, R, M
		Failing to commit customers in integration projects	P, K

		Discovering a way to satisfy customers by integration	P, M
Technical obstacles	**ERP-product selection & implementation strategy** Issues regarding selecting and comparing different ERP products	Selecting unsuitable integration technologies	P
		Troublesome management of integration product licenses	P, M
	ERP system characteristics Issues related to the lack of ERP system's quality	Design flaws in ERP system	P
		ERP system's incompatibility	P
	IT-infrastructure & legacy systems Problems in integrating the ERP system with other systems and converting the data between the systems as well as managing the master data	Characteristics of integrative systems	P, Q
		Complex systems landscape	P, D
		Troublesome migration	P, Q
	ERP software development & configuration Issues dealing with requirement specifications definition and changes, system configuration, and software development tools and methods. Also, issues related to troubleshooting and functional testing of the software	Poor evaluation of integration requirements	P
		Slow development process	P, Q, R
		Inadequate testing of integration	P
		Lack of knowledge on integration	P, M
Managerial obstacles	**Business visioning & planning** Issues in the creation of the business case for the system, setting up business goals and justifying the ERP acquisition financially	Cost-cutting hindering integration projects	P
		Insufficient identification of business needs & evaluation of the benefits of integration	P
	Organizational management & leadership	Top management does not understand integration	P, R, K

	Issues related to top-level management involvement, capabilities and actions in the project	Top management does not support integration	P, K, M
		Lack of company-wide policies for integration	P, K
	Project management Issues regarding project scope, responsibilities, and resources. Also, issues related to crisis and expectation management	Troublesome management of integration projects	P
	Project team & human resources Challenges related to structure and composition and skills of the people in the project team. Also, issues related to empowerment, motivation, and incentives	Lack of integration experts	K
		No dedicated persons for integration	K
	Quality management & evaluation Challenges related to measuring the performance and acceptance of the system	Not measuring integration projects	P
Organizational obstacles	**Change management** Issues related to business process re-engineering, training, and education. Also, factors related to misunderstanding the change caused by the system and its implication to organizational culture, personal factors, and political issues	The need for comprehensive training	P, R, K
		Personnel change resistance	P
	Communication & coordination Factors related to communication style, coverage, and planning. In addition, issues related to knowledge management and unsuitable communication tools	Lack of collaboration	P, K, M

4.2.3 Relation to the whole

This study investigated the integration obstacles during ERP development. Furthermore, this study revealed one of the major issues that hindered the integration projects to be the architectural descriptions of the interconnected systems. Contributing to the larger theme, the results of this study highlighted the importance of EA during integration projects. *Publication I* began the search for the relationship between EA and EI. By starting the investigation with the EI challenges, the understanding followed that in order to have a successful integration project, it is crucial to maintain architectural descriptions of the

interconnected systems. The results of this study formed the basis for the subsequent studies targeted towards understanding EA development obstacles.

4.3 Publication III: Understanding obstacles in enterprise architecture development

4.3.1 Research objectives

Publication III presents the obstacles that practitioners faced during EA development projects. According to the literature, architects were faced with several obstacles during EA development, and sometimes, projects have been terminated because of those obstacles. EA development cannot be successful, unless the obstacles are addressed properly. To be successful in EA, it is important to understand the issues that hinder EA development. Thus, this study aims to form a better understanding of EA development obstacles and to provide solutions to remove or avoid those obstacles. The research questions for this study were: (1) What are the EA development obstacles? (2) Are there any relationships among the identified obstacles? (3) What managerial actions can be taken to eliminate the obstacles during EA development?

4.3.2 Results

Based on the results of *Publication II*, the inefficiency of architectural descriptions was understood to be one of the major issues in integration projects. EA is inefficient when it is not up to date, complete, understandable, or in detail. The issue of inefficient EA not only hinders the integration projects but also creates chaos in organizations, as there is no guideline or plan to determine the consequences of actions in the organization. Therefore, it is crucial to have an efficient EA in the organization.

Aiming to increase the understanding of obstacles in EA, 20 semi-structured interviews were conducted with practitioners from 14 large enterprises to identify the EA development obstacles. This thematic, exploratory, and qualitative study using multiple case studies approach identified 20 EA development obstacles, which were then categorized into four main themes: environmental, technical, managerial, and organizational. The Grounded theory technique was employed to analyze the data. Table 7 presents the identified obstacles categorized based on themes and provides an answer to the main research question of this publication (What are the EA development obstacles?).

4.3 Publication III: Understanding obstacles in enterprise architecture development

Table 7 Taxonomy of identified obstacles during EA development

Themes	Identified EA obstacles
Environmental*: issues related to the inter- and intra-organizational environment such as organizational culture and experience in EA projects and issues related to vendors and consultants.*	- Political issues of the government - EA consultant-related issues - Outdated organizational statutes - Restricted rules in governmental organizations
Technical*: issues related to EA tools, infrastructure, outputs, and configuration.*	- Old infrastructure - Lack of change management tools - Ineffective EA outputs
Managerial*: issues related to EA visions and goals, management and leadership, project team and human resource.*	- Lack of management knowledge - Lack of management support - Constant change of management - Inability to set a common goal and understanding - Setting too ambitious goals - Unclear organizational strategies - Budget provision - Organizational structure deficiencies
Organizational*: issues related to EA training and educating personnel, communication and collaboration in the organization.*	- Personnel change resistance - Lack of personnel knowledge - Lack of communication and cooperation - Inefficient human resource department - High costs of training personnel

Five new obstacles that have not been mentioned in the literature before were identified: political issues, EA consultant-related issues, outdated organizational statutes, constant change of management, and inefficient human resource department. Several EA development challenges and issues have been studied before, for example, by Lucke et al. (2010), Roth et al. (2013), and Isomäki and Liimatainen (2008). *Publication III* can be considered an extension to the previous list of EA challenges in literature. *Publication III* also presents management recommendations during EA development in order to remove or to avoid obstacles.

4.3.3 Relation to the whole

As *Publication II* showed, architectural descriptions play an important role in integration projects, with incomplete, not up-to-date, incomprehensible, or vague EA descriptions leading to inefficiency in EA development. This lead to *Publication III*, where EA development obstacles were studied to understand what the reasons behind EA inefficiency that hinder integration projects are.

In *Publication III*, the EA development obstacles were identified and recommendations to facilitate the development of EA were suggested. This publication shed light on how practitioners experience EA obstacles. In *Publication III*, it was observed that the identified obstacles were related to each other, which lead to *Publication IV*, where the relationships between different obstacles were studied.

4.4 Publication IV: Lack of communication and collaboration in enterprise architecture development

4.4.1 Research objectives

Publication IV was an extension to *Publication III*. This publication presented obstacles in pre-development, development, and post-development phases of EA development projects. The aim of this publication was to present the relationships between EA obstacles and to find a core obstacle that can explain many other obstacles. After identifying the lack of communication and collaboration as the core obstacle, this study also proposed approaches to improve it during EA development. The research questions of this study were: (1) What are the obstacles in EA development? (2) What obstacles repeat themselves during the stages of EA development? (3) How are different obstacles related to each other, and is there a core obstacle that explains most of the others?

4.4.2 Results

In *Publication IV*, data from rounds 1 and 2 was utilized in addition to the organizational documents related to EA projects received from interviewees. In this publication, the repetition of EA obstacles was studied during three stages of EA development: pre-development, development, and post-development; and it was observed that if the organization does not address these obstacles properly before starting the EA project, the obstacles will persist throughout all stages of development, and thus endanger the entire project.

To answer the main research question of this publication (How are different obstacles related to each other, and is there a core obstacle that explains most of the others?), the relationships between different obstacles were identified. As the possibly most impactful goal of this study was to identify a core obstacle that can explain other obstacles, only the causal relationships between obstacles were considered. Based on the analyses, the lack of communication and collaboration was recognized as the core obstacle that can explain most of other EA development obstacles. Figure 9 illustrates the emergence of the core category.

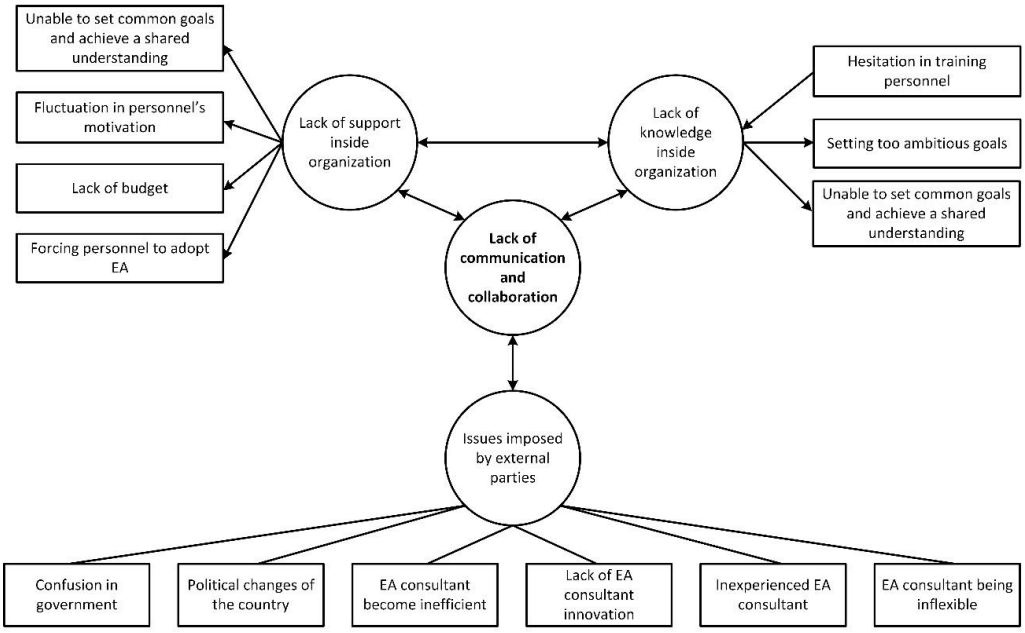

Figure 9 The emergence of the core category

Lack of support inside organization, lack of knowledge inside organization, and issues imposed by external parties were identified as the general obstacles that can all cause and have effects on the lack of communication and collaboration in EA development. I further investigated the lack of communication and collaboration by revisiting the data from this perspective. Besides the three general obstacles, 11 causes (white boxes) and 6 effects (gray boxes) of the lack of communication and collaboration were identified. Figure 10 illustrates all identified causes and effects.

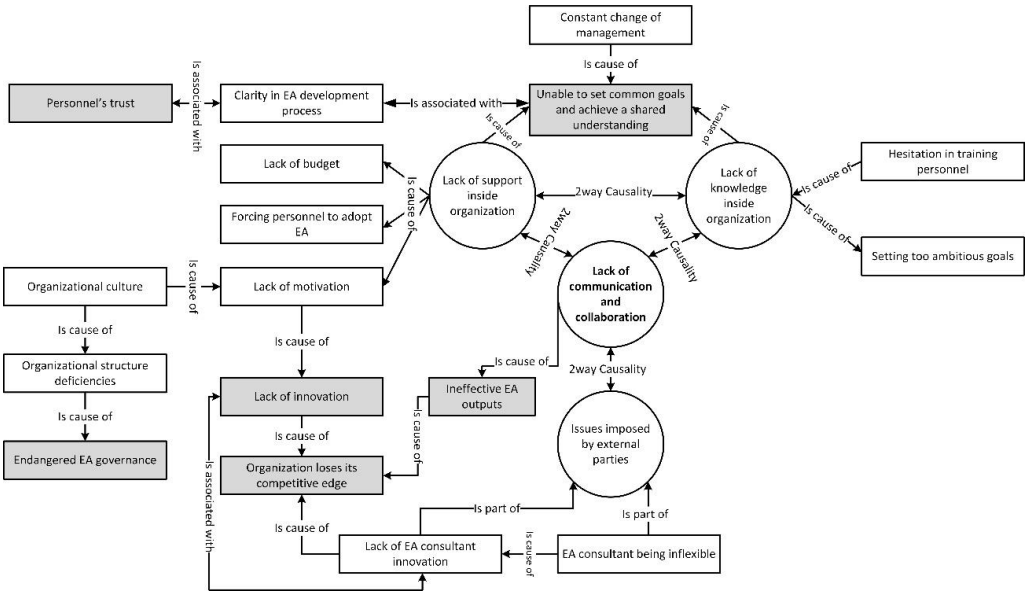

Figure 10 Causes and effects of the lack of communication and collaboration

In literature, a number of studies have already addressed the challenges and obstacles that practitioners face in EA development (Armour and Kaisler, 2001; Bricknall et al., 2006; Chuang and van Loggerenberg, 2010; Hauder et al., 2013; Isomäki and Liimatainen, 2008; Iyamu, 2009; Jahani et al., 2010; Kaisler et al., 2005; Löhe and Legner, 2014; Lucke et al., 2010; Nikpay et al., 2013; Roth, Hauder, Farwick, et al., 2013; Saarelainen and Hotti, 2011; Seppänen et al., 2009; Valtonen et al., 2011; Wan et al., 2014; Ylimäki, 2008); however, none of these studies has gone further than proposing taxonomies. In *Publication IV*, the aim was to increase the understanding of EA development obstacles and to extend the body of knowledge by investigating the relationships between obstacles in order to find the core obstacle. While previous studies have focused mostly on identifying obstacles in the development stage of EA development, *Publication IV* extended the scope of analysis to the stages of pre-development and post-development.

4.4.3 Relation to the whole

Publication IV identified a core obstacle that can explain other obstacles during EA development. After analyzing the EI challenges, it became apparent that architectural descriptions are major issues in integration projects. The literature already showed that architects are faced with many obstacles during EA development, and sometimes, projects are terminated because of those obstacles. Therefore, it became vital to investigate these obstacles during EA development. When analyzing the data, communication and collaboration was determined to be a core obstacle that can explain other obstacles. Approaches to facilitate communication and collaboration during EA development were proposed, and EI was identified as an action to improve communication and collaboration during EA development.

5 Discussion

This chapter presents the theoretical and practical contributions and implications of this dissertation by extracting the results from different publications and presenting them as a summary. Later in this chapter, the dissertation is evaluated and the limitations of the research are discussed.

5.1 Theoretical contributions and implications

This study contributed to the field of information systems by addressing the intersection scope of EA and EI. In particular, the research concentrated on addressing obstacles during EA and EI development in large organizations. This research also focused on the communication and collaboration aspect during EA development as a core obstacle that explains many others. This led to the realization that in order to face fewer obstacles during EA development, organizations should improve communication and collaboration before embarking on EA development.

The information gathered during different phases of this research improves the understanding of EA and EI obstacles in practice. This study contributes to the EA and EI research domain by moving forward and studying not only the obstacles, but also the relationships between the obstacles, and by providing a map of logical relationships between EA obstacles. The results of this study shed light on the obstacles faced by practitioners in EA and EI development. Furthermore, this research provides guidelines to assist practitioners in preventing the obstacles from occurring.

5.1.1 The role of EA in EI

The first goal of this study was to understand the role that EA plays during EI projects in an organization. The study began with a systematic mapping study to provide an answer to the research question: *What is the role of EA in EI?* This question was answered in *Publication I* through the literature review and identifying the most relevant papers in the intersection area of EA and EI. The selected papers were classified with respect to research focus, research method, and paper type.

Five main categories of research focus were identified: EA framework, EI framework, enterprise interoperability, SOA, and enterprise engineering. It was discovered that most papers in this area focused on EA frameworks to achieve or maintain integration. For example, Kim et al. (2006) proposed EA frameworks as the optimal solution to address the integration issues of information systems. Goethals et al. (2006) pointed out that constant re-architecting of the enterprise is crucial to achieve integration.

Investigating the publication timeline based on a number of articles from 1996 to 2014 revealed an especially strong upward trend in the last decade. However, it became evident that between 2011 and 2013, the number of publications in this area decreased from 16

into 9. According to (Mayall, 2009), this decline in the number of publications could be due to the financial stress imposed on organizations by the economic recession, because management often considers EA development as a luxury project with a low priority and postpones it.

5.1.2 Enterprise integration obstacles

The second goal of this research was to understand integration based on empirical data. Therefore, integration obstacles during an information system project, such as ERP development, were investigated. The main research question here was: *What are the issues that hinder integration projects in organizations?* Results presented in *Publication II* provide the answer to this question.

It was found that the term 'integration' as a concept is surrounded by confusion (Chowanetz et al., 2012; Gulledge, 2006; Lee and Myers, 2004). For instance, it is not clear whether integration is an outcome of a project or a technical feature (Chowanetz et al., 2012). We aimed to understand the nature of integration by examining the issues that hinder it. As a result of this study, 31 integration obstacles were identified. In addition to technical aspects, this study reveals other aspects of integration obstacles, such as environmental, managerial, and organizational. The study also revealed that integration is tightly coupled with ERP development and should not be considered a separate task. Integration is a continuous effort that requires attention during any information system development life cycle.

As another result in *Publication II*, some integration obstacles that had not been mentioned in literature before were identified such as political sanctions, management of product licenses, a lack of measurements for integration projects, discovering a way to satisfy customers by integration, lack of previous experience in integration projects, and a lack of company-wide policies for integration. This study also highlighted the importance of maintaining the architectural descriptions of the organization in order to facilitate the identification of integration needs and requirements.

5.1.3 Enterprise architecture obstacles

Concerning the architectural descriptions as an issue during integration projects, the main questions were: what are the problems with architectural descriptions of the organizations? why do these problems hinder integration? and what are the consequences of these problems?

From data 4, problems with the architectural descriptions of the organizations were identified: (1) not being up-to-date, (2) not being in detail, (3) not being understandable by the integration team, and (4) not being complete. The consequence of these architectural problems brought chaos and confusion to the organizations as:

1) People act as they want without considering the effect of their actions on the whole organization.
2) There was no proper big picture of the organizational systems and roles in the organizations
3) The opinion of the architects did not have any power in organizational governance
4) There was no future plan to enhance the agility of the organizations in order to respond quickly to the environmental changes
5) No change management
6) People from different departments of the organization could not understand each other
7) Redundancy and high costs existed in the organization

Understanding architectural descriptions of an organization is a major issue during integration projects, and the realization of the negative consequences of this issue in the organizations can be a solution to the issue itself. However, it is clear from the literature that it is difficult to find a successfully developed EA in an organization (Iyamu, 2009). In theory, EA has been well-developed by focusing on frameworks and methods (Bernus and Noran, 2010; Erol et al., 2010; Fatolahi et al., 2007; Hoogervorst, 2004), but in practice, architecture teams are faced with a lot of obstacles in developing and maintaining EA (Armour et al., 2007). Sometimes, these obstacles even cause project termination and failure. Therefore, it is vital to improve the understanding of obstacles that practitioners face during EA development projects.

The third goal of this research was to understand EA development obstacles by answering the following research question: *What are the obstacles in EA development?* The results are presented in *Publication III* and *Publication IV*.

In *Publication III*, 20 obstacles that prevent architects from developing error-free EA were identified. These obstacles were classified into environmental, technical, managerial, and organizational categories. While investigating these obstacles, it was found that there are logical relationships between EA development obstacles, investigated further in *Publication IV*.

Analogous to previous literature, five obstacles were identified that had not been mentioned in the literature before: political issues, EA consultant-related issues, outdated organizational statutes, constant change of management, and an inefficient human resource department. In *Publication III*, some guidelines were provided based on managerial advice in order to remove or avoid obstacles during EA development.

5.1.4 Communication and collaboration during EA development

After *Publication III*, it became evident that there are logical relationships between identified obstacles during EA development. Therefore, the fourth aim of this research was to identify these relationships and to look for a core obstacle that could address other obstacles. The main research question at this stage of research was*: How are different obstacles related to each other, and is there a core obstacle that explains most of the others?*

Publication IV investigated the relationships between EA development obstacles and reached the conclusion that there are logical relationships between different obstacles.

From the analysis, eight obstacles were identified that occurred more frequently than others across the stages of EA development (pre-development, development, and post-development) . These obstacles are:

(1) Lack of communication and collaboration
(2) Lack of management support
(3) Lack of knowledge among management
(4) Lack of motivation among personnel
(5) Lack of knowledge among personnel
(6) Personnel resistance to change
(7) EA consultant-related issues
(8) Government-related political issues

To simplify the network diagram presented in Figure 7, we decided to move to a higher level of abstraction explained in Table 8.

Table 8 Higher level of abstraction

Higher level of abstraction	**Most frequently repeated obstacles**
Lack of support inside the organization	Lack of management support
	Lack of motivation among personnel
	Personnel resistance to change
Lack of knowledge inside the organization	Lack of knowledge among personnel
	Lack of knowledge among management
Issues imposed by external parties	EA consultant-related issues
	Government-related political issues
Lack of communication and collaboration	Lack of communication and collaboration

Five types of relationships between different EA development obstacles were identified: is part of, is cause of, is associated with, and contradicts. In order to identify a core obstacle that can explain others, the focus was placed on *is causal* relationships. It was

clear that most of the obstacles were directly or indirectly related to the lack of communication and collaboration. Figure 9 presented the emergence of the core category.

Identifying the lack of communication and collaboration as the core obstacle directly leads to a search for the cause of the obstacle in EA development projects – what are the causes and effects of the phenomenon? What specifically leads to these three general obstacles related to the core obstacle? In addition to the lack of knowledge and support inside the organization and issues imposed by the external parties, 11 causes (white boxes) and 6 effects (gray boxes) of the lack of communication and collaboration in EA development were identified.

It was concluded that in order to become successful in EA development, organizations should first improve and solve the issues related to communication and collaboration before initiating the EA development project. *Publication IV* revealed that organizational culture was an important issue in communication and collaboration during EA development. Organizational culture affects the motivations of personnel to communicate and collaborate actively. Clarity in the process of EA development will improve the collective understanding in the organizations, which may consequently increase trust and satisfaction among employees and may motivate them to communicate and collaborate better in EA development.

One of the characteristics of *Publication IV* in contrast to previous literature regarding EA obstacles is that in *Publication IV,* obstacles were investigated in all the EA development stages: Pre-development, development, and post-development. Most of previous literature focused on the development stage (Ylimäki, 2008; Seppänen et al., 2009; Nakakawa et al., 2010; Chuang and van Loggerenberg, 2010; Roth, Hauder, Farwick, et al., 2013; Hauder et al., 2013; Nikpay et al., 2013; Löhe and Legner, 2014; Aalst et al., 2010); a few also covered the pre-development stage of EA development obstacles (Jahani et al., 2010; Lucke et al., 2010). No article was found to discuss the EA obstacles in the post-development stage.

Comparing the findings with the previous research in this area, I concluded that:

(1) Organizational culture influences the motivation of personnel in EA development.
(2) Clarifying the EA development process to the personnel will result in their trust and collaboration.
(3) Instability in the organization, which is caused by constant change of management and their lack of support causes the personnel to lose motivation when collaborating in the EA project. Consequently, the organization faces a lack of innovation and loses its competitive edge.
(4) EA must be defined on the highest level in the organizational structure in order to be successful and effective.
(5) It is crucial that organizations address their communication and collaboration issues before initiating EA development, because obstacles, such as the lack of

communication and collaboration, will persist throughout the development stages and constantly hinder the project.

5.2 Practical contributions and implications

The initial goal of this dissertation was to identify the role of EA in EI. The research began by investigating the EI obstacles (*Publication II*), which led to the realization that integration is not only about technical issues, but also involves the environmental, managerial, and organizational aspects. This study can help practitioners understand the integration obstacles better. In order to face fewer obstacles during integration projects, it is crucial that the integration team is selected from experienced people who have enough knowledge about integration projects.

This study also revealed the importance of maintaining architectural descriptions of organizational systems to facilitate integration. Focusing on the architectural description issue during integration, the goal was to understand what the problems and the consequences were. This goal was reached when EA was found to be a solution to facilitating integration by maintaining architectural descriptions; but it became apparent that EA development is not an easy task to accomplish, and that most EA development projects are not completed successfully. This lead to the need to study the factors that prevented EA from being complete and successful.

Publication III discusses obstacles in large organizations during EA development. In this publication, 20 obstacles that practitioners faced during EA development were presented. The themes of these obstacles were environmental, technical, managerial, and organizational. Further, *Publication III* also presents recommendations for practitioners during EA development in order to remove or avoid obstacles.

To eliminate consultant-related issues, managers suggested:

- Choosing an EA consultant that is easily reachable.
- Choosing a more experienced consultant.
- Getting a free pilot test from consultants to check the quality of their work.
- Being more restricting with the EA consultant on the timetable.

To eliminate change resistance issues:

- Involving the resisting entities more during EA development.
- Educating personnel, instead of just making them familiar with EA.
- Tighter cooperation of personnel and the EA consultant.

To eliminate the risk of failure:

- Plan the project as accurately as possible.
- Apply a strategic plan.
- Provide the EA consultant with the most accurate data.
- Consider the timing of your EA development.
- Get consultants from EA experts outside of the company.
- The IT department should directly be supervised by the CEO.
- Employ motivated and creative personnel.
- Promote systems thinking in the organization.

To increase and maintain the current and future use of EA:

- Regular updates to EA.
- The EA consultant participates and makes suggestions in the tender to select a vendor to implement EA results.

Publication IV took the investigation of obstacles during EA development to the next level by analyzing the relationships between different obstacles. Additionally, the aim was to identify the core obstacle that can explain other obstacles. The analyses revealed that a lack of communication and collaboration was the core obstacle that can explain most obstacles. This part of the research can help practitioners forecast the issues that they might face during an EA project. Furthermore, the causes and effects of a lack of communication and collaboration were investigated in this publication. *Publication IV* concluded that to experience fewer obstacles in EA development, practitioners should solve communication and collaboration issues before embarking on an EA project. Later in the research, organizational culture and clarity in the process of EA development were identified to influence trust and satisfaction among personnel and to motivate them to communicate and collaborate better in EA development.

This research provided good insight for both practitioners as well as researchers to understand the relationships between different EA obstacles and the causes and effects of a lack of communication and collaboration in EA development. *Publication IV* provided the following recommendations for practitioners to address obstacles that hindered communication and collaboration in EA development:

Be clear and precise about the EA development process to increase the trust of the personnel: feeling threatened and insecure about their jobs, employees resist

collaborating in the EA project. Although managers reassure personnel that EA development does not threaten their jobs, based on the findings, employees do not trust and collaborate in the project as expected. Improving the knowledge of the personnel through educational seminars and courses will add trust and reduce resistance. It is crucial to clarify the processes and steps of EA development and its effects on the jobs of the personnel before initiating the EA development.

Motivate personnel to communicate and collaborate in order to bring innovation to the EA development: organizations should motivate and encourage their personnel to collaborate in the EA project. A strong leader is required to increase the motivation of the personnel to communicate and collaborate. Based on the findings, employees become motivated to communicate and collaborate when they see that their manager is actively involved and supportive of the EA project.

EA must be placed on the highest level of the organization: decisions and issues regarding EA development must be discussed with the high-level management of the organization. In order to be successful in EA development, the EA development project must have full support of the management.

EA team should consist of not only EA experts, but also non-EA experts from other departments: EA should be developed in such a way that people from different departments can understand its descriptions. To improve the comprehensibility of EA, it could be useful to have at least one person from each department of the organization in the EA team.

The above considerations are possible via:

- Formal meetings on the management level
- Informal meetings (during lunch and coffee breaks)
- Official letters
- Educational seminars on the management level
- Educational seminars on the employee level
- EA consultant training of personnel through close collaboration
- Documentation
- Outsourced training
- Internal WIKI
- CEO directly managed by CIO

- Reward systems
- E-learning systems
- Intranets
- Q&A sessions with personnel

5.3 Validity and limitations of the research

According to Corbin and Strauss (2008 p. 297), an evaluation of quality is necessary, but what it should consist of is unclear. As Seale (2002 p. 102) pointed out, *"quality is elusive, hard to specify, but we often feel we know it when we see it. In this respect research is like art rather than science."* There are no generally accepted guidelines or evaluation criteria for validation in qualitative research, and the issue of validation is surrounded by confusion (Venkatesh et al., 2013; Winter, 2000).

One of the most cited definitions of validity is that of Hammersley (1992 p. 69): *"An account is valid or true if it represents accurately those features of the phenomena, that it is intended to describe, explain or theorise."* For some researchers, validity is not just a singular test that can be applied to the whole research process (Winter, 2000). For example, Maxwell (1992) proposed five typologies of validity for qualitative research based on different stages of research: descriptive validity, interpretive validity, theoretical validity, generalizability, and evaluation validity. These categories were considered suitable to judge the validity of the research, as this is a piece of qualitative research, and many researchers have applied these categories to their research to judge the validity of their work.

Descriptive validity

Descriptive validity is concerned with the initial stages of research such as data collection. The main concern is with the factual accuracy of the things that the researcher reports. Descriptive validity means the accuracy of information that the researcher observed, recorded, and reported (Maxwell, 1992). In this research, interviews and organizational documents were used to collect data. Interviews were audio-recorded to ensure accuracy and minimize misinterpretations during transcription. The accuracy of the organizational documents was checked by the organizations, and their validity was confirmed by their representatives.

Although interviews during qualitative data collection provide depth by allowing researchers to gain deep insights from rich narratives (Venkatesh et al., 2013), there are some concerns regarding collecting data through interviews (Hammersley, 2003). The main concerns are erroneous statements and bias of the interviewees, who are not trained objective observers and have their own innate biases outside of the interview situation (Hammersley, 2003). This issue was addressed by interviewing more than one person

from each organization, whenever possible. Furthermore, organizational documents were used to query the data in addition to the interviews to reduce bias. To address descriptive validity, in one of the publications (*Publication II*), the data was analyzed by two researchers, and their interpretations of the data were constantly compared. However, it should be noted that most of the data collected for this research were gained through interviews, and shortcomings should not be forgotten.

Interpretive validity

Interpretive validity is about the accuracy of interpreting what is going on in the minds of the people engaged and how accurately the researcher understood the perspective of the participant when trying to improve the interpretive validity of this research; the interpretation of an issue was confirmed either during the interview or later, via e-mail and other online forms of communication. Also, some of the interviews were analyzed by more than one researcher, which increases the validity of the analyses. As the publications that make up this dissertation have all been published in peer-reviewed scientific journals and conference proceedings, together with the co-authors, researcher bias can be considered diminished.

Theoretical validity

Theoretical validity is a more abstract analysis than descriptive and interpretive validities, addressing the *"immediate physical and mental phenomena studied"* (Maxwell, 1992). It means the degree to which the developed theoretical explanation fits the data and is therefore credible and defensible.

In this research, the qualitative research method was used to gather data and build theory iteratively. The issue of theoretical validity is tackled by explaining how the theory evolved from data step by step. The case organizations were selected from various industries and two countries not only to address the theoretical validity, but also to improve the generalizability of this research.

Generalizability

Generalizability refers to the degree that an account of a particular situation or population can be extended (Maxwell, 1992). It means the ability to generalize the findings to a wider range of groups and situations. According to Maxwell (1992), generalization in qualitative research is more difficult than quantitative research. Generalization in qualitative research happens through theory development, which is normally based on assumptions that the theory may be applicable to similar populations or situations (Yin, 2013; Maxwell, 1992).

Yin (2013), defines two types of generalization: statistical generalization and analytical generalization. He defines statistical generalization as occurring when *"an inference is made about a population (or universe) on the basis of empirical data collected about a sample"*. Statistical generalization critically depends on the sample size and variation of

the sample and population (Meredith, 1998). In contrast, analytical generalization is that in which *"a previously developed theory is used as a template with which to compare the empirical results of the case study. If two or more cases are shown to support the same theory, replication may be claimed"*.

Eisenhardt (1989), Glaser and Strauss (1967), and Yin (2013) describe statistical and analytical generalization in terms of sampling by considering that the purpose of statistical sampling is to get statistically accurate evidence of the distributions of variables within the population. However, the purpose of theoretical sampling is to *"replicate or extend the emergent theory by identifying extremes, polar types (opposite situations along some dimension), or candidates for niche situations to help discover categories, properties, and interrelationships that will extend the theory"* (Meredith, 1998).

Lee and Baskerville (2003) argue that generalizability does not always need to have a statistical or a quantitative dimension, proposing a generalizability framework that consists of four types of generalizability: (1) generalizing from data to description, (2) generalizing from description to theory, (3) generalizing from theory to description, and (4) generalizing from concepts to theory. With this framework in mind, this research falls under the second form of generalizability, generalizing from description to theory, which is the base idea of grounded theory.

The findings of this research are related to enterprise architecture and enterprise integration projects in large organizations, and the findings can be used as guidelines and recommendations when extending to other areas or populations. The data to conduct this research was gathered from large Iranian and Finnish organizations.

Evaluative validity

Evaluative validity refers to the application of an evaluative framework (Maxwell, 1992). As pointed out by Maxwell (1992), evaluative validity is not as central as other types of validity for qualitative researchers. According to (Winter, 2000), *"recognising that evaluation of some sort is an inescapable inevitability within research, enables the control of that evaluation, and offers a measurement of the research in terms of its overall 'validity.'"* As this dissertation consists of four scientific publications, most of the evaluation has been done by the scientific communities of journals and conferences.

6 Conclusions

This dissertation employed empirical research methods to study the intersection area of enterprise architecture and enterprise integration in large Finnish and Iranian organizations. This chapter summarizes the contribution of this research and outlines directions for future work.

6.1 Contributions and summary

The scope of this research was limited to investigating EA and EI obstacles in large organizations to understand the role of EA in EI. The dissertation was divided into four phases. The first phase reviewed the literature to scope out the existing domain of knowledge and gaps in research. The second phase investigated enterprise integration obstacles and identified architectural descriptions as one of the issues in integration projects. In the third phase, obstacles during EA development projects were studied. The fourth phase investigated EA development obstacles further and the relationships between obstacles.

The results of this research provide good insight regarding enterprise architecture and enterprise integration in the large organizations. It provides new knowledge on enterprise integration obstacles, such as how the issue of architectural description can be addressed through the successful development of enterprise architecture. The results of this dissertation are presented for both researchers and industrial practitioners in the following list:

Results related to the EI:

- Integration is not just about technical challenges, but other perspectives of integration obstacles, such as the environmental, managerial, and organizational obstacles, should also be considered.
- Integration projects should be regarded as a systematic and well-planned activity that involves multiple systems and stakeholders.
- Communication and collaboration are crucial among the stakeholders during integration projects.

Results related to the intersection area of EA and EI:

- As integration is a complex project, it is necessary to maintain architectural descriptions of organizational systems.
- It is crucial for organizations to have accurate, up-to-date, complete, and understandable architectural descriptions.
- Not having accurate, up-to-date, complete, and understandable architectural descriptions puts organizations in danger of chaos, as people do as they please

without considering the consequences of their actions on other parts of the organization. This situation is especially problematic in integration projects.

Results related to EA:

- Enterprise architecture development obstacles are more social than technical.
- Communication and collaboration could be key to addressing obstacles during EA development.
- It is crucial for the organizations to improve communication and collaboration before embarking on EA.
- Organizational culture influences the motivation of personnel in EA development.
- Clarifying the EA development process to the personnel will result in their trust and collaboration.
- Instability of the organization, which is caused by the constant change of management and their lack of support, causes the personnel to lose their motivation to collaborate in the EA project. Consequently, the organization faces a lack of innovation and loses its competitive edge.
- It is crucial that organizations address their communication and collaboration issues before initiating EA development, because obstacles, such as the lack of communication and collaboration, will persist throughout the development stages and constantly hinder the project.
- To improve communication and collaboration within an organization, it was recommended:
    - To be clear and precise about the EA development process to increase personnel's trust.
    - To motivate personnel to communicate and collaborate in order to bring innovation to EA development.
    - To place EA on the highest level of organization.
    - To build the EA team not only from EA experts but also non-EA experts from other departments.
- An enterprise architecture project is not a one-time project and requires constant attention and updates during the organization's lifecycle.

To summarize, (1) in order to improve enterprise integration projects, architectural descriptions of an organization should be accurate, up-to-date, complete, and understandable. Enterprise architecture can address this need of the organization. However, having accurate, up-to-date, complete, and understandable EA is not easy to accomplish. (2) Communication and collaboration play a critical role in EA development, as they can improve the knowledge of the personnel, reduce the resistance to change, reduce EA consultant-related issues, and increase the motivation. Organizations should consider addressing communication and collaboration issues before initiating EA

development. (3) The final conclusion is that improving communication and collaboration during EA development will result in successful development of EA, which will greatly aid in removing or avoiding enterprise integration obstacles. The consequences of successful EA development would be great for enterprise integration projects, as EI and EA have a lot of common obstacles that can be addressed during EA development.

6.2 Future research topics

Sections 5.1 and 5.2 presented the research contributions and implications. Qualitative data was gathered regarding obstacles in enterprise architecture and enterprise integration obstacles from Finnish and Iranian large organizations. It would be interesting to compare the results with similar studies conducted in other countries with different organizational environments. For example, political sanctions hindered both integration and enterprise architecture development in Iranian organizations, but this situation was not applicable to Finnish organizations.

This research shed light on some dimensions of enterprise architecture that require further research. It was mentioned that enterprise architecture should be accurate, up-to-date, complete, and understandable, which needs further research to define what is meant by those terms. This research examined the enterprise architecture obstacles from the point of view of the internal stakeholders, but it would be interesting to also study this from the point of view of the external enterprise architecture consultants.

To verify the generalizability of the results, a global survey is required to measure how the obstacles vary globally. Moreover, further research is required on how to improve communication and collaboration during EA development in the organizations.

This study investigated the EA and EI obstacles in large organizations only; medium- and small-size organizations were neglected. It would be interesting to see how different the obstacles are from large organizations.

As mentioned before, an Enterprise architecture project is not a one-time project, and it requires constant attention and updates. Although the post-development obstacles of EA have been addressed, further research requires exhaustive study of those obstacles.

In this dissertation, the importance of the social and organizational aspect of organizations (especially communication and collaboration) in EA development was emphasized. It is possible to further study the factors that have already been found to be the most influential in communication and collaboration. A model that addresses the issue of communication and collaboration in EA development can be proposed for the future. To accomplish this, an exhaustive literature review in other disciplines, such as organizational communication, organizational behavior, and social science is required to understand, for example, how organizational studies have addressed communication and collaboration issues in organizations. There are several models, methods, and approaches proposed in

the literature to facilitate communication and collaboration in the organizational context (Blaschke et al., 2012; Fulk and Boyd, 1991; Ladegaard and Jenks, 2015; Taylor and Robichaud, 2004). The final model that will be proposed in future based on this dissertation will focus on the social and organizational aspects of EA. Therefore, it will be of great value to the field of EA, because most of the current EA development methods and frameworks have deficiencies when it comes to addressing social issues.

Another possible future direction of this study is to collect more data regarding communication and collaboration in EA development and to investigate the relationship between the level of organizational maturity and communication and collaboration in EA, for which, it is also possible to propose a standard framework.

References

Aalst, W.M.P. van der, Rubin, V., Verbeek, H.M.W., Dongen, B.F. van, Kindler, E. and Günther, C.W. 2010. Process mining: a two-step approach to balance between underfitting and overfitting. *Software & Systems Modeling*. **9**(1),p.87.

Aier, S., Ahrens, M., Stutz, M. and Bub, U. 2007. Deriving SOA Evaluation Metrics in an Enterprise Architecture Context *In*: *Service-Oriented Computing - ICSOC 2007 Workshops* [Online]. Lecture Notes in Computer Science. Springer, Berlin, Heidelberg, pp. 224–233. [Accessed 14 September 2017]. Available from: https://link.springer.com/chapter/10.1007/978-3-540-93851-4_22.

Aier, S., Gleichauf, B. and Winter, R. 2011. Understanding Enterprise Architecture Management Design - An Empirical Analysis *In*: A. Bernstein and G. Schwabe, eds. *Proceedings of the 10th International Conference on Wirtschaftsinformatik* [Online]. Zurich, pp. 645–654. [Accessed 5 March 2018]. Available from: http://www.zora.uzh.ch/60516/1/20120227114121_merlin-id_2354.pdf.

Aier, S., Labusch, N. and Pähler, P. 2015. Implementing Architectural Thinking *In*: *Advanced Information Systems Engineering Workshops* [Online]. Lecture Notes in Business Information Processing. Springer, Cham, pp. 389–400. [Accessed 18 September 2017]. Available from: https://link.springer.com/chapter/10.1007/978-3-319-19243-7_36.

Akbarifar, I. and Hamdi, K. 2016. IT Strategic Planning with the Approach of Enterprise Architecture. *International Journal of Humanities and Cultural Studies (IJHCS) ISSN 2356-5926*. **1**(1),pp.1733–1746.

Aloini, D., Dulmin, R. and Mininno, V. 2007. Risk management in ERP project introduction: Review of the literature. *Information & Management*. **44**(6),pp.547–567.

Anaya, V. and Ortiz, A. 2005. How enterprise architectures can support integration *In*: *Proceedings of the first international workshop on Interoperability of heterogeneous information systems* [Online]. ACM, pp. 25–30. [Accessed 8 April 2014]. Available from: http://dl.acm.org/citation.cfm?id=1096973.

Armour, F. and Kaisler, S. 2001. Enterprise architecture: Agile transition and implementation. *IT professional*. **3**(6),pp.30–37.

Armour, F., Kaisler, S. and Bitner, J. 2007. Enterprise Architecture: Challenges and Implementations *In*: *System Sciences, 2007. HICSS 2007. 40th Annual Hawaii International Conference on* [Online]. IEEE, pp. 217–217. [Accessed 14 September 2015]. Available from: http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=4076819.

Avgeriou, P. and Zdun, U. 2005. Architectural patterns revisited-a pattern language. [Accessed 12 September 2017]. Available from: http://eprints.cs.univie.ac.at/2698/1/ArchPatterns.pdf.

Banaeianjahromi, N. and Smolander, K. 2016. What do we know about the role of enterprise architecture in enterprise integration? A systematic mapping study. *Journal of Enterprise Information Management*. **29**(1),pp.140–164.

Barki, H. and Pinsonneault, A. 2002. Explaining ERP implementation effort and benefits with organizational integration. *Cahier du GReSI no. 02*. [Online]. **1**. [Accessed 3 September 2015]. Available from: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.4.3572&rep=rep1&type=pdf.

Benbasat, I., Goldstein, D.K. and Mead, M. 1987. The case research strategy in studies of information systems. *MIS quarterly*.,pp.369–386.

Benbasat, I. and Weber, R. 1996. Research Commentary: Rethinking "Diversity" in Information Systems Research. *Information Systems Research*. **7**(4),pp.389–399.

Bente, S., Bombosch, U. and Langade, S. 2012. *Collaborative enterprise architecture: enriching EA with lean, agile, and enterprise 2.0 practices* [Online]. Newnes. [Accessed 16 August 2017]. Available from: https://books.google.com/books?hl=en&lr=&id=6JLpOM_DqNcC&oi=fnd&pg=PP2&dq=Bente,+S.,+Bombosch,+U.,+Langade,+S.:+Collaborative+Enterprise+Architecture.+Morgan+Kaufmann&ots=NxyuL7sXFi&sig=LpMAVfoE63Edq0_bO1JHuZ4yM44.

Bernard, S.A. 2012. *An Introduction to Enterprise Architecture: Third Edition*. AuthorHouse.

Bernus, P. and Nemes, L. 1996. A framework to define a generic enterprise reference architecture and methodology. *Computer Integrated Manufacturing Systems*. **9**(3),pp.179–191.

Bernus, P. and Noran, O. 2010. A Metamodel for Enterprise Architecture *In*: P. Bernus, G. Doumeingts and M. Fox, eds. *Enterprise Architecture, Integration and Interoperability* [Online]. IFIP Advances in Information and Communication Technology. Springer Berlin Heidelberg, pp. 56–65. [Accessed 11 April 2014]. Available from: http://link.springer.com/chapter/10.1007/978-3-642-15509-3_6.

Bernus, P., Noran, O. and Molina, A. 2015. Enterprise architecture: Twenty years of the GERAM framework. *Annual Reviews in Control*. **39**,pp.83–93.

Betha, A. 2007. Enterprise Integration for Value Creation in an Organization *In*: G. L. BSc MSc and R. C. BEng, eds. *Complex Systems Concurrent Engineering*

[Online]. Springer London, pp. 649–656. [Accessed 12 August 2014]. Available from: http://link.springer.com/chapter/10.1007/978-1-84628-976-7_71.

Bick, M. and Pawlowski, J.M. 2006. Interface standards: Integration of learning and business information systems *In*: *Handbook on quality and standardisation in e-learning* [Online]. Springer, pp. 275–289. [Accessed 26 October 2016]. Available from: http://link.springer.com/content/pdf/10.1007/3-540-32788-6_19.pdf.

Blaschke, S., Schoeneborn, D. and Seidl, D. 2012. Organizations as networks of communication episodes: Turning the network perspective inside out. *Organization Studies*. **33**(7),pp.879–906.

Boh, W.F. and Yellin, D. 2007. Using enterprise architecture standards in managing information technology. *Journal of Management Information Systems*. **23**(3),pp.163–207.

Borbinha, J. 2007. It is the time for the digital library to meet the enterprise architecture. *Asian Digital Libraries. Looking Back 10 Years and Forging New Frontiers*.,pp.176–185.

Bowen, G.A. 2008. Naturalistic inquiry and the saturation concept: a research note. *Qualitative Research*. **8**(1),pp.137–152.

Brereton, P., Kitchenham, B.A., Budgen, D., Turner, M. and Khalil, M. 2007. Lessons from applying the systematic literature review process within the software engineering domain. *Journal of systems and software*. **80**(4),pp.571–583.

Bricknall, R., Darrell, G., Nilsson, H. and Pessi, K. 2006. Enterprise architecture: critical factors affecting modelling and management. *In*: *ECIS* [Online]., pp. 2349–2361. [Accessed 1 October 2015]. Available from: http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1064&context=ecis2006.

Brosey, W.D., Neal, R.E. and Marks, D.F. 2001. Grand challenges of enterprise integration *In*: *Emerging Technologies and Factory Automation, 2001. Proceedings. 2001 8th IEEE International Conference on* [Online]. IEEE, pp. 221–227. [Accessed 15 August 2014]. Available from: http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=997689.

Budgen, D., Turner, M., Brereton, P. and Kitchenham, B. 2008. Using mapping studies in software engineering *In*: *Proceedings of PPIG* [Online]., pp. 195–204. [Accessed 1 June 2014]. Available from: http://www.ppig.org/papers/20th-budgen.pdf.

Buschmann, F., Henney, K. and Schimdt, D. 2007. *Pattern-oriented Software Architecture: on patterns and pattern language*. John wiley & sons.

Chalmeta, R., Campos, C. and Grangel, R. 2001. References architectures for enterprise integration. *Journal of Systems and Software*. **57**(3),pp.175–191.

Chen, D. and Doumeingts, G. 2003. European initiatives to develop interoperability of enterprise applications—basic concepts, framework and roadmap. *Annual Reviews in Control*. **27**(2),pp.153–162.

Chen, D., Doumeingts, G. and Vernadat, F. 2008. Architectures for enterprise integration and interoperability: Past, present and future. *Computers in Industry*. **59**(7),pp.647–659.

Chen, D., Vallespir, B. and Doumeingts, G. 1997. GRAI integrated methodology and its mapping onto generic enterprise reference architecture and methodology. *Computers in Industry*. **33**(2–3),pp.387–394.

Chowanetz, M., Legner, C. and Thiesse, F. 2012. Integration: an omitted variable in information systems research. *INTEGRATION*. **5**,pp.15–2012.

Chuang, C.-H. and van Loggerenberg, J. 2010. Challenges Facing Enterprise Architects: A South African Perspective *In*: *2010 43rd Hawaii International Conference on System Sciences (HICSS)*., pp. 1–10.

Corbin, J. and Strauss, A. 2008. *Basics of qualitative research: Techniques and Procedures for Developing Grounded Theory* 3rd Edition. London: Sage.

Creswell, J.W. 2013. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. SAGE Publications.

Cuenca, L., Boza, A. and Ortiz, A. 2010. Enterprise engineering approach for business and is/it strategic alignment *In*: *8th international conference of modeling and simulation—MOSIM* [Online]., pp. 10–12. [Accessed 8 April 2014]. Available from: http://www.enim.fr/mosim2010/articles/263.pdf.

Dezdar, S. and Sulaiman, A. 2009. Successful enterprise resource planning implementation: taxonomy of critical factors. *Industrial Management & Data Systems*. **109**(8),pp.1037–1052.

Dubé, L. and Paré, G. 2003. Rigor in information systems positivist case research: current practices, trends, and recommendations. *MIS quarterly*.,pp.597–636.

Easterbrook, S., Singer, J., Storey, M.-A. and Damian, D. 2008. Selecting empirical methods for software engineering research *In*: *Guide to advanced empirical software engineering* [Online]. Springer, pp. 285–311. [Accessed 29 November 2016]. Available from: http://link.springer.com/10.1007/978-1-84800-044-5_11.

Eisenhardt, K.M. 1989. Building theories from case study research. *Academy of management review*. **14**(4),pp.532–550.

Erol, O., Mansouri, M. and Sauser, B. 2009. A framework for enterprise resilience using service oriented architecture approach *In*: *3rd annual IEEE International Systems Conference* [Online]. Vancouver, Canada: IEEE, pp. 127–132. [Accessed 9 April 2014]. Available from: http://www.ieeeexplore.com/search/searchresult.jsp?newsearch=true&queryText=Framework+for+Enterprise+Resilience+Using+Service+Oriented+Architecture+Approach.

Erol, O., Sauser, B.J. and Boardman, J.T. 2009. Creating Enterprise Flexibility through Service Oriented Architecture. *Global Journal of Flexible Systems Management*. **10**(1),pp.11–16.

Erol, O., Sauser, B.J. and Mansouri, M. 2010. A framework for investigation into extended enterprise resilience. *Enterprise Information Systems*. **4**(2),pp.111–136.

Ettlie, J.E. and Reza, E.M. 1992. Organizational Integration and Process Innovation. *The Academy of Management Journal*. **35**(4),pp.795–827.

Fatolahi, A., Jalalinia, S., Dabestani, Z. and Eskandari, M. 2007. Extracting business process decomposition: A practical approach using the ISIran V methodology. *Business Process Management Journal*. **13**(2),pp.214–222.

Feagin, J.R., Orum, A.M. and Sjoberg, G. 1991. *A case for the case study* [Online]. UNC Press Books. [Accessed 7 December 2015]. Available from: https://books.google.com/books?hl=en&lr=&id=7A39B6ZLyJQC&oi=fnd&pg=PA1&dq=Feagin,+A+Case+for+Case+Study&ots=H_8D_amne8&sig=aPU1MHzzi9qK6w5GJeFyczixShk.

Finney, S. and Corbett, M. 2007. ERP implementation: a compilation and analysis of critical success factors. *Business Process Management Journal*. **13**(3),pp.329–347.

Foorthuis, R., Hofman, F., Brinkkemper, S. and Bos, R. 2012. Compliance Assessments of Projects Adhering to Enterprise Architecture. *Journal of Database Management (JDM)*. **23**(2),pp.44–71.

Foorthuis, R., Steenbergen, M. van, Brinkkemper, S. and Bruls, W.A.G. 2016. A theory building study of enterprise architecture practices and benefits. *Information Systems Frontiers*. **18**(3),pp.541–564.

Franke, U., Cohen, M. and Sigholm, J. 2016. What can we learn from enterprise architecture models? An experiment comparing models and documents for capability development. *Software & Systems Modeling*.,pp.1–17.

Fulk, J. and Boyd, B. 1991. Emerging theories of communication in organizations. *Journal of management*. **17**(2),pp.407–446.

Gable, G.G. 1994. Integrating case study and survey research methods: an example in information systems. *European journal of information systems*. **3**(2),pp.112–126.

Gardner, D., Fehskens, L., Naidu, M., Rouse, W.B. and Ross, J.W. 2012. Point-counterpoint: enterprise architecture and enterprise transformation as related but distinct concepts. *Journal of Enterprise Transformation*. **2**(4),pp.283–294.

Gartner 2017. Enterprise Architecture - EA. *Gartner IT Glossary*. [Online]. [Accessed 2 March 2017]. Available from: http://www.gartner.com/it-glossary/enterprise-architecture-ea/.

Gartner 2005. Gartner's Enterprise Architecture Process and Framework Help Meet 21st Century Challenges. [Accessed 22 February 2018]. Available from: https://www.gartner.com/doc/486650/gartners-enterprise-architecture-process-framework.

Giachetti, R.E. 2004. A framework to review the information integration of the enterprise. *International Journal of Production Research*. **42**(6),pp.1147–1166.

Giacomazzi, F., Panella, C., Pernici, B. and Sansoni, M. 1997. Information systems integration in mergers and acquisitions: A normative model. *Information & Management*. **32**(6),pp.289–302.

Glaser, B.G. 1992. *Basics of Grounded Theory Analysis: Emergence Vs. Forcing*. Mill Valley, CA: Sociology Pr.

Glaser, B.G. and Strauss, A.L. 1967. *The discovery of grounded theory: Strategies for qualitative research* [Online]. Transaction Publishers. [Accessed 13 January 2015]. Available from: http://books.google.com/books?hl=en&lr=&id=rtiNK68Xt08C&oi=fnd&pg=PP1&dq=The+Discovery+of+Grounded+Theory,&ots=UVvSTkXLWO&sig=MzcNz8FcLGSiZTPYUwLK0o55eoA.

Goethals, F.G., Snoeck, M., Lemahieu, W. and Vandenbulcke, J. 2006. Management and enterprise architecture click: The FAD(E)E framework. *Information Systems Frontiers*. **8**(2),pp.67–79.

Goodhue, D.L., Kirsch, L.J., Quillard, J.A. and Wybo, M.D. 1992. Strategic data planning: lessons from the field. *MIS Quarterly*.,pp.11–34.

Guerreiro, S., Gaaloul, K. and Franke, U. 2016. Analysis of Enterprise Architecture Evolution Using Markov Decision Processes *In*: *Enterprise and Organizational Modeling and Simulation* [Online]. Lecture Notes in Business Information

Processing. Springer, Cham, pp. 37–51. [Accessed 13 September 2017]. Available from: https://link.springer.com/chapter/10.1007/978-3-319-49454-8_3.

Gulledge, T. 2006. What is integration? *Industrial Management & Data Systems*. **106**(1),pp.5–20.

Gunasekaran, A. and Ngai, E.W.T. 2004. Information systems in supply chain integration and management. *European Journal of Operational Research*. **159**(2),pp.269–295.

Hammersley, M. 2003. Recent radical criticism of interview studies: any implications for the sociology of education? *British Journal of Sociology of Education*. **24**(1),pp.119–126.

Hammersley, M. 1992. *What's Wrong with Ethnography?: Methodological Explorations*. Psychology Press.

Hansen, P. and Hacks, S. 2017. Continuous Delivery for Enterprise Architecture Maintenance. *Full-scale Software Engineering/The Art of Software Testing*.,p.56.

Hasselbring, W. 2000. Information System Integration. *Commun. ACM*. **43**(6),pp.32–38.

Hauder, M., Roth, S., Schulz, C. and Matthes, F. 2013. An Examination Of Organizational Factors Influencing Enterprise Architecture Management Challenges. *In*: *ECIS* [Online]., p. 175. [Accessed 1 October 2015]. Available from: http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1398&context=ecis2013_cr.

Henderson, J.C. and Venkatraman, N. 1993. Strategic alignment: Leveraging information technology for transforming organizations. *IBM systems journal*. **32**(1),pp.4–16.

Hinkelmann, K., Gerber, A., Karagiannis, D., Thoenssen, B., van der Merwe, A. and Woitsch, R. 2016. A new paradigm for the continuous alignment of business and IT: Combining enterprise architecture modelling and enterprise ontology. *Computers in Industry*. **79**,pp.77–86.

Hirschheim, R. 1985. Information systems epistemology: An historical perspective. *Research methods in information systems*.,pp.13–35.

Hitt, M.A., Hoskisson, R.E. and Nixon, R.D. 1993. A mid-range theory of interfunctional integration, its antecedents and outcomes. *Journal of Engineering and Technology Management*. **10**(1),pp.161–185.

Hjort-Madsen, K. 2006. Enterprise architecture implementation and management: A case study on interoperability *In*: *System Sciences, 2006. HICSS'06. Proceedings of the 39th Annual Hawaii International Conference on* [Online]. IEEE, p. 71c–71c.

[Accessed 1 December 2015]. Available from: http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=1579432.

Ho, L.T. and Lin, G.C.I. 2004. Critical success factor framework for the implementation of integrated-enterprise systems in the manufacturing environment. *International Journal of Production Research*. **42**(17),pp.3731–3742.

Hoogervorst, J. 2004. Enterprise architecture: enabling integration, agility and change. *International Journal of Cooperative Information Systems*. **13**(03),pp.213–233.

Hoogervorst, J.A.P. 2009. Enterprise Governance *In*: *Enterprise Governance and Enterprise Engineering* [Online]. The Enterprise Engineering Series. Springer Berlin Heidelberg, pp. 261–342. [Accessed 11 April 2014]. Available from: http://link.springer.com/chapter/10.1007/978-3-540-92671-9_7.

Hope, T., Chew, E. and Sharma, R. 2017. The Failure of Success Factors: Lessons from Success and Failure Cases of Enterprise Architecture Implementation [Best Paper Nominee] *In*: *Proceedings of the 2017 ACM SIGMIS Conference on Computers and People Research* [Online]. SIGMIS-CPR '17. New York, NY, USA: ACM, pp. 21–27. [Accessed 13 September 2017]. Available from: http://doi.acm.org/10.1145/3084381.3084392.

Hung, W.-H., Chang, I.-C., Yen, D. and Lee, C.-M. 2015. Critical Factors of Adopting Enterprise Application Integration Technology: An Empirical Study on Larger Hospitals. *Communications of the Association for Information Systems*. [Online]. **36**(1). Available from: http://aisel.aisnet.org/cais/vol36/iss1/31.

IFIP-IFAC, T.F. 1999. *GERAM: generalised enterprise reference architecture and methodology version 1.6. 3, 1999*.

Isomäki, H. and Liimatainen, K. 2008. Challenges of government enterprise architecture work–stakeholders' views *In*: *Electronic Government* [Online]. Springer, pp. 364–374. [Accessed 1 October 2015]. Available from: http://link.springer.com/chapter/10.1007/978-3-540-85204-9_31.

Iyamu, T. 2009. The factors affecting institutionalisation of enterprise architecture in the organisation *In*: *Commerce and Enterprise Computing, 2009. CEC'09. IEEE Conference on* [Online]. IEEE, pp. 221–225. [Accessed 14 September 2015]. Available from: http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5210794.

Jahani, B., Reza Seyyed Javadein, S. and Abedi Jafari, H. 2010. Measurement of enterprise architecture readiness within organizations. *Business Strategy Series*. **11**(3),pp.177–191.

Janssen, M. 2012. Sociopolitical aspects of interoperability and enterprise architecture in e-government. *Social Science Computer Review*. **30**(1),pp.24–36.

Järvinen, P. 2004. *On research methods*. Opinpajan kirja.

Josey, A. 2011. *TOGAF® Version 9.1 A Pocket Guide* [Online]. Van Haren. [Accessed 25 November 2015]. Available from: https://books.google.com/books?hl=en&lr=&id=F29eAgAAQBAJ&oi=fnd&pg=PA9&dq=TOGAF&ots=dOUzbk0Pp1&sig=iuGChH9asnLwJ4avPr08gLbXhUc.

Kähkönen, T., Alanne, A., Pekkola, S. and Smolander, K. 2017. Explaining the Challenges in ERP Development Networks with Triggers, Root Causes, and Consequences. *CAIS*. **40**,p.11.

Kähkönen, T., Smolander, K. and Maglyas, A. 2017. Lack of integration governance in ERP development: a case study on causes and effects. *Enterprise Information Systems*. **11**(8),pp.1173–1206.

Kaisler, S.H., Armour, F. and Valivullah, M. 2005. Enterprise architecting: Critical problems *In*: *System Sciences, 2005. HICSS'05. Proceedings of the 38th Annual Hawaii International Conference on* [Online]. IEEE, p. 224b–224b. [Accessed 14 September 2015]. Available from: http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=1385698.

Kamoun, F. 2013. Rethinking the Role of Enterprise Architecture During Times of Economic Downturn: A Dynamic Capabilities Approach. *Journal of Information Technology Management*. **24**(1),p.26.

Kang, D., Lee, J., Choi, S. and Kim, K. 2010. An ontology-based enterprise architecture. *Expert Systems with Applications*. **37**(2),pp.1456–1464.

Kaplan, B. and Duchon, D. 1988. Combining Qualitative and Quantitative Methods in Information Systems Research: A Case Study. *MIS Quarterly*. **12**(4),pp.571–586.

Kilpeläinen, T. 2007. Business Information Driven Approach for EA Development in Practice *In*: *the Proceedings of the 18th Australasian Conference on Information Systems. Australia* [Online]. Citeseer, pp. 5–7. [Accessed 8 April 2014]. Available from: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.88.8418&rep=rep1&type=pdf.

Kim, J.-W., Kwon, J.-H., Kim, Y.-G., Song, C.-Y., Kim, H.-S. and Baik, D.-K. 2006. EAFoC: Enterprise Architecture Framework Based on Commonality. *Journal of Computer Science and Technology*. **21**(6),pp.952–964.

Kitchenham, B. 2004. Procedures for performing systematic reviews. *Keele, UK, Keele University*. **33**,p.2004.

Kitchenham, B.A., Budgen, D. and Pearl Brereton, O. 2011. Using mapping studies as the basis for further research – A participant-observer case study. *Information and Software Technology*. **53**(6),pp.638–651.

Kitchenham, B.A. and Charters, S. 2007. Guidelines for performing systematic literature reviews in software engineering. [Accessed 12 May 2014]. Available from: http://www.citeulike.org/group/14013/article/7874938.

Klein, H.K. and Myers, M.D. 1999. A set of principles for conducting and evaluating interpretive field studies in information systems. *MIS quarterly*.,pp.67–93.

Korhonen, J.J., Lapalme, J., McDavid, D. and Gill, A.Q. 2016. Adaptive Enterprise Architecture for the Future: Towards a Reconceptualization of EA *In*: *2016 IEEE 18th Conference on Business Informatics (CBI)*., pp. 272–281.

Kosanke, K. 2006. ISO Standards for Interoperability: a comparison *In*: *Interoperability of Enterprise Software and Applications* [Online]. Springer, pp. 55–64. [Accessed 23 June 2014]. Available from: http://link.springer.com/chapter/10.1007/1-84628-152-0_6.

Kosanke, K. and Nell, J.G. 1999. Standardisation in ISO for enterprise engineering and integration. *Computers in Industry*. **40**(2–3),pp.311–319.

Kosanke, K., Vernadat, F. and Zelm, M. 1999. CIMOSA: enterprise engineering and integration. *Computers in Industry*. **40**(2–3),pp.83–97.

Kotusev, S., Singh, M. and Storey, I. 2015. Consolidating Enterprise Architecture Management Research *In*: *2015 48th Hawaii International Conference on System Sciences*., pp. 4069–4078.

Ladegaard, H.J. and Jenks, C.J. 2015. Language and intercultural communication in the workplace: critical approaches to theory and practice. *Language and Intercultural Communication*. **15**(1),pp.1–12.

Lam, W. 2005. Barriers to e-government integration. *Journal of Enterprise Information Management*. **18**(5),pp.511–530.

Lange, M. and Mendling, J. 2011. An experts' perspective on enterprise architecture goals, framework adoption and benefit assessment *In*: *Enterprise Distributed Object Computing Conference Workshops (EDOCW), 2011 15th IEEE International* [Online]. IEEE, pp. 304–313. [Accessed 15 September 2015]. Available from: http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6037633.

Lankhorst, M. 2013. Enterprise Architecture at Work: Modelling, Communication and Analysis. [Accessed 1 April 2014]. Available from: http://library.wur.nl/WebQuery/clc/2004404.

Lankhorst, M. 2009. *Enterprise Architecture at Work: Modelling, Communication and Analysis (The Enterprise Engineering Series)*. Springer, 2nd ed. edn.(Sep 2009).

Lankhorst, M.M. 2004. Enterprise architecture modelling—the issue of integration. *Advanced Engineering Informatics*. **18**(4),pp.205–216.

Lee, A.S. and Hubona, G.S. 2009. A Scientific Basis for Rigor in Information Systems Research. *MIS Quarterly*. **33**(2),pp.237–262.

Lee, J., Siau, K. and Hong, S. 2003. Enterprise Integration with ERP and EAI. *Communications of the ACM*. **46**(2),pp.54–60.

Lee, J.-C. and Myers, M. 2004. The challenges of enterprise integration: cycles of integration and disintegration over time. *ICIS 2004 Proceedings*.,p.75.

Lee, Z. and Lee, J. 2000. An ERP implementation case study from a knowledge transfer perspective. *Journal of information technology*. **15**(4),pp.281–288.

Lim, S.H., Juster, N. and de Pennington, A. 1998. A role interaction approach to support manufacturing enterprise integration. *Proceedings of the Institution of Mechanical Engineers*. **212**(6),p.439.

Linthicum, D.S. 2000. *Enterprise application integration* [Online]. Addison-Wesley Professional. [Accessed 26 January 2015]. Available from: http://books.google.com/books?hl=en&lr=&id=LIYadz3qEyEC&oi=fnd&pg=PR17&dq=Linthicum,++Enterprise+Application+Integration&ots=jgnS-FJHGK&sig=FZe0sFt9hkNCek-TGnnVDzj0zho.

Linthicum, D.S. 2003. *Next generation application integration: from simple information to Web services* [Online]. Addison-Wesley Longman Publishing Co., Inc. [Accessed 11 May 2015]. Available from: http://dl.acm.org/citation.cfm?id=940822.

Locke, K. 2001. *Grounded theory in management research* [Online]. Sage. [Accessed 14 January 2015]. Available from: http://books.google.com/books?hl=en&lr=&id=OcDWB-rWvWUC&oi=fnd&pg=PR7&dq=grounded+theory+in+management+research&ots=XpJKgN-74o&sig=-TyCttfGr7qRou_Vj0YUzDqFvJA.

Löhe, J. and Legner, C. 2014. Overcoming implementation challenges in enterprise architecture management: a design theory for architecture-driven IT Management (ADRIMA). *Information Systems and e-Business Management*. **12**(1),pp.101–137.

Lucke, C., Krell, S. and Lechner, U. 2010. Critical Issues in Enterprise Architecting – A Literature Review. *AMCIS 2010 Proceedings*. [Online]. Available from: http://aisel.aisnet.org/amcis2010/305.

Luftman, J. and Zadeh, H.S. 2011. Key information technology and management issues 2010–11: an international study. *Journal of Information Technology*. **26**(3),pp.193–204.

Malone, T.W. and Crowston, K. 1994. The Interdisciplinary Study of Coordination. *ACM Comput. Surv.* **26**(1),pp.87–119.

Matavire, R. and Brown, I. 2008. Investigating the use of grounded theory in information systems research *In*: *Proceedings of the 2008 annual research conference of the South African Institute of Computer Scientists and Information Technologists on IT research in developing countries: riding the wave of technology* [Online]. ACM, pp. 139–147. [Accessed 13 January 2015]. Available from: http://dl.acm.org/citation.cfm?id=1456676.

Maxwell, J. 1992. Understanding and validity in qualitative research. *Harvard educational review*. **62**(3),pp.279–301.

Mayall, A. 2009. Coming Out of the Recession: The Role of Enterprise Architecture. *Architecture&Governance Magazine*. [Online]. **5**(10). Available from: http://architectureandgovernance.com/sites/architectureandgovernance.com/files/AG-5-10.pdf.

Meredith, J. 1998. Building operations management theory through case and field research. *Journal of operations management*. **16**(4),pp.441–454.

Momoh, A., Roy, R. and Shehab, E. 2010. Challenges in enterprise resource planning implementation: state-of-the-art. *Business Process Management Journal*. **16**(4),pp.537–565.

Moynihan, G.P. 1997. The Application of Enterprise Modeling for Aerospace Manufacturing System Integration. *International Journal of Flexible Manufacturing Systems*. **9**(2),pp.195–210.

Myers, M.D. and Avison, D. 2002. *Qualitative Research in Information Systems: A Reader*. SAGE.

Nah, F.-H., Lau, J.L.-S. and Kuang, J. 2001. Critical factors for successful implementation of enterprise systems. *Business process management journal*. **7**(3),pp.285–296.

Nakakawa, A., Bommel, P. van and Proper, H.A. 2010. Challenges of involving stakeholders when creating enterprise architecture *In*: *5th SIKS/BENAIS*

Conference on Enterprise Information Systems [Online]., pp. 43–55. [Accessed 16 November 2015]. Available from: http://ceur-ws.org/Vol-662/EIS2010_proceedings.pdf#page=57.

Narman, P., Johnson, P. and Nordstrom, L. 2007. Enterprise Architecture: A Framework Supporting System Quality Analysis *In*: *11th IEEE International Enterprise Distributed Object Computing Conference (EDOC 2007)*., pp. 130–130.

Ngai, E.W., Law, C.C. and Wat, F.K. 2008. Examining the critical success factors in the adoption of enterprise resource planning. *Computers in Industry*. **59**(6),pp.548–564.

Ngeru, J., David, D. and Hargrove, S.K. 2009. Developing an Enterprise Integration Strategy using an AHP-Delphi Approach *In*: *Journal of Management & Engineering Integration* [Online]. tURLOCK, United States: International Conference on Industry, Engineering, & Management Systems, pp. 92–101. [Accessed 6 August 2014]. Available from: http://search.proquest.com/docview/900577277/citation/9296641EE45C4801PQ/10?accountid=27292.

Ni, Q., Lu, W.F., Yarlagadda, P.K.D.V. and Ming, X. 2007. Business information modeling for process integration in the mold making industry. *Robotics and Computer-Integrated Manufacturing*. **23**(2),pp.195–207.

Niemi, E. and Pekkola, S. 2013. Enterprise architecture quality attributes: A case study *In*: *System Sciences (HICSS), 2013 46th Hawaii International Conference on* [Online]. IEEE, pp. 3878–3887. [Accessed 30 September 2015]. Available from: http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6480313.

Nikpay, F., Selamat, H., Rouhani, B.D. and Nikfard, P. 2013. A Review of Critical Success Factors of Enterprise Architecture Implementation *In*: *2013 International Conference on Informatics and Creative Multimedia (ICICM)* [Online]. IEEE, pp. 38–42. [Accessed 1 December 2015]. Available from: http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6702779.

Noran, O. 2013. Building a support framework for enterprise integration. *Computers in Industry*. **64**(1),pp.29–40.

Obitz, T. and Babu, M.K. 2009. Enterprise architecture expands its role in strategic business transformation: Infosys enterprise architecture survey 2008/2009. *Bangalore, India: Infosys*.

Oh, L.-B., Leong, Y.-X. and Teo, H.-H. 2007. A model of IT-enabled organizational integration and sustained competitive advantage. *BLED 2007 Proceedings*.,p.1.

Orlikowski, W.J. and Baroudi, J.J. 1991. Studying information technology in organizations: Research approaches and assumptions. *Information systems research*. **2**(1),pp.1–28.

Panetto, H., Jardim-Goncalves, R. and Molina, A. 2012. Enterprise Integration and Networking: Theory and practice. *Annual Reviews in Control*. **36**(2),pp.284–290.

Panetto, H. and Molina, A. 2008. Enterprise integration and interoperability in manufacturing systems: Trends and issues. *Computers in industry*. **59**(7),pp.641–646.

Panetto, H. and Whitman, L. 2016. Knowledge engineering for enterprise integration, interoperability and networking: Theory and applications. *Data & Knowledge Engineering*. [Online]. [Accessed 21 October 2016]. Available from: http://www.sciencedirect.com/science/article/pii/S0169023X16300246.

Papazoglou, M.P. and Heuvel, W.-J. van den 2007. Service oriented architectures: approaches, technologies and research issues. *The VLDB Journal*. **16**(3),pp.389–415.

Patton, M.Q. 2005. *Qualitative research* [Online]. Wiley Online Library. [Accessed 31 August 2016]. Available from: http://onlinelibrary.wiley.com/doi/10.1002/0470013192.bsa514/full.

Peristeras, V. and Tarabanis, K. 2000. Towards an enterprise architecture for public administration using a top-down approach. *European Journal of Information Systems*. **9**(4),pp.252–260.

Petersen, K., Feldt, R., Mujtaba, S. and Mattsson, M. 2008. Systematic mapping studies in software engineering *In*: *12th International Conference on Evaluation and Assessment in Software Engineering* [Online]., p. 1. [Accessed 12 May 2014]. Available from: http://www.rbsv.eu/courses/rmtw/mtrl/SM.pdf.

Plazaola, L., Flores, J., Vargas, N. and Ekstedt, M. 2008. Strategic business and IT alignment assessment: A case study applying an enterprise architecture-based metamodel *In*: *Hawaii International Conference on System Sciences, Proceedings of the 41st Annual* [Online]. IEEE, pp. 398–398. [Accessed 6 August 2014]. Available from: http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=4439103.

Proper, H.A. 2013. Enterprise architecture: informed steering of enterprises in motion *In*: *International Conference on Enterprise Information Systems* [Online]. Springer, pp. 16–34. [Accessed 13 February 2017]. Available from: http://link.springer.com/chapter/10.1007/978-3-319-09492-2_2.

Richardson, G.L., Jackson, B.M. and Dickson, G.W. 1990. A principles-based enterprise architecture: Lessons from Texaco and Star Enterprise. *MIS quarterly*.,pp.385–403.

Ritchie, J., Lewis, J. and Elam, R.G. 2013. Designing and Selecting Samples *In*: *Qualitative research practice: A guide for social science students and researchers* [Online]. Sage Publications, p. 111. [Accessed 7 March 2017]. Available from: https://books.google.com/books?hl=en&lr=&id=EQSIAwAAQBAJ&oi=fnd&pg=PA111&dq=%22Theoretical+sampling+is+a+particular+type+of+purposive+sampling+in+which+units+are+selected+specifically+on+the+basis+of+their+potential+contribution+to+theory.%22&ots=lZXUnwVt6Q&sig=eurQ6U0s5Wrf17RwRLbQU1aiuNs.

Rodon, J. 2006. A methodological and conceptual review of inter organizational information systems integration. *In*: *ECIS*., pp. 402–413.

Rohloff, M. 2005. Enterprise architecture-framework and methodology for the design of architectures in the large. *ECIS 2005 Proceedings*.,p.113.

Romero, D. and Vernadat, F. 2016. Enterprise information systems state of the art: Past, present and future trends. *Computers in Industry*. **79**,pp.3–13.

Ross, J.W. 2003. Creating a strategic IT architecture competency: Learning in stages. [Accessed 7 June 2016]. Available from: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=416180.

Ross, J.W. and Quaadgras, A. 2012. Enterprise architecture is not just for architects. *Center for Information Systems Research Sloan School of Management Massachusetts Institute of Technology*.

Ross, J.W., Weill, P. and Robertson, D. 2006. *Enterprise architecture as strategy: Creating a foundation for business execution* [Online]. Harvard Business Press. [Accessed 19 September 2017]. Available from: https://books.google.com/books?hl=en&lr=&id=ng3AbVQlEncC&oi=fnd&pg=PT3&dq=ROSS+JW,+WEILL+P+and+ROBERTSON+D+(2009)+Enterprise+Architecture+As+Strategy:+Creating+a+Foundation+for+Business+Execution.+Harvard+School+Press,+Boston,+Massachusetts.&ots=xGXfEz5583&sig=FRmT1TOW6McieRhw3HwdYACp4os.

Ross, J.W., Weill, P. and Robertson, D.C. 2006. *Enterprise architecture as strategy: Creating a foundation for business execution* [Online]. Harvard Business Press. [Accessed 1 April 2014]. Available from: http://books.google.com/books?hl=en&lr=&id=5MVcnOyJ2bEC&oi=fnd&pg=PR7&dq=Enterprise+Architecture+As+Strategy:+Creating+a+Foundation+for+Business+Execution.&ots=qS0or7s0t7&sig=ypWdYtdFifzGZvXOa-gZFGSHOHc.

Roth, S., Hauder, M., Farwick, M., Breu, R. and Matthes, F. 2013. Enterprise Architecture Documentation: Current Practices and Future Directions. *In*: *Wirtschaftsinformatik* [Online]., p. 58. [Accessed 1 October 2015]. Available from: http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1057&context=wi2013.

Roth, S., Hauder, M. and Matthes, F. 2013. Collaborative evolution of enterprise architecture models *In*: *8th International Workshop on Models at Runtime (Models@ run. time)* [Online]. [Accessed 14 September 2017]. Available from: https://wwwmatthes.in.tum.de/file/13jzg7w961pyz/Sebis-Public-Website/-/Ro13e-Collaborative-Evolution-of-Enterprise-Architecture-Models/Ro13e.pdf.

Ruh, W.A., Maginnis, F.X. and Brown, W.J. 2002. *Enterprise Application Integration: A Wiley Tech Brief*. John Wiley & Sons.

Saarelainen, M.-M. and Hotti, V. 2011. Does Enterprise Architecture Form the Ground for Group Decisions in eGovernment Programme? Qualitative Study of the Finnish National Project for IT in Social Services *In*: *Enterprise Distributed Object Computing Conference Workshops (EDOCW), 2011 15th IEEE International*., pp. 11–17.

Saha, P. 2004. Analyzing The open group architecture framework from the GERAM perspective. *The Open Group, Tech. Rep*. [Online]. [Accessed 8 April 2014]. Available from: http://www.opengroup.org/architecture/wp/saha/TOGAF_GERAM_Mapping.htm.

Seale, C. 2002. Quality Issues in Qualitative Inquiry. *Qualitative Social Work*. **1**(1),pp.97–110.

Senge, P.M. 1996. Leading learning organizations. *Training & Development*. **50**(12),pp.36–37.

Seppänen, V., Heikkilä, J. and Liimatainen, K. 2009. Key issues in EA-implementation: case study of two Finnish government agencies *In*: *Commerce and Enterprise Computing, 2009. CEC'09. IEEE Conference on* [Online]. IEEE, pp. 114–120. [Accessed 1 October 2015]. Available from: http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5210807.

Shah, H. and Kourdi, M.E. 2007. Frameworks for Enterprise Architecture. *IT Professional*. **9**(5),pp.36–41.

Shaul, L. and Tauber, D. 2013. Critical Success Factors in Enterprise Resource Planning Systems: Review of the Last Decade. *ACM Comput. Surv.* **45**(4),p.55:1–55:39.

Shen, W., Hao, Q., Wang, S., Li, Y. and Ghenniwa, H. 2007. An agent-based service-oriented integration architecture for collaborative intelligent manufacturing. *Robotics and Computer-Integrated Manufacturing*. **23**(3),pp.315–325.

Simon, D., Fischbach, K. and Schoder, D. 2014. Enterprise architecture management and its role in corporate strategic management. *Information Systems and e-Business Management*. **12**(1),pp.5–42.

Singletary, L., Pawlowski, S. and Watson, E. 2003. What is applications integration? Understanding the perspectives of managers, IT professionals, and end users. *AMCIS 2003 Proceedings*.,p.61.

Stol, K.-J., Ralph, P. and Fitzgerald, B. 2016. Grounded theory in software engineering research: a critical review and guidelines *In*: *Proceedings of the 38th International Conference on Software Engineering* [Online]. ACM, pp. 120–131. [Accessed 22 November 2016]. Available from: http://dl.acm.org/citation.cfm?id=2884833.

Strauss, A. and Corbin, J. 1990. *Basics of Qualitative Research: Grounded Theory Procedures and Techniques*. Sage Publications.

Strauss, A. and Corbin, J. 1998. *The Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory* 1st Edition. Sage, London.

Suddaby, R. 2006. From the editors: What grounded theory is not. *Academy of management journal*. **49**(4),pp.633–642.

Tamm, T., Seddon, P.B., Shanks, G. and Reynolds, P. 2011. How Does Enterprise Architecture Add Value to Organisations? *Communications of the Association for Information Systems*. **28**(1),pp.141–168.

Taylor, J.R. and Robichaud, D. 2004. Finding the organization in the communication: Discourse as action and sensemaking. *Organization*. **11**(3),pp.395–413.

Themistocleous, M. 2004. Justifying the decisions for EAI implementations: a validated proposition of influential factors. *Journal of Enterprise Information Management*. **17**(2),pp.85–104.

Themistocleous, M. and Irani, Z. 2002. Novel taxonomy for application integration. *Benchmarking: An International Journal*. **9**(2),pp.154–165.

Toh, K.T.K., Nagel, P. and Oakden, R. 2009. A business and ICT architecture for a logistics city. *International Journal of Production Economics*. **122**(1),pp.216–228.

Torre, L. van der and Zee, M. van 2017. Rational Enterprise Architecture *In*: *Advances in Artificial Intelligence: From Theory to Practice* [Online]. Lecture Notes in

Computer Science. Springer, Cham, pp. 9–18. [Accessed 13 September 2017]. Available from: https://link.springer.com/chapter/10.1007/978-3-319-60042-0_2.

Tragatschnig, S. and Zdun, U. 2013. Enterprise integration using event actor based event transformations *In*: *Proceedings of the 28th Annual ACM Symposium on Applied Computing* [Online]. ACM, pp. 1434–1440. [Accessed 12 September 2017]. Available from: http://dl.acm.org/citation.cfm?id=2480630.

Umapathy, K., Purao, S. and Barton, R.R. 2008. Designing enterprise integration solutions: effectively. *European Journal of Information Systems*. **17**(5),pp.518–527.

Urquhart, C. and Fernández, W. 2013. Using grounded theory method in information systems: the researcher as blank slate and other myths. *Journal of Information Technology*. **28**(3),pp.224–236.

Valtonen, K., Mäntynen, S., Leppänen, M. and Pulkkinen, M. 2011. Enterprise Architecture Descriptions for Enhancing Local Government Transformation and Coherency Management: Case Study *In*: *Enterprise Distributed Object Computing Conference Workshops (EDOCW), 2011 15th IEEE International*., pp. 360–369.

Van Der Raadt, B., Schouten, S. and Van Vliet, H. 2008. Stakeholder perception of enterprise architecture. *Software Architecture*.,pp.19–34.

Venkatesh, V., Brown, S.A. and Bala, H. 2013. Bridging the qualitative-quantitative divide: Guidelines for conducting mixed methods research in information systems. *MIS quarterly*. **37**(1),pp.21–54.

Vernadat, F.B. 2009. Enterprise Integration and Interoperability *In*: P. S. Y. Nof, ed. *Springer Handbook of Automation* [Online]. Springer Berlin Heidelberg, pp. 1529–1538. [Accessed 11 April 2014]. Available from: http://link.springer.com/chapter/10.1007/978-3-540-78831-7_86.

Vernadat, F.B. 2002. Enterprise modeling and integration (EMI): Current status and research perspectives. *Annual Reviews in Control*. **26**(1),pp.15–25.

Vernadat, F.B. 2003. Enterprise Modelling and Integration *In*: K. Kosanke, R. Jochem, J. G. Nell and A. O. Bas, eds. *Enterprise Inter- and Intra-Organizational Integration* [Online]. IFIP — The International Federation for Information Processing. Springer US, pp. 25–33. [Accessed 21 October 2016]. Available from: http://link.springer.com/chapter/10.1007/978-0-387-35621-1_4.

Vernadat, F.B. 2003. *Enterprise modelling and integration* [Online]. Springer. [Accessed 23 June 2014]. Available from: http://link.springer.com/chapter/10.1007/978-0-387-35621-1_4.

Vernadat, F.B. 2007. Interoperable enterprise systems: Principles, concepts, and methods. *Annual Reviews in Control*. **31**(1),pp.137–145.

Wan, H., Luo, A. and Luo, X. 2014. How Enterprise Architecture Formative Critical Success Facets Might Affect Enterprise Architecture Success: A Literature Analysis *In*: *Service Science and Knowledge Innovation* [Online]. Springer, pp. 197–209. [Accessed 2 December 2015]. Available from: http://link.springer.com/chapter/10.1007/978-3-642-55355-4_20.

Winter, G. 2000. A comparative discussion of the notion of'validity'in qualitative and quantitative research. *The qualitative report*. **4**(3),pp.1–14.

Winter, R. 2014. Architectural Thinking. *Business & Information Systems Engineering*. **6**(6),pp.361–364.

Winter, R. and Fischer, R. 2006. Essential layers, artifacts, and dependencies of enterprise architecture *In*: *Enterprise Distributed Object Computing Conference Workshops, 2006. EDOCW'06. 10th IEEE International* [Online]. IEEE, pp. 30–30. [Accessed 14 September 2017]. Available from: http://ieeexplore.ieee.org/abstract/document/4031290/.

Wu, R.C.-Y. 2007. Enterprise integration in e-government. *Transforming Government: People, Process and Policy*. **1**(1),pp.89–99.

Yin, R.K. 2013. *Case study research: Design and methods* [Online]. Sage publications. [Accessed 11 November 2015]. Available from: https://books.google.com/books?hl=en&lr=&id=AjV1AwAAQBAJ&oi=fnd&pg=PP1&dq=yin+case+study+research+design&ots=gkRfnAPSaL&sig=0Dvet9hfVwny5BCV8EI_dJetyX8.

Ylimäki, T. 2008. Potential critical success factors for enterprise architecture. *Evaluation of enterprise and software architectures: critical issues, metrics and practices:[AISA Project 2005-2008]/Eetu Niemi, Tanja Ylimäki & Niina Hämäläinen (eds.). Jyväskylä: University of Jyväskylä, Information Technology Research Institute, 2008.-(Tietotekniikan tutkimusinstituutin julkaisuja, ISSN 1236-1615; 18). ISBN 978-951-39-3108-7 (CD-ROM).* [Online]. [Accessed 16 November 2015]. Available from: https://jyx.jyu.fi/dspace/handle/123456789/41369.

Zachman, J.A. 1987. A framework for information systems architecture. *IBM systems journal*. **26**(3),pp.276–292.

Zheng, T. and Zheng, L. 2013. Examining e-government enterprise architecture research in China: A systematic approach and research agenda. *Government Information Quarterly*. **30**,pp.S59–S67.

Publication I

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What Do We Know about the Role of Enterprise Architecture in Enterprise Integration? A Systematic Mapping Study

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What do we know about the role of enterprise architecture in enterprise integration? A systematic mapping study

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Abstract

Purpose – Constant changes in the environment seem to have become the biggest challenge of a modern enterprise, which emphasizes the constant need to integrate the enterprise into its changing environment. Aiming at eliminating the integration challenges, EA is proposed as a solution. The purpose of this paper is to survey and analyse the available literature on determining the role of EA in EI and also to identify gaps and state-of-the-art in research.

Design/methodology/approach – This paper presents a systematic mapping study that found 50 papers in the intersection of EA and EI, these papers were surveyed, analysed, and classified with respect to research focus, research method, and paper type.

Findings – Based on the analyses of the final 50 articles, the authors realized that "EA framework" is the dominating research focus of these studies. "Evaluation research" is recognized as the most common paper type in this area. However, "Experience paper" was a rare paper type in this research domain. "Constructive research" and "Case study/multiple case studies" are widely applied as the research method. "Survey", "Delphi study" and "Grounded theory" are the least employed research methods. The conclusion was that there is a need for empirical research in this area. After analysing the articles based on their publication year, the authors also noticed a significant growth between 2004 and 2010. After 2010 the number of publications had a downward trend.

Originality/value – To the knowledge of the authors, this study is the first systematic literature study regarding the role of EA in EI. There are several systematic literature reviews about the EA or EI separately but none of them has addressed the specific realm of the research. Hence, the goal of this study is to provide a map of existing literature to enable improvement of the practice with the known research results and to identify gaps for future research.

Keywords Enterprise architecture, Enterprise integration, Systematic mapping study

Paper type Literature review

1. Introduction

Constant change is the inseparable and the most important characteristic of today's enterprises. To survive in this competitive era, the enterprises need to adapt themselves to the change. Enterprise integration (EI) is the task of performance improvement in complex organizations by managing the participants interactions (Huat Lim *et al.*, 1997). EI provides a discipline to organize all the knowledge that is required to identify and carry out the change in the enterprises (Bernus and Nemes, 1997). To achieve EI many scholars have believed in enterprise architecture (EA) as the ultimate solution

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(Anaya and Ortiz, 2005; Chen *et al.*, 1997, 2008; Erol *et al.*, 2009a; Hoogervorst, 2004; Kang *et al.*, 2010; Lam, 2005a; Noran, 2013; Panetto *et al.*, 2012; Peristeras and Tarabanis, 2000; Vernadat, 2007).

Conventionally, EA has been used for EI to align business and Information Technology (IT) in the organizations (Bernus and Nemes, 1997; Chen *et al.*, 1997; IFIP-IFAC TF, 1999; Sowa and Zachman, 1992; Zachman, 1987). EA provides organizations means to cope with the core challenges of the ICT age (Chen *et al.*, 2008; Goel *et al.*, 2009; Kim *et al.*, 2006): integration; interoperability; agility; and change.

While the strategic alignment between business and IT in companies generate added value to business processes, technological complexities will arise (Henderson and Venkatraman, 1993) and meanwhile the companies should also achieve integration and coordination to ensure survival among their competitors. Attaining these goals is tough. EA is believed to provide appropriate concepts, methods, models, and tools to facilitate business IT alignment and integration (Vargas *et al.*, 2014).

In order to get a perspective of existing research we conducted a systematic mapping study (SMS). To the knowledge of the authors, this study is the first SMS study regarding the role of EA in EI. Although, there are several systematic literature reviews (SLR) about the EA or EI separately (Boucharas *et al.*, 2010; Giachetti, 2004; Lucke *et al.*, 2010; Sedek *et al.*, 2011; Stelzer, 2010; Tamm *et al.*, 2011), but none of them have addressed the specific realm of our research. Hence, the goal of this study is to provide a map of existing literature to achieve useful results for practical use and to identify gaps for future research.

The objective is to form a background for further research as well as obtain a deeper insight about the topic. The complexity of the EI has been cited in many sources (Chalmeta *et al.*, 2001; Lim *et al.*, 1998; Ngeru *et al.*, 2009). Also EA is known as a holistic approach to manage complexity (Armour *et al.*, 1999; Ross *et al.*, 2006; Winter and Fischer, 2006). This understanding of the complexity of EA and EI motivated us to conduct this study to find out how the EI issues have been addressed by the EA in literature. Since we found only 50 articles determining the role of EA in EI, choosing SMS as the research approach seems appropriate, because SMS is a valid approach when there is limited number of literature available (Kitchenham, 2007; Petersen *et al.*, 2008).

In total, we analyse the results of 50 scientific papers in this study. The main answered research questions in this study include:

RQ1. What research focuses on determining the role of EA in EI are prevalent?

RQ2. What methodologies and paper types are utilized?

RQ3. How publication trends changed over time?

The outcomes of this study deliver a comprehensive research approach in determining the role of EA in EI as well as implications and guidelines for both scholars and practitioners.

The paper is organized as follows: Section 2 describes EA and EI and the role of EA in EI based on the pervious literature. In Section 3 the applied research method including research questions, search steps, selected publication forum, search string, and exclusion/inclusion criteria are clarified. The classification process and schema are illustrated in Section 4. The results of the mapping study are discussed

exhaustively in Section 5. Section 6 summarizes the findings of the study, discusses about the validity threats, and reports the limitations of this study. Finally, Section 7 contains the conclusions and discusses research.

2. Background

2.1 EI

A variety of definitions have been proposed to clarify the meaning of EI. Lim *et al.* (1998), describe EI as a very complex task to achieve an overall organizational improvement by emphasizing on the unification of enterprise functions. In another study, EI is defined as the organizational function that comprises activities, resources, decisions, and information flow and provides coordination in order to satisfy global objectives and improves performance (Chalmeta *et al.*, 2001). EI, sometimes referred to as system integration, is the process of interconnecting silo business functions to streamline organizational processes (Umapathy *et al.*, 2008). Ngeru *et al.* (2009), refer to EI as a technology that promises to rapid information sharing among business processes both intra and inter organization. All in all, EI refers to the terms, such as coordination, performance improvement, information flow, and processes.

Some studies contrast EI with enterprise interoperability. Enterprise interoperability addresses the ability of interactions between enterprise systems, which is seen as a technical problem (Chen *et al.*, 2008; Vernadat, 2009). In contrast, EI is the task of performance improvement in a complex organization by managing the interactions of participants (Huat Lim *et al.*, 1997). Therefore, EI is a process to ensure the interaction between various entities of the enterprise to attain domain objectives (Chen *et al.*, 2008).

According to Enterprise Integration Council, the ultimate goals of EI are flexibility and agility in order to swiftly respond to new business opportunities. The Enterprise Integration Council proposes benefits of EA as cycle time reduction, cost reduction, and cost containment (Lee *et al.*, 2003).

2.2 EA

Although there are different perspectives to describe EA (Niemann, 2006; Ross *et al.*, 2006; Simon *et al.*, 2014; Winter and Fischer, 2006; Zachman, 1987), they all explain EA as a strategic instrument to control and manage the complexity in an organization through structured description of the enterprise and its relationships. EA has tended into a holistic management of information systems in organizational approaches (Ross *et al.*, 2006; Winter and Fischer, 2006). All the entities, such as systems, stakeholders, relationships and dependencies, and business strategies can be included in an EA effort. In order to minimize the existing gap between business and IT, EA performs as a mediator to improve integration (Wu, 2007). In organizations, EA is placed between IT and business strategy, and it is responsible to translate the strategic principles, capabilities, and goals into the systems and processes (Tamm *et al.*, 2011).

EA is based on the business and IT models with systematic frameworks which detail enterprise structures. EA can be built with a specific architectural framework or adopt and customize a previously defined framework (Plazaola *et al.*, 2008). The outcome of EA is a set of artefacts that describe what business does, how it operates and what resources it requires, these artefacts are often presented graphically (Lankhorst, 2009; Ross *et al.*, 2006; Zachman, 1987).

Several benefits of EA have been recognized, including complexity management, faster adaptability, a comprehensive enterprise view, improved change management, and increased interoperability and integration (Armour *et al.*, 1999; Hoogervorst, 2004; Jonkers *et al.*, 2006; Morganwalp and Sage, 2004; Niemi, 2008).

2.3 EA and EI relationship

EI and interoperability have become one of the major concerns of today's enterprises. To achieve a competitive advantage and to facilitate integration processes, the enterprises must rethink the whole process of EI. Several integration approaches have been proposed since the companies realized the critical role of EI. However, at some point these approaches (such as Enterprise Application Integration, Enterprise Service Bus, and middleware) cannot fulfil EI issues due to tightly coupled applications, lack of interoperability, and poor scalability and security (Tang *et al.*, 2010). For these problems EA approach is proposed to solve EI problems. Several studies explicitly refer to EA as a solution to solve EI issues (Erol *et al.*, 2009b; Goethals *et al.*, 2006; Kang *et al.*, 2010; Kim *et al.*, 2006). To cope with the dynamic business environment, these studies suggest that adopting EA is one of the most successful approaches. Also, companies cannot gain alignment, flexibility, or integration if they do not architect their enterprises.

One of the many benefits of EA reported by Tamm *et al.* (2011) is the improvement of integration. EA has also been suggested to enhance information sharing through EI (Boh and Yellin, 2007; Ross *et al.*, 2006; Spewak and Hill, 1993).

3. Research method

SLR is a secondary study, which has its roots in medical research (Kitchenham, 2004). The application of SLR is to identify, evaluate, and interpret all the available and relevant literature related to a research question or domain of interest (Kitchenham, 2004, 2007; Petersen *et al.*, 2008). The most common reasons for undertaking SLR are: first, to summarize the existing evidence about the topic; second, to identify gaps in current research and provide suggestion for future investigation; and third, to provide background to position new research activities (Kitchenham, 2004).

A SMS or scoping review is another type of literature review that complements SLR (Kitchenham, 2004, 2007). A SMS study is applied to outline the types of research activity that have been engaged in the study. Unlike SLR, SMS describes the study in a high level and "map-out" the research rather than investigating research questions in details (Brereton *et al.*, 2007; Budgen *et al.*, 2008; Petersen *et al.*, 2008). In other words, a SMS can be considered as a method to get an overview of an specific research area (Kitchenham *et al.*, 2011), because, it narrates the studies rather than extracting detailed information (Brereton *et al.*, 2007). A SMS is preferred if during the examination of a domain and before initiating SLR, it is realized that, there is little existing research or the topic is too broad (Kitchenham, 2007; Petersen *et al.*, 2008). Since, our goal is to prepare an overview of the topic, SMS seems to be a viable approach to get an overview of existing research in the intersection of EA and EI.

3.1 Research questions

Research questions in SMS are much broader than in SLR to address the wider scope of study (Budgen *et al.*, 2008; Kitchenham, 2007). The research questions of this study

concentrate on categorizing and structuring the intersection of EA and EI. Table I shows all the research questions of this study.

3.2 Search steps

In order to augment the accuracy of this SMS study the searching and analysing processes have to be as transparent as possible. Thus, the following sections characterize the processes of selecting data sources, the applied strategy for creating the search string, and defining the exclusion and inclusion criteria. We adopt the process of search steps from Petersen *et al.* (2008) study. In this process each step has an outcome and the systematic map is the final outcome of the process. Figure 1 illustrates the complete SMS process used in this paper, which was done according to instructions by Petersen *et al.* (2008) and Wendler (2012).

3.2.1 Data sources and research strategy selection. We did electronic searches in the following databases: ACM Digital Library, Citeseer, Business Source Complete and

Table I. Research questions of this study

No.	Research question	Description
RQ1	What are the main research focuses on the literature about the role of EA in EI?	The answer provides an overview of main fields and research focuses regarding the role of EA in EI studies
RQ2	What are the most common research methods and paper types applied?	Investigations on types of paper and applied methods, determine the most important designs and methods and reveal gaps in the previous studies
RQ3	How has the number of publications changed over time?	This question reveals study trends and publications timeline

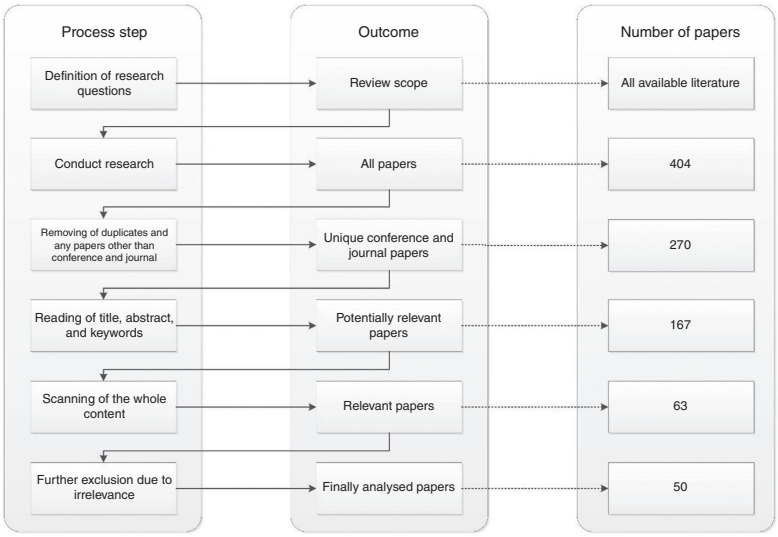

Figure 1. Search process

Academic Search Elite of EBSCO, Emerald Insight, IEEEXplore Digital Library, ScienceDirect, and SpringerLink. These digital libraries were selected because they are common and important libraries in the field of information systems.

The search string was created using the strategy from Barbosa and Alves (2011): first, we defined the main keywords; second, checked the already known papers in this area; third, looked for alternative forms of the keywords; fourth, we used Boolean operator to synthesize them into one search string. The final search string is as follows:

> "enterprise architecture" AND ("enterprise integration" OR "enterprise interoperability" OR "enterprise coordination" OR "enterprise coherence" OR "integration of enterprise" OR "coordination of enterprise")

This search string was applied to search within the all article parts, such as title, abstract, keywords, and main body. The search process began in May 2014.

The search string synonyms for "EI" were taken from dictionaries. After that we went through some sample articles and confirmed the synonyms. Besides "EI", the synonyms used were "enterprise interoperability", "enterprise coherence", and "enterprise coordination". In order to limit the number of search results and to have a more accurate set of search results from the databases, we placed each part of the search string in quotation marks to find the exact phrase.

3.2.2 Exclusion and inclusion criteria. The inclusion and exclusion criteria step is one of the activities of a mapping study to exclude irrelevant and include relevant studies (Petersen *et al.*, 2008). In other words, it ensures that only appropriate articles will be analysed.

For this study, the authors applied the following criteria for exclusion and inclusion of the articles (Table II).

We excluded book sections and theses because the number of search result would otherwise become too high it would be impossible in practice to analyse all of them. Besides, original scientific research is typically published in scientific journals and conferences for the first time. Thus, we minimized our search scope to only journal and conference papers.

To minimize the risk of excluding relevant articles, the articles that were not clear cases to exclude were read in detail at the last step of the SMS process. This process took place in Step 6 of SMS process, where 13 articles were excluded at last (refer to Figure 1).

Inclusion	Exclusion
Papers that focus both on EA and EI	The papers that lie outside of the EA and EI domain
English Language papers	Papers in other language than English
Only journal and conference papers	Dissertations, theses, book sections, product descriptions, presentations, work reports, trade literature, editorial notes, newsletters, grey literature, and indexes
Peer reviewed papers	Non-peer reviewed papers
	Duplicate papers

Table II. Inclusion and exclusion criteria

We used Zotero as the reference management software application to manage the references and to assist us in the third step of this mapping study to remove the duplicates. To remove the duplicates by using Zotero, first we sorted all the initial 404 articles based on the author's name and then by going through the author's name column, if the author's name was repeated in sequence then we checked the titles and the years and in case of repetition one of the articles that was not downloaded from one of the main publishers, such as Springer, ACM, IEEE, Emerald, and ScienceDirect had deleted. For instance, when we found a duplicate, one from Citeseer and the other one from ScienceDirect, and the original publisher of the article was ScienceDirect, then we deleted the article, which was downloaded from Citeseer database. In this way, we ended up having unique articles.

4. Classification scheme

To analyse and classify the articles, a classification scheme was developed. We took the idea of a classification scheme from Petersen *et al.* (2008) study. The process of classifying the articles is illustrated in Figure 2.

We created three facets to classify the studies. One facet categorized the articles based on their research methods. For research methods we were inspired by the classification provided by Palvia *et al.* (2004) for methodologies in MIS research and modified it based on our needs. The second facet defined the paper type based on the classification presented in Wieringa *et al.* (2006). In addition, we identified five categories of research focus by applying the keyword method described in Petersen *et al.* (2008). Table III describes the classification schemes of this study.

5. Mapping results

In the following sections based on the mapping results the research questions are answered. The results are based on the 50 selected articles. Table IV shows the categorization of the 50 articles based on their research focus, paper type, research method, and database. In total, 11 of these articles are conference papers and 39 journal papers.

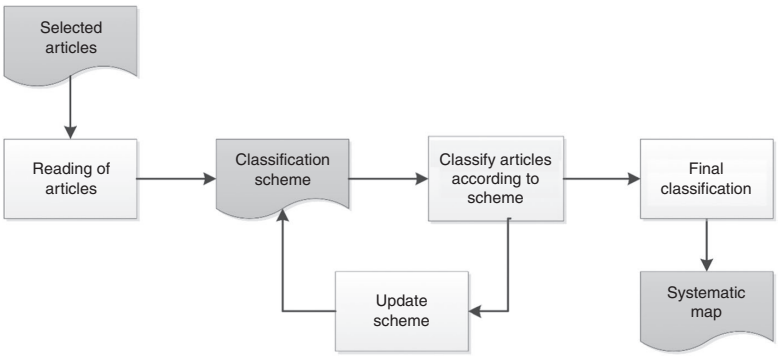

Figure 2.
Classification process

Paper type	
Validation research	Investigated methods are new and not yet implemented in practice
Evaluation research	Investigated methods are implemented in practice and the evaluation of the method is presented
Solution proposal	A solution for a problem is proposed, this solution proposal can be either new or applies and existing approach
Philosophical paper	These papers introduce a new perspective of an existing things by using taxonomy or conceptual framework
Experience paper	Personal experience of the author about what and how something has been done in practice
Research method	
Case study/multiple case studies	Study of a single phenomenon in one or more than one organization over a logical timeframe
Constructive study	Research that intends to construct a new framework, software artefact or conceptual model
Literature study	Research that analyses and extends existing literature
Discussion paper	Research that discusses an argument or a phenomena
Grounded theory	Research that aims towards theory development through the analysis of data
Survey	Research that uses predefined and structured questionnaires to capture data from individuals
Delphi study	Research that consists of two or more rounds of questionnaires answered by experts and it is based on forecasting methods
Research focus	
EA framework	Articles that their focus are on EA frameworks, methods, models, and tools that provide EI and interoperability
EI framework	Articles that their focus are on EI frameworks, methods, models, and tools by paying special attention to the role of EA
Enterprise interoperability	Articles that contains information about enterprise interoperability and its relation with EA and EI
Service-oriented architecture (SOA)	Articles that introduce SOA as an approach towards EI
Enterprise engineering	Articles that apply enterprise engineering approaches to reach to the EI by considering the special role of EA

Table III. Classification scheme

5.1 Research focuses (RQ1)

To answer *RQ1*, the classification of 50 articles per research topic and focus area is conducted by going through the title, abstract, and keywords. We categorized the research focus in five different categories of EA framework, EI framework, enterprise interoperability, service-oriented architecture (SOA), and enterprise engineering (EE). Description of each research focus is provided in Table III.

The categorization revealed five main topic areas (see Table III). The distribution of these research focuses is presented in Figure 3. We decided to classify each article only by its main research focus.

EA framework with 20 articles and EI framework with 15 articles are the two dominant topic areas. In comparison, only three articles had focused on EE. For instance, Cuenca *et al.* (2010) propose EE as a way to provide alignment between business and IT by utilizing EA to ensure the coherency and integration. Kosanke *et al.* (1999) discussed EE as an enterprise life-cycle oriented discipline to provide EI through modelling.

References	Research focus	Paper type	Research method	Database	Conference/ journal
Anaya and Ortiz (2005)	EA framework	Case study	Solution proposal	ACM	Conference
Rohloff (2008)	EA framework	Case study, discussion	Philosophical paper	ACM	Conference
Chen *et al.* (2005)	EA framework	Constructive research, case study	Experience paper	ACM	Conference
Boh *et al.* (2003)	EA framework	Grounded theory, case study, survey	Evaluation research	Citeseer	Conference
Buckl *et al.* (2009)	EA framework	Case study	Solution proposal	Citeseer	Conference
Goel *et al.* (2009)	EA framework	Discussion	Solution proposal	Citeseer	Conference
Hoogervorst (2004)	EA framework	Literature studies	Philosophical paper	Citeseer	Journal
Kilpeläinen (2007)	EA framework	Constructive research, case study	Evaluation research	Citeseer	Conference
Peristeras and Tarabanis (2000)	EA framework	Constructive research	Solution proposal	Citeseer	Journal
Umar (2007)	EA framework	Constructive research, case study	Evaluation research	Citeseer	Journal
Erol *et al.* (2010)	EA framework	Constructive research, literature studies	Philosophical paper	EBSCO	Journal
Bernus and Nemes (1997)	EA framework	Constructive research, discussion	Validation research	ScienceDirect	Journal
Bernus and Nemes (1996)	EA framework	Constructive research, discussion	Validation research	ScienceDirect	Journal
Kang *et al.* (2010)	EA framework	Constructive research	Solution proposal	ScienceDirect	Journal
Pulkkinen *et al.* (2007)	EA framework	Case study	Philosophical paper	ScienceDirect	Journal
Toh *et al.* (2009)	EA framework	Case study	Evaluation research	ScienceDirect	Journal
Zheng and Zheng (2013)	EA framework	Literature studies	Philosophical paper	ScienceDirect	Journal
Kim *et al.* (2006)	EA framework	Constructive research	Solution proposal	Springer	Journal
Goethals *et al.* (2006)	EA framework	Constructive research, discussion	Validation research	Springer	Journal
Vargas *et al.* (2014)	EA framework	Constructive research	Validation research	Springer	Journal
Chalmeta (2000)	EI framework	Constructive research	Validation research	Citeseer	Journal
Soomro and Awan (2012)	EI framework	Literature studies, discussion	Evaluation research	Citeseer	Journal
Lam (2005b)	EI framework	Case study	Evaluation research	EBSCO	Journal
Wu (2007)	EI framework	Constructive research	Validation research	Emerald	Journal
Lam (2005a)	EI framework	Grounded theory	Philosophical paper	Emerald	Journal

Table IV.
Systematic map overview

(*continued*)

References	Research focus	Paper type	Research method	Database	Conference/ journal
Wang *et al.* (2011)	EI framework	Literature studies	Philosophical paper	IEEE	Conference
Chen *et al.* (1997)	EI framework	Discussion	Philosophical paper	ScienceDirect	Journal
Li *et al.* (2010)	EI framework	Constructive research, case study	Evaluation research	ScienceDirect	Journal
Li *et al.* (2013)	EI framework	Constructive research, case study	Evaluation research	ScienceDirect	Journal
Ni *et al.* (2007)	EI framework	Constructive research, case study	Evaluation research	ScienceDirect	Journal
Noran (2013)	EI framework	Constructive research	Validation research	ScienceDirect	Journal
Panetto *et al.* (2012)	EI framework	Discussion	Philosophical paper	ScienceDirect	Journal
Namba and Iijima (2003)	EI framework	Constructive research, case study	Evaluation research	Springer	Journal
Moynihan (1997)	EI framework	Constructive research, case study	Evaluation research	Springer	Journal
Wang *et al.* (2012)	EI framework	Literature studies, discussion	Philosophical paper	Springer	Journal
Maheshwari and Janssen (2012)	Enterprise interoperability	Constructive research, case study	Evaluation research	ACM	Conference
Chen *et al.* (2008)	Enterprise interoperability	Literature studies, discussion	Philosophical paper	ScienceDirect	Journal
Chituc *et al.* (2008)	Enterprise interoperability	Constructive research, case study, literature studies	Evaluation research	ScienceDirect	Journal
Panetto and Molina (2008)	Enterprise interoperability	Discussion	Philosophical paper	ScienceDirect	Journal
Mezgár and Rauschecker (2014)	Enterprise interoperability	Constructive research, case study	Evaluation research	ScienceDirect	Journal
Vernadat (2007)	Enterprise interoperability	Discussion	Philosophical paper	ScienceDirect	Journal
Utomo (2011)	SOA	Case study	Experience paper	Citeseer	Journal
Erol *et al.* (2009b)	SOA	Constructive research	Validation paper	EBSCO	Journal
Pahl *et al.* (2009)	SOA	Constructive research	Solution proposal	EBSCO	Journal
Erol *et al.* (2009a)	SOA	Constructive research	Validation research	IEEE	Conference
Umar and Zordan (2009)	SOA	Case study	Evaluation research	ScienceDirect	Journal
Tang *et al.* (2010)	SOA	Constructive research, multiple case studies	Evaluation research	Springer	Journal
Cuenca *et al.* (2010)	Enterprise engineering	Case study, literature studies	Solution proposal	Citeseer	Conference
Kosanke and Nell (1999)	Enterprise engineering	Delphi study	Philosophical paper	ScienceDirect	Journal
Kosanke *et al.* (1999)	Enterprise engineering	Discussion	Philosophical paper	ScienceDirect	Journal

Table IV.

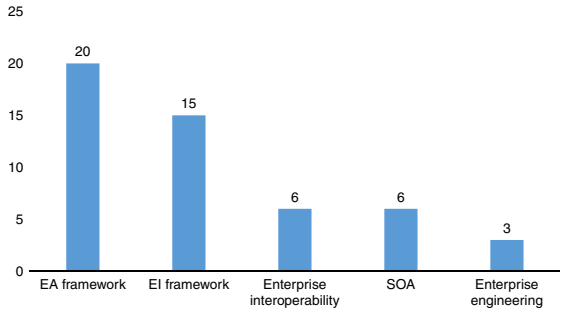

Figure 3.
Number of articles per research focus

Six articles contain descriptions about applying SOA approach to provide integration. Besides EI, enterprise flexibility, enterprise resilience, enterprise application reengineering and enterprise SOA were the other topics that are included in this category (Erol *et al.*, 2009a, b; Pahl *et al.*, 2009; Tang *et al.*, 2010).

Finally, six articles discussed about the role of EA in enterprise interoperability. Among these six articles some of them explicitly mentioned the difference between EI and enterprise interoperability (Chen *et al.*, 2008; Panetto and Molina, 2008), whereas some other articles refer to the enterprise interoperability as a kind of EI (Chituc *et al.*, 2008; Mezgár and Rauschecker, 2014). Despite all the similarities and differences between EI and enterprise interoperability, all of the articles in this classification have emphasized on the role of EA as a concept, method, or entity to reach to the integration.

5.1.1 EA framework. This category contains articles that have their emphasis on an EA framework. This included description of different EA frameworks and conceptual models in order to either manage EA or to implement and develop EA.

The significant role of EA in integrating an enterprise could be perceived even from the primary literature of EA. For instance, Richardson *et al.* (1990), referred to EA as an opportunity to support business functions and manage decision making by interrelating data, hardware, software and communications resources. In another study, Bernus and Nemes (1996) proposed a generic enterprise reference architecture to design and maintain enterprises for their entire life-cycle and to organize existing EI knowledge in the frequently changing environments. According to Kim *et al.* (2006) in order to solve information systems' integration problems, enterprises adopt the EA frameworks as an optimal solution. The criticality of change in enterprises and the role of EA can be realized from Zachman (1997) study that declared, quality, timeliness, and change as the issues that force us to consider EA more seriously. Therefore, it is crucial for an enterprise to be constantly re-architected to achieve integration (Goethals *et al.*, 2006).

The majority of the studies in the EA framework category have focused on frameworks and methodologies suggested to achieve EI (Bernus and Nemes, 1996; Chen *et al.*, 2005; Erol *et al.*, 2010; Goethals *et al.*, 2006; Hoogervorst, 2004; Kilpeläinen, 2007; Kim *et al.*, 2006; Peristeras and Tarabanis, 2000; Rohloff, 2008; Vargas *et al.*, 2014). The rest of the studies in this category have focused on tools, methods, and descriptions on how EA can help enterprises to achieve EI (Anaya and Ortiz, 2005; Buckl *et al.*, 2009; Goel *et al.*, 2009; Kang *et al.*, 2010; Pulkkinen *et al.*, 2007; Toh *et al.*, 2009; Umar, 2007; Zheng and Zheng, 2013).

5.1.2 EI framework. Integration issues have attracted much attention among scholars during the past decade (11 out of 14 articles in this category are between 2005 and 2013). This category contains the articles that emphasize on EI frameworks, methods, tools, and models. For instance, Chen *et al.* (1997) presented GERAM and GRAI, the two frameworks which assist to build integrated enterprise. In another recent attempt Noran (2013) proposed an EI framework to support integration. Besides EI frameworks enterprise modelling has mentioned as another approach to achieve EI, for instance, Moynihan utilized enterprise modelling to provide integration in manufacturing systems (Moynihan, 1997). Ni *et al.* (2007) proposed an approach to achieve business process integration in an enterprise applying modelling of business information model.

5.1.3 Enterprise interoperability. This category includes studies that distinguish integration from interoperability. For instance, the early study conducted by Papazoglou *et al.* (2000) referred to enterprise interoperability as one of the important requirement in order to achieve integrated value chain, and they defined interoperability as "the ability of one system to process information from and to another at a syntactic and semantic level without requiring either system to make changes to accommodate the other".

As mentioned in Section 2, some studies consider integration and interoperability as two different concepts (Chen and Doumeingts, 2003; Kosanke, 2006; Panetto and Molina, 2008; Vernadat, 2003). These studies argue that interoperability has the meaning of coexistence, autonomy, and federated environment, whereas they referred to integration as coordination, coherence, and uniformalization. In terms of coupling degree, Chen *et al.* (2008) referred to integrated systems as tightly coupled and interoperable systems as loosely coupled. In other words, they interpreted enterprise interoperability as loose integration of systems. This view includes that two integrated systems may be interoperable but not necessarily integrated (Chen and Doumeingts, 2003).

5.1.4 SOA. This category contains articles that have emphasized on SOA to gain EI. In spite of being only about ten years old as a concept, SOA has been applied widely as an approach to enterprise information systems development and EI. According to Erol *et al.* (2009a) SOA is recognized as a solution to overcome integration and interoperability issues.

Aiming to solve integration and interoperability problems, SOA provides novel integration patterns and infrastructures (Li *et al.*, 2010). The primary idea of SOA is to decompose applications into reusable components to deliver the business services (Umar and Zordan, 2009).

Pahl *et al.* (2009), referred to SOA as an integration architecture solution that supports various application scenarios. In their study, Pahl *et al.* presented a solution to integrate business information systems applying SOA and web services.

5.1.5 EE. The category of EE contains only three but important articles that highlight the significance of EE in EI. EA is considered to be the foundation of EE, and EI is an essential part of EE. In other words, gaining and maintaining EI are parts of EE tasks; therefore, EE project managers should constantly evaluate the current situation and be prepared for future optimal state (Cuenca *et al.*, 2010; Kosanke, 2005; Kosanke *et al.*, 1999; Lillehangen and Krogstie, 2008; Noran, 2013; Panetto and Molina, 2008). Managers can benefit from EA to manage the on-going EE efforts to achieve and maintain EI (Cuenca *et al.*, 2010; Kosanke *et al.*, 1999; Kosanke and Nell, 1999).

5.2 Paper type and research method (RQ2)

Paper type indicates the classification of papers with the categorization proposed by Wieringa *et al.* (2006), in which research is classified into six categories: validation research; evaluation research; proposal of solution; philosophical papers; opinion papers; and personal experience papers. To provide an answer to *RQ2*, we categorized the final 50 papers with this classification, but because we were not able to find any papers that can be fitted in the criteria of opinion papers, we did not include this type in our classification. Opinion papers are the type of papers that contain the author's personal opinion about something. The explanation of each category can be found in Table III.

Figure 4 illustrates the distribution of paper type based on the research topic of the paper. The most frequent paper type is evaluation research with 32 per cent. The next most frequent paper type is philosophical paper with 30 per cent. Validation research and solution proposal are the third and fourth most frequent paper type with 18 and 16 per cent, respectively. However, only 4 per cent of the papers are experience reports.

The research method classification is based on Palvia *et al.* (2004) classification of MIS research. While analysing the selected 50 articles additional research methods, such as Delphi study, grounded theory, and discussion paper are added. We identified seven research methods in the 50 analysed papers (refer to Table III for explanation of each category). We analysed the employed research methods for each paper. For example Boh *et al.* (2003) applied three research methods in their study. They used grounded theory to develop hypotheses and they used case study and survey to test their hypotheses. In this situation we considered all of these three applied research methods in our analysis for this paper.

Figure 5, shows the distribution of research method based on the research topic of this paper. Constructive research with 35 per cent is recognized as the predominant research method. After that case study or multiple case studies with 30 per cent ranked

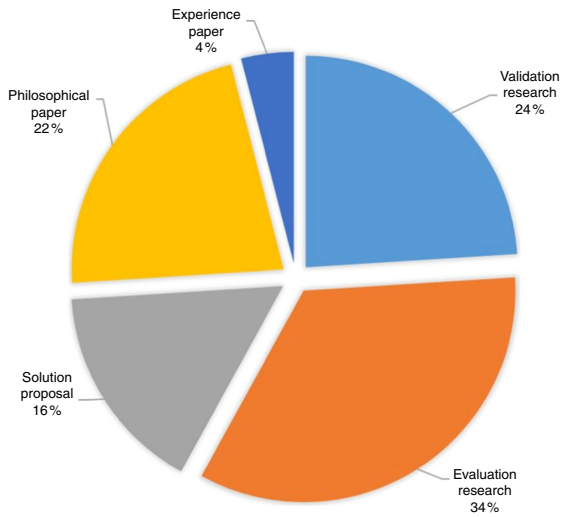

Figure 4.
Distribution of paper types

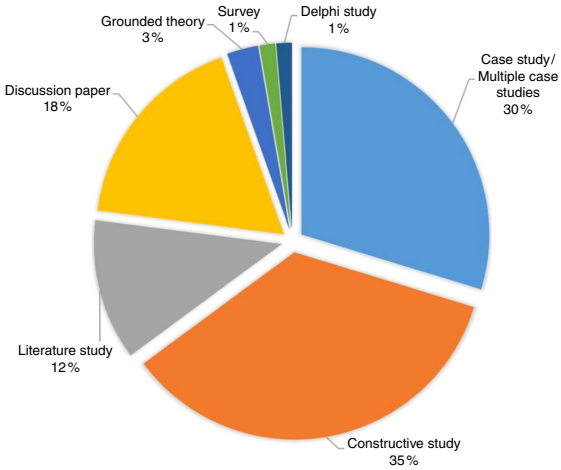

Figure 5. Distribution of research methods

in the second place of the most frequent research methods. Discussion paper and literature study with 18 and 12 per cent are the third and fourth most used research methods. Grounded theory with 3 per cent, survey and Delphi study both with 1 per cent are the least applied research methods.

Another way of analysis regarding *RQ2* is to disclose the distribution of research content over the research method and research type (see Figure 6). The bubble chart diagram in Figure 6 displays the mapping of the 50 studies based on the research content. This mapping chart illustrates the concentration of the articles. From this bubble chart we can conclude that constructive research and case study are the two most frequent research methods; evaluation research and solution proposal are the two most frequent paper types for the papers focused on an EA framework. Constructive research and case study are the most applied research methods for the papers in the EI framework category and evaluation research is the dominant paper type. Surprisingly, there is only one survey and one Delphi study conducted among the papers in the intersection of EA and EI. Grounded theory is not applied often. Also, the experience paper type is rarely employed in this research topic.

To analyse the distribution of articles from another dimension, Figure 7 presents the number of articles per research method combined with paper type. Constructive research is the predominant research method for the validation research articles (nine articles). For instance, Erol *et al.* (2009b) proposed a conceptual model to create enterprise flexibility using SOA approach. The second most common research method in this mapping study is case study, which is the major research method for the evaluation research type of papers. For instance, Li *et al.* (2013), proposed a framework for the inter-organizational integration and discussed this framework in the content of a real-world case study. Constructive research and case study are the two most frequent applied research methods for the papers considered as solution proposal. As for the philosophical papers, literature studies and discussion are the dominant research methods. Case study and constructive research are the only two research methods applied in the experience papers.

Figure 6.
Number of articles per research method and paper type combined with research focus

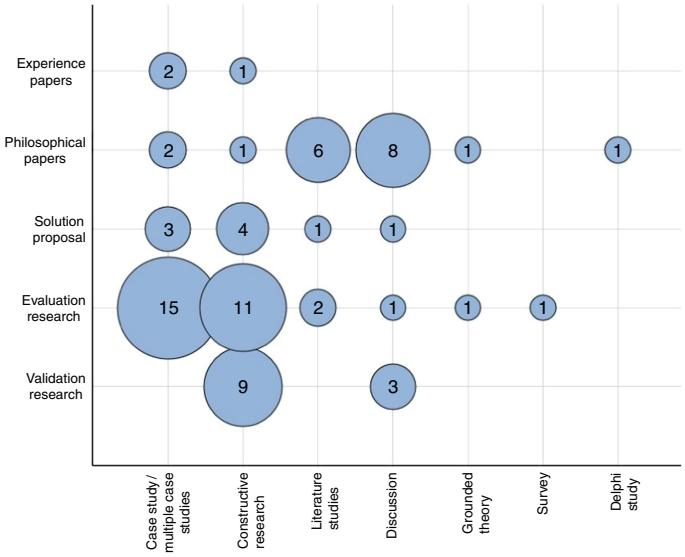

Figure 7. Distribution of articles per research method combined with paper type

5.3 Research trends (RQ3)

To answer *RQ3*, the distribution of 50 analysed articles is illustrated in Figure 8 in periods of three years from 1996 to the beginning of 2014. Starting from 2004, a steady rise is noticeable, reaching in peak with 16 articles by the end of 2010. This result indicates that the topic to determine the role of EA in EI have become more important for the scholars during the last few years. One reason for this increase could be that governments force organizations to develop EA. However, the number of published articles in this area declined to nine articles between 2011 and 2013. At this time we cannot discuss only about 2014 articles since our time scope is three years.

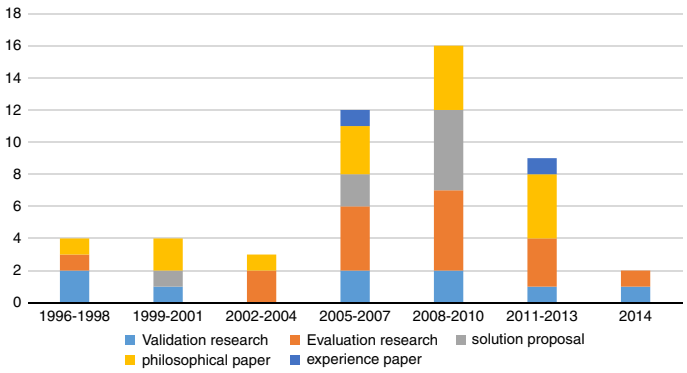

Figure 8. Publication timeline based on number of articles in periods of three years

The downward trend in the number of publications from 2010 to 2013, could be due to the economic recession (Mayall, 2009), because management may often consider EA development as a low-priority and costly task. Therefore, in situations like in an economic recession CIOs postpone the development of EA and consider it as a low-priority task.

Figure 8 also illustrates the number of paper types in each year. From this stacked column chart we may note that between 1996 and 2001 the dominate paper types were "Philosophical paper" and "Validation research" which means that during these years new frameworks and models were developed but they were not validated in practice. However, from 2002 to beginning of 2014 number of "Evaluation research" papers has increased significantly, which means that during these years new frameworks were developed and evaluated in practice. The number of "Solution proposal" papers have also noticeably growth, which can imply the importance of the role of EA as a solution to facilitate EI.

6. Discussion

6.1 Summary of findings

This study is a SMS that provides a comprehensive overview on the intersection of EA and EI. Researchers and experts, for instance, may use the result of this study as an initial point for their research and projects.

During this study, after defining our research strategy we searched through the selected databases and found 404 articles. Not all of these were relevant and unique, therefore we defined the exclusion and inclusion criteria. Then we had 50 relevant and unique articles to analyse. To analyse the 50 papers, we developed a classification scheme. We classified the articles based on their research focus, paper type, and research method (refer to Table III).

Regarding the research focus, we concluded that "EA framework" with 20 articles is the dominant research focus and "EI framework" with 15 articles is the next dominant one. Regarding the paper type, "Evaluation research" is the most frequently employed paper type. We identified only two papers that can be categorized in the "Experience papers" category, which is the least used paper type.

"Constructive study" and "Case study/Multiple case studies", respectively with 35 and 30 per cent of the papers were the most used research methods in this area. However, "Survey", "Delphi study", and "Grounded theory" were used less often.

"Solution proposal" and "Evaluation research" were the two most employed paper type for papers focused on "EA framework". Employing bubble chart illustration, the gaps in this research area were discovered and highlighted the current emphases in this research.

We concluded that the majority of "Evaluation research" papers employed "Case study/Multiple case studies" as the research method. Moreover, most of the "Validation research" papers were "Constructive research" and majority of the papers that used "Constructive research" as their research method, were "Evaluation research". This means that the articles proposed new framework or conceptual model and they implemented and evaluated the novel proposal in practice. However, the numbers of "Validation research" in this category was still noticeable.

"Validation research" and "Philosophical paper" were the most common paper type between 1996 and 2004, and after that "Evaluation research" was the dominant research paper type. This indicates that the research has been more practical during the last decade. We noticed that number of publications between 2010 and 2013 declined, which may be because of the economic downturn.

6.2 Threats to validity

In this kind of research it is necessary to identify potential problems of bias and validity to permit readers to verify the credibility of the presented results. On account of the fact that there are some threats to the validity of our study, it is crucial to evaluate the validity of this mapping study. There are at least three kinds of threats that should be addressed to validate the credibility of the results (Perry *et al.*, 2000): construct validity; internal validity; and external validity.

Construct validity refers to what extend the inferences can be made with respect to research questions of the study. Construct validity measures the operability of a construct against theory (Perry *et al.*, 2000). To assure construct validity of this article, we explicitly defined the research questions and objectives of the current work in the research method steps, therefore, it helps to provide the same interpretations for other scholars who are interested in replicating this research process in future. To find the maximum number of relevant articles for mapping study regarding our research questions, we defined and refined our search queries based on the obtained results and considered synonym words in our search string and performed the queries in the most well known and related electronic databases.

Another aspect of construct validity that should be taken into account is to assure that all the relevant articles are included (Mohabbati *et al.*, 2013). Thus, we strove to incorporate as many articles as possible by using only the electronic databases. However, it is possible that we might have missed some articles that electronic databases could not find them.

It is also crucial to address internal and external validity threats on a study. Internal validity is related to the extent to which the designing and conducting of the study minimizes the systematic error or bias results. Whereas external validity is related to the extent to which the result of a study can be applied to other situations outside of the study.

Replication of mapping study is one way to mitigate the threats of internal and external validity (Shull *et al.*, 2008). Moreover, in terms of internal validity, to extract data we limited ourselves to the specific techniques mentioned in the research method section and unveiled the results by charts, graphs, and tables. In other words, applying a well defined methodology minimized bias of the study. The external validity is guaranteed since we did not make any generalizations, claims, and projections.

6.3 Limitations

This SMS study suffers from few limitations. First, we limited ourselves to only seven scientific databases, thus we could not cover all the existing journal and conference databases. Moreover, we considered only peer reviewed articles, such as journal and conference papers, and we did not include any book sections or magazines in our study.

In the realm of search keywords, we strove to apply synonym terms as much as possible in order to get maximum amount of results. For instance we used "interoperability", "coordination", and "coherence" as the alternatives for "integration". However, it is possible that we miss some articles that have used other terms, such as "enterprise unification".

7. Conclusion remarks and future work

The main motivation of the presented study was to provide an overview of existing literature that have investigated the role of EA in EI. We applied

a SMS method (Kitchenham, 2007; Petersen *et al.*, 2008) in order to determine what issues have been studied in this research domain. We classified the existing studies based on the employed research methods as well as the paper types. The adopted research method (SMS) is a practical research method to recognize the areas where there is adequate information about a topic, as well as those domains where more research is required. The results of this study provide a guideline to assist researchers in planning future research through the discovery of research gaps.

The presented study, analysed the content of 50 articles and categorized them based on their research focus, research method, and paper type; it also examined the research trend and the distribution of paper types over the years.

By conducting this SMS study we realized that almost two-third of the previous studies were focused on frameworks and conceptual models. Despite the importance of some topics, such as SOA, enterprise interoperability, and EE, however, the modest role of research in these areas is quite surprising. Regarding the paper type we noticed that experience papers appeared rarely in the literature. The significant number of "Evaluation research" in the last decade, emphasizes the development and implementation of EA and EI in practice.

Our research has implications for both researchers and practitioners. Going through the papers categorized as "Evaluation research" in Table IV, practitioners can realize which EA or EI methods are implemented and evaluated in practice. For researchers, this paper provides a good insight into the existing research in the intersection of EA and EI. Also, this study indicated the gaps in this area of research. For instance, the need for having more research using empirical research methods has been realized. Considering the publication trend researchers can realize the tendency in publication of "Evaluation research" in the last decade.

Primary implications for future research include a need for more research using empirical methods, such as surveys and interviews. Delphi study as a research method that employs questionnaires has been applied very rarely in this area of research. Surprisingly, we identified only two papers that applied grounded theory. It is notable that qualitative approaches, such as ethnography and action research are completely missing from the population of the selected 50 articles.

It is important that enterprises can solve their integration issues rapidly and efficiently. Therefore, one important aspect is to first realize the integration challenges and barriers in a company. For future research we can employ empirical research methods, such as surveys and ethnographies to collect data and experience about integration challenges. After that, we can provide solutions on how EA can help enterprises to eliminate the EI challenges. It is also possible in the future to investigate how the trends and attention change in this research domain.

References

Anaya, V. and Ortiz, A. (2005), "How enterprise architectures can support integration", *Proceedings of the First International Workshop on Interoperability of Heterogeneous Information Systems. ACM*, pp. 25-30.

Armour, F.J., Kaisler, S.H. and Liu, S.Y. (1999), "A big-picture look at enterprise architectures", *IT Professional*, Vol. 1 No. 1, pp. 35-42.

Barbosa, O. and Alves, C. (2011), "A systematic mapping study on software ecosystems", Workshop on Software Ecosystems, Brussels, pp. 15-26.

Bernus, P. and Nemes, L. (1996), "A framework to define a generic enterprise reference architecture and methodology", *Computer Integrated Manufacturing Systems*, Vol. 9 No. 3, pp. 179-191.

Bernus, P. and Nemes, L. (1997), "Requirements of the generic enterprise reference architecture and methodology", *Annual Reviews in Control*, Vol. 21, pp. 125-136. doi: 10.1016/S1367-5788 (97)00036-9.

Boh, W.F. and Yellin, D. (2007), "Using enterprise architecture standards in managing information technology", *Journal of Management Information Systems*, Vol. 23 No. 3, pp. 163-207.

Boh, W.F., Yellin, D., Dill, B. and Herbsleb, J.D. (2003), "Effectively managing information systems architecture standards: an intra-organization perspective", MISQ Special Issue Workshop on Standard Making: A Critical Frontier for Information Systems, pp. 12-14.

Boucharas, V., van Steenbergen, M., Jansen, S. and Brinkkemper, S. (2010), "The contribution of enterprise architecture to the achievement of organizational goals: a review of the evidence", in Proper, E., Lankhorst, M.M., Schönherr, M., Barjis, J. and Overbeek, S. (Eds), *Trends in Enterprise Architecture Research*, Springer, Berlin Heidelberg, pp. 1-15.

Brereton, P., Kitchenham, B.A., Budgen, D., Turner, M. and Khalil, M. (2007), "Lessons from applying the systematic literature review process within the software engineering domain", *Journal of Systems and Software*, Vol. 80 No. 4, pp. 571-583.

Buckl, S., Ernst, A.M., Kopper, H., Marliani, R., Matthes, F., Petschownik, P. and Schweda, C.M. (2009), "EA management patterns for consolidations after mergers", presented at the Patterns in Enterprise Architecture Management (PEAM2009) Workshop, Kaiserslautern.

Budgen, D., Turner, M., Brereton, P. and Kitchenham, B. (2008), "Using mapping studies in software engineering", *Proceedings of PPIG*, pp. 195-204.

Chalmeta, R. (2000), "Virtual transport enterprise integration", *Journal of Integrated Design and Process Science*, Vol. 4 No. 4, pp. 45-55.

Chalmeta, R., Campos, C. and Grangel, R. (2001), "References architectures for enterprise integration", *Journal of Systems and Software*, Vol. 57 No. 3, pp. 175-191. doi: 10.1016/ S0164-1212(01)00008-5.

Chen, D. and Doumeingts, G. (2003), "European initiatives to develop interoperability of enterprise applications – basic concepts, framework and roadmap", *Annual Reviews in Control*, Vol. 27, pp. 153-162. doi: 10.1016/j.arcontrol.2003.09.001.

Chen, D., Doumeingts, G. and Vernadat, F. (2008), "Architectures for enterprise integration and interoperability: past, present and future", *Computers in Industry, Enterprise Integration and Interoperability in Manufacturing Systems*, Vol. 59 No. 7, pp. 647-659. doi: 10.1016/j. compind.2007.12.016.

Chen, D., Vallespir, B. and Doumeingts, G. (1997), "GRAI integrated methodology and its mapping onto generic enterprise reference architecture and methodology", *Computers in Industry, Co-Operation in Manufacturing Systems, CIM at Work*, Vol. 33 Nos 2-3, pp. 387-394. doi: 10.1016/S0166-3615(97)00043-2.

Chen, Y., Chen, M. and Faulkner, G. (2005), "Towards a conceptual design of an intelligent system for an international trade centre in China", *Proceedings of the 7th International Conference on Electronic Commerce. ACM*, pp. 78-84.

Chituc, C.-M., Toscano, C. and Azevedo, A. (2008), "Interoperability in collaborative networks: independent and industry-specific initiatives – the case of the footwear industry", *Computers in Industry, Enterprise Integration and Interoperability in Manufacturing Systems*, Vol. 59 No. 7, pp. 741-757. doi: 10.1016/j.compind.2007.12.012.

Cuenca, L., Boza, A. and Ortiz, A. (2010), "Enterprise engineering approach for business and is/it strategic alignment", *8th International Conference of Modeling and Simulation – MOSIM*, pp. 10-12.

Erol, O., Mansouri, M. and Sauser, B. (2009a), "A framework for enterprise resilience using service oriented architecture approach", *3rd Annual IEEE International Systems Conference. Presented at the IEEE SysCon 2009, IEEE, Vancouver*, pp. 127-132. doi: 10.1109/SYSTEMS.2009.4815785.

Erol, O., Sauser, B.J. and Boardman, J.T. (2009b), "Creating enterprise flexibility through service oriented architecture", *Global Journal of Flexible Systems Management*, Vol. 10 No. 1, pp. 11-16.

Erol, O., Sauser, B.J. and Mansouri, M. (2010), "A framework for investigation into extended enterprise resilience", *Enterprise Information Systems*, Vol. 4 No. 2, pp. 111-136.

Giachetti, R.E. (2004), "A framework to review the information integration of the enterprise", *International Journal of Production Research*, Vol. 42 No. 6, pp. 1147-1166. doi: 10.1080/00207540310001622430.

Goel, A., Schmidt, H. and Gilbert, D. (2009), "Towards formalizing virtual enterprise architecture", *13th Enterprise Distributed Object Computing Conference Workshops, EDOCW, IEEE*, pp. 238-242.

Goethals, F.G., Snoeck, M., Lemahieu, W. and Vandenbulcke, J. (2006), "Management and enterprise architecture click: the FAD(E)E framework", *Information Systems Frontiers*, Vol. 8 No. 2, pp. 67-79. doi: 10.1007/s10796-006-7971-1.

Henderson, J.C. and Venkatraman, N. (1993), "Strategic alignment: leveraging information technology for transforming organizations", *IBM Systems Journal*, Vol. 32 No. 1, pp. 4-16.

Hoogervorst, J. (2004), "Enterprise architecture: enabling integration, agility and change", *International Journal of Cooperative Information Systems*, Vol. 13 No. 3, pp. 213-233.

Huat Lim, S., Juster, N. and de Pennington, A. (1997), "Enterprise modelling and integration: a taxonomy of seven key aspects", *Computers in Industry*, Vol. 34 No. 3, pp. 339-359. doi: 10.1016/S0166-3615(97)00069-9.

IFIP-IFAC TF (1999), "GERAM: generalised enterprise reference architecture and methodology version 1.6. 3", IFIP-IFAC TF, avaialable at: www2.mitre.org/public/eabok/pdf/geram.pdf (accessed 20 January 2016).

Jonkers, H., Lankhorst, M.M., ter Doest, H.W., Arbab, F., Bosma, H. and Wieringa, R.J. (2006), "Enterprise architecture: management tool and blueprint for the organisation", *Information Systems Frontiers*, Vol. 8 No. 2, pp. 63-66.

Kang, D., Lee, J., Choi, S. and Kim, K. (2010), "An ontology-based enterprise architecture", *Expert Systems with Applications*, Vol. 37 No. 2, pp. 1456-1464.

Kilpeläinen, T. (2007), "Business information driven approach for EA development in practice", *The Proceedings of the 18th Australasian Conference on Information Systems*, Citeseer, pp. 5-7.

Kim, J.-W., Kwon, J.-H., Kim, Y.-G., Song, C.-Y., Kim, H.-S. and Baik, D.-K. (2006), "EAFoC: enterprise architecture framework based on commonality", *Journal of Computer Science and Technology*, Vol. 21 No. 6, pp. 952-964. doi: 10.1007/s11390-006-0952-5.

Kitchenham, B. (2004), "Procedures for performing systematic reviews", Keele University, Keele.

Kitchenham, B.A. (2007), "Guidelines for performing systematic literature reviews in software engineering", EBSE Technical Report No. EBSE-2007-01, Software Engineering Group, School of Computer Science and Mathematics, Keele University, Keele, Staffordshire, and Department of Computer Science, University of Durham, Durham, 9 July, version 2.3.

Kitchenham, B.A., Budgen, D. and Pearl Brereton, O. (2011), "Using mapping studies as the basis for further research – a participant-observer case study", *Information and Software Technology*, Special Section: Best papers from the APSEC, Vol. 53 No. 6, pp. 638-651. doi: 10.1016/j.infsof.2010.12.011.

Kosanke, K. (2005), "Standards in enterprise inter- and intra-organisational integration", in Bernus, P. and Fox, M. (Eds), *Knowledge Sharing in the Integrated Enterprise, IFIP – The International Federation for Information Processing*, Springer, pp. 9-20.

Kosanke, K. (2006), "ISO standards for interoperability: a comparison", in Konstantas, D., Bourrières, J.-P., Léonard, M. and Boudjlida, N. (Eds), *Interoperability of Enterprise Software and Applications*, Springer, London, pp. 55-64.

Kosanke, K. and Nell, J.G. (1999), "Standardisation in ISO for enterprise engineering and integration", *Computers in Industry*, Vol. 40 Nos 2-3, pp. 311-319. doi: 10.1016/S0166-3615(99)00034-2.

Kosanke, K., Vernadat, F. and Zelm, M. (1999), "CIMOSA: enterprise engineering and integration", *Computers in Industry*, Vol. 40 Nos 2-3, pp. 83-97. doi: 10.1016/S0166-3615(99)00016-0.

Lam, W. (2005a), "Barriers to e-government integration", *Journal of Enterprise Information Management*, Vol. 18 No. 5, pp. 511-530. doi: 10.1108/17410390510623981.

Lam, W. (2005b), "An enterprise application integration (EAI) case-study: seamless mortgage processing at Harmond Bank", *Journal of Computer Information Systems*, Vol. 46 No. 1, pp. 35-43.

Lankhorst, M. (2009), *Enterprise Architecture at Work: Modelling, Communication and Analysis (The Enterprise Engineering Series)*, 2nd ed., Springer, Berlin Heidelberg.

Lee, J., Siau, K. and Hong, S. (2003), "Enterprise integration with ERP and EAI", *Communications of the ACM*, Vol. 46 No. 2, pp. 54-60.

Li, Q., Zhou, J., Peng, Q.-R., Li, C.-Q., Wang, C., Wu, J. and Shao, B.-E. (2010), "Business processes oriented heterogeneous systems integration platform for networked enterprises. Computers in industry", *Integration and Information in Networked Enterprises*, Vol. 61 No. 2, pp. 127-144. doi: 10.1016/j.compind.2009.10.009.

Li, S.-H., Huang, S.-M., Yen, D.C., Shih, D.-H. and Hsueh, H.-Y. (2013), "Business-to-government application integration framework: a case study of the high technology industry in Taiwan", *Computer Standards & Interfaces*, Vol. 35 No. 6, pp. 582-595. doi: 10.1016/j.csi.2013.04.005.

Lillehangen, F. and Krogstie, J. (2008), "Customer challenges and demands", *Active Knowledge Modeling of Enterprises*, Springer, Berlin Heidelberg, pp. 27-64.

Lim, S.H., Juster, N. and de Pennington, A. (1998), "A role interaction approach to support manufacturing enterprise integration", *Proceedings of the Institution of Mechanical Engineers Vol. 212*, p. 439.

Lucke, C., Krell, S. and Lechner, U. (2010), "Critical issues in enterprise architecting – a literature review", *AMCIS 2010 Proceedings of the 16th Americas Conference on Information Systems, Lima*.

Maheshwari, D. and Janssen, M. (2012), "Measuring organizational interoperability in practice: the case study of population welfare department of government of Sindh, Pakistan", in Gil-Garcia, J.R., Helbig, N. and Ojo, A. (Eds), *Proceedings of the 6th International Conference on Theory and Practice of Electronic Governance*, ACM, New York, NY, pp. 216-225.

Mayall, A. (2009), "Coming out of the recession: the role of enterprise architecture", *Architecture & Governance Magazine*, September, p. 5.

Mezgár, I. and Rauschecker, U. (2014), "The challenge of networked enterprises for cloud computing interoperability", *Computers in Industry*, Vol. 65 No. 4, pp. 657-674. doi: 10.1016/j.compind.2014.01.017.

Mohabbati, B., Asadi, M., Gašević, D., Hatala, M. and Müller, H.A. (2013), "Combining service-orientation and software product line engineering: a systematic mapping study", *Information and Software Technology*, Vol. 55 No. 11, pp. 1845-1859. doi: 10.1016/j.infsof.2013.05.006.

Morganwalp, J.M. and Sage, A.P. (2004), "Enterprise architecture measures of effectiveness", *International Journal of Technology, Policy and Management*, Vol. 4 No. 1, pp. 81-94.

Moynihan, G.P. (1997), "The application of enterprise modeling for aerospace manufacturing system integration", *International Journal of Flexible Manufacturing Systems*, Vol. 9 No. 2, pp. 195-210. doi: 10.1023/A:1007971819123.

Namba, Y. and Iijima, J. (2003), "'EII Meta-model' on integration framework for viable enterprise systems – city planning metaphor based on structural similarity", *Journal of Systems Science and Systems Engineering*, Vol. 12 No. 1, pp. 111-126.

Ngeru, J., David, D. and Hargrove, S.K. (2009), "Developing an enterprise integration strategy using an AHP-Delphi approach", *Journal of Management & Engineering Integration*, Vol. 2 No. 1, pp. 92-101.

Ni, Q., Lu, W.F., Yarlagadda, P.K.D.V. and Ming, X. (2007), "Business information modeling for process integration in the mold making industry", *Robotics and Computer-Integrated Manufacturing*, Vol. 23 No. 2, pp. 195-207. doi: 10.1016/j.rcim.2005.12.006.

Niemann, K.D. (2006), *From Enterprise Architecture to IT Governance*, Springer, MercedesDruck, Berlin.

Niemi, E. (2008), "Enterprise architecture benefits: perceptions from literature and practice", *Proceedings of the 7th IBIMA Conference Internet & Information Systems in the Digital Age, Brescia, 14-16 December 2006*.

Noran, O. (2013), "Building a support framework for enterprise integration", *Computers in Industry*, Vol. 64 No. 1, pp. 29-40. doi: 10.1016/j.compind.2012.09.006.

Pahl, C., Zhu, Y. and Gacitua-Decar, V. (2009), "A template-driven approach for maintainable service-oriented information systems integration", *International Journal of Software Engineering and Knowledge Engineering*, Vol. 19 No. 7, pp. 889-912.

Palvia, P., Leary, D., Mao, E., Midha, V., Pinjani, P. and Salam, A.F. (2004), "Research methodologies in MIS: an update", *Communications of the Association for Information Systems*, Vol. 14 No. 1, pp. 526-542.

Panetto, H. and Molina, A. (2008), "Enterprise integration and interoperability in manufacturing systems: trends and issues", *Computers in Industry*, Vol. 59 No. 7, pp. 641-646.

Panetto, H., Jardim-Goncalves, R. and Molina, A. (2012), "Enterprise integration and networking: theory and practice", *Annual Reviews in Control*, Vol. 36, pp. 284-290. doi: 10.1016/j.arcontrol.2012.09.009.

Papazoglou, M.P., Ribbers, P. and Tsalgatidou, A. (2000), "Integrated value chains and their implications from a business and technology standpoint", *Decision Support Systems*, Vol. 29 No. 4, pp. 323-342. doi: 10.1016/S0167-9236(00)00081-6.

Peristeras, V. and Tarabanis, K. (2000), "Towards an enterprise architecture for public administration using a top-down approach", *European Journal of Information Systems*, Vol. 9 No. 4, pp. 252-260.

Perry, D.E., Porter, A.A. and Votta, L.G. (2000), "Empirical studies of software engineering: a roadmap", *Proceedings of the Conference on the Future of Software Engineering, ICSE '00. ACM, New York, NY*, pp. 345-355. doi: 10.1145/336512.336586.

Petersen, K., Feldt, R., Mujtaba, S. and Mattsson, M. (2008), "Systematic mapping studies in software engineering", *12th International Conference on Evaluation and Assessment in Software Engineering*, p. 1.

Plazaola, L., Flores, J., Vargas, N. and Ekstedt, M. (2008), "Strategic business and IT alignment assessment: a case study applying an enterprise architecture-based metamodel", *Hawaii International Conference on System Sciences, Proceedings of the 41st Annual, IEEE*, pp. 398-398.

Pulkkinen, M., Naumenko, A. and Luostarinen, K. (2007), "Managing information security in a business network of machinery maintenance services business – enterprise architecture as a coordination tool", *Journal of Systems and Software, Methodology of Security Engineering for Industrial Security Management Systems*, Vol. 80 No. 10, pp. 1607-1620. doi: 10.1016/j.jss.2007.01.044.

Richardson, G.L., Jackson, B.M. and Dickson, G.W. (1990), "A principles-based enterprise architecture: lessons from Texaco and star enterprise", *MIS Quarterly*, Vol. 14 No. 4, pp. 385-403.

Rohloff, M. (2008), "An integrated view on business-and IT-architecture", *Proceedings of the 2008 ACM Symposium on Applied Computing*, pp. 561-565.

Ross, J.W., Weill, P. and Robertson, D.C. (2006), *Enterprise Architecture as Strategy: Creating a Foundation for Business Execution*, Harvard Business Press, Boston, MA.

Sedek, K.A., Sulaiman, S. and Omar, M.A. (2011), "A systematic literature review of interoperable architecture for e-government portals", *5th Malaysian Conference on Software Engineering (MySEC)*, pp. 82-87. doi: 10.1109/MySEC.2011.6140648.

Shull, F.J., Carver, J.C., Vegas, S. and Juristo, N. (2008), "The role of replications in empirical software engineering", *Empirical Software Engineering*, Vol. 13 No. 2, pp. 211-218.

Simon, D., Fischbach, K. and Schoder, D. (2014), "Enterprise architecture management and its role in corporate strategic management", *Information Systems and e-Business Management*, Vol. 12 No. 1, pp. 5-42. doi: 10.1007/s10257-013-0213-4.

Soomro, T.R. and Awan, A.H. (2012), "Challenges and future of enterprise application integration", *International Journal of Computer Applications*, Vol. 42 No. 7, pp. 42-45.

Sowa, J.F. and Zachman, J.A. (1992), "Extending and formalizing the framework for information systems architecture", *IBM Systems Journal*, Vol. 31 No. 3, pp. 590-616.

Spewak, S.H. and Hill, S.C. (1993), *Enterprise Architecture Planning: Developing a Blueprint for Data, Applications and Technology*, QED Information Sciences, Inc, Wellesley, MA.

Stelzer, D. (2010), "Enterprise architecture principles: literature review and research directions", in Dan, A., Gittler, F. and Toumani, F. (Eds), *Service-Oriented Computing – ICSOC 2009 Workshops*, Springer, Berlin Heidelberg, pp. 12-21.

Tamm, T., Seddon, P.B., Shanks, G. and Reynolds, P. (2011), "How does enterprise architecture add value to organisations?", *Communications of the Association for Information Systems*, Vol. 28 No. 1, pp. 141-168.

Tang, L., Dong, J., Peng, T. and Tsai, W.-T. (2010), "Modeling enterprise service-oriented architectural styles", *Service Oriented Computing and Applications*, Vol. 4 No. 2, pp. 81-107. doi: 10.1007/s11761-010-0059-2.

Toh, K.T.K., Nagel, P. and Oakden, R. (2009), "A business and ICT architecture for a logistics city", *International Journal of Production Economics, Transport Logistics and Physical Distribution Interlocking of Information Systems for International Supply and Demand Chains Management ICPR19*, Vol. 122 No. 1, pp. 216-228. doi: 10.1016/j.ijpe.2009.05.021.

Umapathy, K., Purao, S. and Barton, R.R. (2008), "Designing enterprise integration solutions: effectively", *European Journal of Information Systems*, Vol. 17 No. 5, pp. 518-527. doi: http://dx.doi.org/10.1057/ejis.2008.39.

Umar, A. (2007), "Intelligent decision support for architecture and integration of next generation enterprises", *Informatica*, Vol. 31 No. 2, pp. 141-150.

Umar, A. and Zordan, A. (2009), "Reengineering for service oriented architectures: a strategic decision model for integration versus migration", *Journal of Systems and Software*, Vol. 82 No. 3, pp. 448-462. doi: 10.1016/j.jss.2008.07.047.

Utomo, W.H. (2011), "Implementation of MDA Method into SOA environment for enterprise Integration", *International Journal of Computer Science Issues (IJCSI)*, Vol. 8 No. 6, pp. 10-18.

Vargas, A., Cuenca, L., Boza, A., Sacala, I. and Moisescu, M. (2014), "Towards the development of the framework for inter sensing enterprise architecture", *Journal of Intelligent Manufacturing*, Vol. 27 No. 1, pp. 1-18. doi: 10.1007/s10845-014-0901-z.

Vernadat, F.B. (2003), *Enterprise Modelling and Integration*, Springer, New York, NY.

Vernadat, F.B. (2007), "Interoperable enterprise systems: principles, concepts, and methods", *Annual Reviews in Control*, Vol. 31, pp. 137-145.

Vernadat, F.B. (2009), "Enterprise integration and interoperability", in Nof, S.Y. (Ed.), *Springer Handbook of Automation*, Springer, Berlin Heidelberg, pp. 1529-1538.

Wang, S., Li, L., Wang, K. and Jones, J.D. (2012), "e-Business systems integration: a systems perspective", *Information Technology and Management*, Vol. 13 No. 4, pp. 233-249.

Wang, S., Xu, L., Li, L., Wang, K. and Choi, J. (2011), "Features of enterprise information systems integration: a systemic analysis", *Proceedings of the IEEE International Conference on Systems, Man and Cybernetics, IEEE, Anchorage, AK, 9-12 October*, pp. 333-339. doi: 10.1109/ICSMC.2011.6083687.

Wendler, R. (2012), "The maturity of maturity model research: a systematic mapping study", *Information and Software Technology*, Vol. 54 No. 12, pp. 1317-1339.

Wieringa, R., Maiden, N., Mead, N. and Rolland, C. (2006), "Requirements engineering paper classification and evaluation criteria: a proposal and a discussion", *Requirements Engineering*, Vol. 11 No. 1, pp. 102-107.

Winter, R. and Fischer, R. (2006), "Essential layers, artifacts, and dependencies of enterprise architecture", *Enterprise Distributed Object Computing Conference Workshops, EDOCW'06. 10th IEEE International*, pp. 30-30.

Wu, R.C.-Y. (2007), "Enterprise integration in e-government", *Transforming Government: People, Process and Policy*, Vol. 1 No. 1, pp. 89-99. doi: 10.1108/17506160710733724.

Zachman, J.A. (1987), "A framework for information systems architecture", *IBM Systems Journal*, Vol. 26 No. 3, pp. 276-292.

Zachman, J.A. (1997), "Enterprise architecture: the issue of the century", *Database Programming and Design*, Vol. 10 No. 3, pp. 44-53.

Zheng, T. and Zheng, L. (2013), "Examining e-government enterprise architecture research in China: a systematic approach and research agenda", *Government Information Quarterly, ICEGOV 2011*, Vol. 30 No. S1, pp. S59-S67. doi: 10.1016/j.giq.2012.08.005.

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Publication II

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Integration Obstacles during ERP Development

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Integration Obstacles during ERP Development

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Abstract

ERP (Enterprise Resource Planning) systems have increasingly been developed and integrated with other internal and external systems. This paper contributes to the field of enterprise systems integration by clarifying the concept of integration in the context of ERP systems. We investigated integration obstacles during ERP development in 5 large organizations through theme-based interviews. Besides considering integration as purely technical challenge, our findings reveal the other perspectives of integration. In total 31 environmental, technical, managerial, and organizational integration obstacles were identified from empirical data and further mapped with 13 ERP challenge categories derived from the literature. Our findings reveal that integration barriers are related to all 13 categories of ERP challenges. This indicates that integration should not be a separate project from ERP development. Identifying the integration obstacles is necessary for practitioners to develop counteractions to enterprise integration problems.

1. Introduction

Companies must improve their business procedures and processes in order to remain competitive. They must also share their in-house information with their suppliers, distributors, and customers [27]. This information should be timely and accurate. Companies adopt Enterprise Resource Planning (ERP) systems to fulfill these objectives. ERP systems are information systems that integrate different business functions [5,11]. Companies spend significant amounts of their IT budget in ERP installations and upgrades [10,11]. However, ERP projects are associated with considerable problems and high failure rates [19,33]. Besides technical aspects, ERP implementation imposes numerous social and organizational issues [10].

Implementing an ERP system does not guarantee the integration of the organization, as ERPs need to co-exist with other enterprise applications and systems [39]. Mainstream ERP studies in the realm of integration address the approaches to achieve integration [25,26] or implementing ERP as a way to achieve integration [16,18] However, it has been identified that integration in the context of enterprise systems is surrounded by confusion [6,17,25].

With this study, we aim to increase the understanding of the nature of integration in ERP development that is often overlooked in research. To achieve this, we employ both literature and empirical data from 52 interviews in 5 large enterprises. This paper addresses the following research questions:

RQ1: What issues hinder integration?

RQ2: How do issues hindering integration relate to general ERP development challenges?

In the remainder of this paper, we first review the literature for this research. After that, we explain the research approach and present the results. Before concluding the paper, we discuss about our contributions and lessons learned based on the findings.

2. Background

ERP systems are configurable Information System (IS) packages that aid in accomplishing the business goals by facilitating real-time planning, production, and customer response [20,32]. They consist of different modules, such as sales, production, human resource, which are interconnected to enable the exchange of business data across different organizational units [12]. ERP systems offer a central repository for enterprise data and promise reduced data redundancy, increased supply chain efficiency, increased customer access to products and services, and reduced operating costs [13,29].

These benefits are not easily accomplished. It has been estimated that 90% of ERP implementations fail to provide all the desired business benefits [28]. Several distinct characteristics make ERP projects troublesome. The implementation involves multiple organizations and stakeholders that need to interact and

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communicate. This makes the implementation prone to errors and misunderstandings [35]. Moreover, there is the constant dilemma to decide, should the system be customized or should the existing ways of working be altered [4]. Due to the role of ERP systems as a backbone for enterprise integration, they need to co-exist with other enterprise systems [38]. Interconnections with internal and external systems is a necessity and a crucial part in ERP development [15]. When replacing the existing legacy systems with the ERP, usually the migration process involves the implementation of temporary interfaces between systems, which can be expensive and time consuming [40]. In general, ERP systems have limited capability in integrating with other systems [5].

Due to the challenging nature of ERP projects, a considerable amount of literature has focused on critical factors in these projects [2,9,14,28,30,31,36]. These studies have not widely addressed integration issues. Integration is mainly seen as something that is finished during the project phase of the system development, such as in terms of data management between legacy systems. However, instead of being an outcome or an activity occurring during a single phase, in the context of ERP systems, integration is a continuous activity conducted during the whole life cycle of the system [22].

Furthermore, the term *integration* is generally a concept surrounded by a fair amount of confusion [6,17,25]. For instance, some authors in the literature tends to consider integration as a project outcome or as a technical feature [6]. We understand ERP system integration as *a process during the ERP system life cycle, in which interfaces and interconnections between the ERP and other internal and external systems are built and managed as a collaborative effort conducted by different organizations and stakeholders involved in development.* With this study, we want to better understand the nature of this activity by examining the issues that hinder it.

3. Research process

This research was designed as a qualitative, thematic study. We deemed this approach to be suitable when approaching the research problem of enterprise system integration because besides its technical nature, it includes organizational and managerial issues [3]. The main instrument in the data collection was theme-based interviews in five companies. The companies were large – their sizes ranged 1000 to 30000 employees. To analyze the data we employed a qualitative inductive analysis, in which we identified new kind of occurrences in the data and classified them with codes. This is also called "open coding" [7] in grounded theory. According to [34] *"qualitative inductive analysis generates new concepts, explanations, results, and/or theories from the specific data of a qualitative study."*

3.1. Data collection

To conduct this study, both literature and empirical data were employed. We carried out two rounds of theme-based interviews. In the first round, we gathered data from three organizations (Case A, B, and C) in the period from February 2013 to May 2014. These interviewees included stakeholders from client organizations, the vendors and third parties, such as a middleware vendor and offshore departments. No strict interview protocol was used, but instead, the questions focused on general challenges in ERP development. More detailed questions were asked based on the answers. Total of 45 interviews with an average duration of one hour were made in the first round. In the second round, we gathered data from three organizations (Case A, D, and E) in May and June 2014. In total, 9 experts were interviewed, with the average duration of the interviews being 1 hour and 15 minutes. The question set included technologies, standards, organizations and stakeholders dealing with integration issues. We consider second round as our main dataset in this study since its focus was on integration issues while the first round data served more as supportive material. Table 1 lists the case organizations and the roles of interviewees.

Table 1 Information about Case organizations and interviewees

Cases	Size and industry	ERP systems	No. of interviews	Role of interviewees
1st Round				
A	Large & global manufacturing enterprise with 30000 employees	Tailored system for sales and logistics SAP ERP for administrative processes	17	Different roles representing the client organization, the vendor and third party organizations
B	Large & global service provider in retail business with 1000 employees	Tailored ERP system for retail business processes	16	
C	Large and global manufacturing enterprise with 20000 employees	Tailored ERP system for the raw material procurement	10	Different roles representing the client organization
2nd Round				

A	Large & global manufacturing enterprise with 30000 employees	Tailored system for sales and logistics SAP ERP for administrative processes	6	Business-IT negotiator IT manager of business area Manager of E-business and integration Head of E-business and integration Business support manager of a business area Director of business process development
D	Large and global manufacturing and service provider enterprise with 5000 employees	Tailored ERP system	2	Head of IT department Manager of IT and enterprise engineering
E	Large and global manufacturing and service provider enterprise with 1600 employees	A system based on Oracle products	1	Head of systems analyze & design

The ERP systems in case organizations were in different phases in their life cycle. In Case A, the tailored system had been in use and development for 20 years. During the interviews the retirement phase of the system had begun as the company was considering replacing it with a SAP ERP. The ERP system in Case B was in the middle of the implementation phase. The system in Case C was in the post-implementation phase, currently being deployed to a new business location in another country. Case D started the implementation of a new ERP system in 2012 and has been since improving the business processes and enhancing the system. Case E was about to change their ERP system from Informix to Oracle. Most of the transition had been done but few systems were needed to be changed to Oracle.

3.2. Data analysis

We extracted and identified integration obstacles from the transcribed interviews. Three researchers used the principles of open coding [8] to label the data and to find the integration obstacles from the primary data set. Due to the fact that each researcher makes his/her own interpretations from the data, it was necessary to discuss and compare the identified obstacles. After several brainstorming sessions, a list of 31 integration obstacles was constructed, with six obstacles not previously mentioned in the literature.

To have a comprehensive view on the integration obstacles and their relationships to general ERP development challenges studied in the literature, we used the classification of ERP development challenges by [1]. In addition, we reviewed seven literature reviews on ERP development challenges [2,9,14,28,30,31,36] and modified the original classification. This comparison produced in total 13 categories of ERP development challenges. For example, in the literature category "Network and communication" concerned with "boundary crossing activities" and issues related to "consultant and vendor companies" was divided into "Inter-organizational environment" and "Communication and coordination".

Inspired by Themistocleus [37] and Shaul & Tauber, [36] we further classified the 13 categories into four main themes: Environmental, Technical, Managerial, and Organizational obstacles. Table 2 presents this categorization. We then mapped the integration obstacles extracted from the data to the general categories of ERP challenges found from literature.

Table 2 Main themes, literature categories and integration obstacles

Main themes	**Categories of general ERP challenges from the literature** [2,9,14,28,30,31,36]	**Integration obstacles derived from data**	**Cases**
Environmental obstacles	**Intra-organizational environment** Issues related to organizational culture as well as organization's experience on ERP projects	Complicated end product	A
		Inexperience on integration projects	A, E
		Heterogeneous operating environment	C
		Different strategic interests of business units	A
	Inter-organizational environment Issues related to external environment such as conflicts between the organizations, poor management of partnerships with these organizations and underperformance of either vendor or consultant	Sanctions in licensing	E
		Competitors taking new technologies into use	A, C, E
		Failing to commit customers in integration projects	A, D
		Discovering a way to satisfy customers by integration	A, E
Technical obstacles	**ERP-product selection & implementation strategy** Issues regarding selecting and comparing different ERP products	Selecting unsuitable integration technologies	A
		Troublesome management of integration product licenses	A, E
	ERP system characteristics Issues related to the lack of ERP system's quality	Design flaws in ERP system	A
		ERP system's incompatibility	A

	IT-infrastructure & legacy systems Problems in integrating the ERP system with other systems and converting the data between the systems as well as managing the master data	Characteristics of integrative systems	A, B
		Complex systems landscape	A, D
		Troublesome migration	A, B
	ERP software development & configuration Issues dealing with requirement specifications definition and changes, system configuration, and software development tools and methods. Also, issues related to troubleshooting and functional testing of the software	Poor evaluation of integration requirements	A
		Slow development process	A, B, C
		Inadequate testing of integration	A
		Lack of knowledge on integration	A, E
Managerial obstacles	**Business visioning & planning** Issues in creation of the business case for the system, setting up business goals and justifying the ERP acquisition financially	Cost cutting hindering integration projects	A
		Insufficient identification of business needs & evaluating the benefits of integration	A
	Organizational management & leadership Issues related to top level management's involvement, capabilities and actions in the project	Top management does not understand integration	A, C, D
		Top management does not support integration	A, D, E
		Lack of company-wide policies for integration	A, D
	Project management Issues regarding the project scope, responsibilities, and resources. Also issues related to crisis and expectations management	Troublesome management of integration projects	A
	Project team & human resources Challenges related to structure and composition, and skills of the people in the project team. Also issues related to empowerment, motivation and incentives	Lack of integration experts	D
		No dedicated persons for integration	D
	Quality management & evaluation Challenges related to measuring the performance and acceptance of the system	Not measuring integration projects	A
Organizational obstacles	**Change management** Issues related to business process re-engineering, training and education. Also factors related to misunderstanding of the change caused by the system and its implication to organizational culture, personal factors and political issues	The need for comprehensive training	A, C, D
		Personnel change resistance	A
	Communication & coordination Factors related to communication style, coverage and planning. In addition, issues related to knowledge management and unsuitable communication tools	Lack of collaboration	A, D, E

4. Results

We mapped the identified 31 integration obstacles into the ERP challenges found from literature. Table 2 shows the categorization. The next sections explain the integration obstacles derived from data.

4.1. Environmental obstacles

In Case A, because of the complicated product of the company, complex structures were needed to store product information in the ERP systems. This made some of the integration projects difficult. For instance, customers faced difficulties when defining the product variables in their systems, as mappings and conversions between different ERP systems required significant efforts. In Cases A and E facilities **inexperience on integration projects** and low maturity level of organization hindered integration. In Case A, some facilities did not have previous experience on ERP system deployments, which hindered the roll-outs. On the other hand in Case E, organizational immaturity was seen as a major barrier for integration. The differing readiness for integration in organizational units was highlighted:

"We have 75% integration in our supply and distribution department but we only achieved 30% integration in after sale service department because the maturity level of this section was very low " –Case E, Head of systems analyze & design

Case C encountered difficulties due to the **heterogeneous operating environments**. The misfit between the ERP system and the new operating environment was learnt the hard way. As the ERP system was to be deployed to a new business location in another country, the drastic differences between the business processes and practices forced the company to consider implementing a new instance of the system which would then have to be integrated with the ERP system currently in use. Initiating the deployment project to this environment was eventually cancelled. The environment was characterized as being "*20 years behind"* the focal country and being a "*conservative, old-fashioned field*".

In Case A, **different strategic interests of business units** introduced conflicts in ERP development. A development need that other unit considered important might not be an interest for the other. As a consequence, integration projects were prioritized differently, which increased the

development time, causing the other units to wait for the needed features.

Besides the intra-organizational environment, integration can also be hindered by external forces. For example, in Case E due to the **political sanctions**, licensing caused problems. An ERP provider refused to sell the required licenses to the company. Therefore, the company bore financial loss, having already trained and prepared to adapt the specific ERP system. Eventually, the company was forced to change the ERP provider.

In Case A, the possibility of **competitors taking new technologies into use** might cause them to re-consider their existing integration solutions. Similarly in Case C, competitors were planning to take a new domain standard into use. This caused pressures for the company. Possibly it had to abandon the application logic developed in-house and re-develop the system interfaces to comply with the new standard:

"If we get involved in [the standardization project], it would mean that part of the ERP system would be outsourced to an external service, which would be integrated with the system" –Case C, Client organization representative

Also in Case E, **the pace of environmental change** was mentioned as a matter setting pressures on integration. It was mentioned that it is difficult to *"attune with those changes"*.

In Cases A and D **customers' loyalty and commitment in integration projects** were considered as an obstacle. Customers facing organizational changes could stop the ongoing integration initiatives in Case A. On the other hand, in Case D, small customers sometimes lacked the needed knowledge on integration, which made it more difficult to cooperate with them. In Case B, it was mentioned that as several business partners are involved in the ERP project, sometimes coordination issues emerge as it is necessary to wait partners to complete certain operations before the development can continue.

Cases A and E looked for tighter integration with customers. Instead of responding to customers' needs, companies were **discovering ways to better satisfy their customers,** trying to *"make it easy to buy from us"* and implement new solutions *"even before they come to us and ask for it"*. This was considered difficult. For instance, in Case A, mobile applications for customers were considered in order to achieve tighter integration with customers.

4.2. Technical obstacles

In Case A, **selecting unsuitable integration technologies** caused the system architecture to be redesigned in the early phases of implementation. According to the middleware provider, not enough attention was paid on the selection of the base technologies of the system. In addition, **troublesome management of integration product licenses** turned out to be an obstacle in Case A and E. Knowing the limitations of licenses and avoiding getting fines or sued by the product providers was emphasized, "*as huge costs are always involved in license management*".

In Case A, certain architectural decisions caused that the facilities used different codes in system messages sent from the facility systems to the ERP system. This later led to problems when trying to collect the same information from all the facility systems:

"Because all [facilities are using] different codes and that's a nightmare […] when you want to report something or when for example our sales offices who are using [the ERP system], for all the [facilities]. They actually see very different data for them, because of the different codes which we have allowed in our ERP." –Case A, Business support manager

This was identified as one of the **design flaws** in the customized ERP system that would not be able to be fixed during the life cycle of the system. In addition, by having a vendor specific message format in the system, integrating the ERP system with external systems was considered challenging. Because of different levels of standards being used internally and externally, the **ERP system incompatibility** challenged integration with external systems.

In Case B, **characteristics of integrative systems** introduced a fundamental obstacle of integration. The data formats of two systems were different and the older system could not handle specific data types. Similarly in Case A, the factor affecting the easiness of rollouts was said to be dependent on the characteristics of the facility system in question.

Complex systems landscape where integration takes place was one aspect that made integration difficult. In Case A, the organization was dealing with a huge number of different systems. Business-IT Negotiator of Case A stated that it is difficult to *"reach the ideal world"* as the landscape of system "*evolves constantly*" due to the organizational changes. An integration project that required exchanging of messages between three ERP systems, was considered as *"a mission impossible"*. A project in which an invoice was to be sent from one office to another through several system, had been initiated four years ago but was still ongoing during the interviews. Furthermore, the increased complexity hindered the information retrieval from the logistics systems:

"[When getting information from logistics systems] there are not only delays, there are total black outs.

We don't always get the information. [Then we] get the customer calls: 'Where is my order? It should be here now'" –Case A, Director of business process development

Troublesome migration was encountered in Cases A and B. During migration, data conversions from legacy systems, master data management and parallel run of systems are needed. In Case A, migration from the old system to the new one took years. In Case B, using two systems simultaneously was considered too difficult from the end-user's viewpoint and because of this, the new ERP system was not deployed to all the sales offices. Major technical problems were encountered when running the two ERP systems in parallel. The data transfer between the two systems was unreliable, due to insufficiently designed interfaces:

"The problems emerged because the interface was the problem. The data might have been accurate in the new system […] but they did not manage to make the logic between two of their applications bullet proof. […] the data that came to our system was somehow corrupted" –Case B, Representative of Finance

Transferring the master data from the old system to the new one was seen problematic in Cases A and B. In Case B, it was claimed that the parent company *"did not have a capability for master data"*. Moreover, different policies for master data were used in group and national levels of the company.

The **slow development process** turned out to make integration more difficult. In order to cut down the development costs caused by a customized system, in Cases A and C the vendor had offshored the development to remote locations. Because of this, it took a long time until new feature requests would realize as new features in a system:

"If the development on our side is something which is then related to [our ERP], then it takes time [...] then we are really talking about six seven eight months." –Case A, Manager of e-business and integration

The slow development process was also highlighted by a representative of Case C, who emphasized that the development process should be made faster.

Poor evaluation of integration requirements was sometimes hindering integration projects. In Case A, it was specifically highlighted that the need for integration and testing of it may appear suddenly, if the development is done without establishing separate projects and the requirements for integration are not comprehensively investigated. Similarly, **inadequate testing of integration** was mentioned as a major obstacle in integration projects. In Case A, a sudden need for testing appeared due to the lack of inappropriate planning. Resources that were not initially allocated for the project were needed:

"It is not realized that [integration] requires a lot of testing […] the resources that are then used, are not specifically allocated for the project but instead internal resources. But then, what are their skills and motivation? How it is being documented that something has been tested?" –Case A, Business-IT Negotiator

Lack of knowledge mentioned as an obstacle for integration. Integration projects that were performed for the first time with no previous experience on similar projects were considered challenging in Case A. For example, having a customer using SAP involved for the first time was considered painful. Similarly, if integration would require an implementation of a totally new business process with new messages, needed more effort that the projects in which already existing knowledge could be utilized. In Case E on the other hand, the lack of documentation about integration frameworks and technologies caused a big halt in the project as the needed information was gathered from different places.

4.3. Managerial obstacles

Another issue hindering integration in Case A was the constant development **cost cutting**. Because of this, fewer resources were available for developing and extending the system further. This caused some of the integration projects to be postponed. According to the current trends and the changed role of the ERP system from a back-end tool to a tool of salesmen that interact with customers on the field, the company was planning to build mobile applications to enable end users and customers to access the ERP system from remote locations. This was, however, considered too expensive, and the initiative was dropped out due to the cost saving:

"We have been talking about [the mobile interfaces of the system] and made some pilots, but they haven't gone further […] they are probably the first thing to drop out when cutting down the development costs." – Case A, vendor, Lead software developer

Cost cutting was also considered as a major barrier when developing the business processes further through integration, it was said that there is *"a lot of unattached potential but no willingness to invest"*.

Identification of business needs and evaluating the benefits of integration was mentioned to be burdensome to integration projects. According to the Enterprise Architect in Case A, the challenging phase in some of the integration projects was the evaluation of costs and the business benefits. The business-IT negotiator stated that evaluating the size and the

complexity of integration projects were difficult, and the significance of integration was *"mainly underestimated"*. This led to resource allocation problems in these projects. Due to the lack of internal collaboration and organizational silos, certain cross-checking and verification (i.e., by finding out which part of the system the development would have an impact) was sometimes omitted when developing new functionality. This also led to wasted resources.

In cases A, C and D, the **top management sometimes lacked the understanding of integration**. In Case A, the management had too high expectations what could be achieved by integration. Similarly in Case D, management lacked the understanding on integration:

"The high management cannot really realize the benefits of integration. It is hard to convince them how an integration project can benefit the organization. In words they say 'Ok, let's do the integration project' but when it comes to practice and reality they withdraw" –Case D, Manager of IT department and organizational engineering

Also, sometimes management was unwilling to participate in integration projects which caused the project to lack the management support. In Case C, as the system was deployed to the new operating environment in different nation, local manager's attitude was not supportive and the project lacked leadership.

The **lack of top management's support in integration projects** came up in Case A and D. The constant changes of top management terminated the on-going customer integration projects in Case A and it took years to re-establish them. Similarly in Case E, changes in top management *"brought chaos and even terminated the existing integration projects"*. The extent to which the top management prioritizes integration was seen crucial in Cases A and E.

Due to the **Lack of companywide policies for integration**, difficult integration scenarios were encountered in Case A. When the ERP system was under the busiest implementation, the policies of individual facilities had an impact on how the integration between the ERP system and a manufacturing execution system in question was done. This led to a problem when querying information from the facilities as the quality of the retrieved information was varying. It was suggested that the common rules should have been decided in advance to prevent this, and there should be *"a dictator"*, when defining these rules. Similarly in Case D, due to the fact that different enterprise systems were developed separately, the end users had to separately log in to each system. It was suggested that there should be a single sign in option instead to avoid the manual work and redundancy.

Difficulties in integration project management were experienced. Allocating resources for these projects and keeping them in budget and schedule were not easy. Some of the development projects were not done in a systematic manner as projects. Instead, *"the one who has the money"* could initiate development activities, without negotiating with other parties. These projects encountered unexpected issues with resources. A representative of Case A highlighted the attitude towards integration:

"The biggest challenge is to evaluate the size and complexity of the project. I state that the significance of integration is mainly underestimated […] is it just stated that the technology and tools are clear, 'this cannot be a big issue'" –Case A, Business-IT Negotiator

Convincing the top management and developers about the value and importance of software testing in integration projects was mentioned as a considerable challenge for project managers.

Case D faced resourcing issues due to the **lack of integration experts.** Lack of personnel with skills on middleware and SOA (Service-Oriented Architecture) hindered integration projects. It was stated that suppliers familiar with specific technologies, such as BizTalk or Oracle *"can't really implement anything themselves"*. Similarly, selecting of the supplier was said to be *"risky because of their limited knowledge"*. In addition the company had no dedicated persons responsible for integration. Instead, managing the IT architecture and doing integration were considered as additional works which reduce the pace of integration:

"When you are integrating systems using middleware, we should unify some architectural basics. Sometimes you need to re-engineer the tasks. This work conflicts with our routine work. We cannot stop this 'moving train' to do integration." –Case D, Manager of IT department and organizational engineering

Not measuring integration projects to evaluate whether or not the desired business goals are met, was considered problematic. Case A was using measurement to evaluate how much the certain business integration solutions were used by different business units. However, in integration projects, measurements were not established. Also, if an integration project was carried out in a non-systematic way, there were no proper quality management practices in place. Measuring the performance of integration project on customers' side and evaluate the value of customers' satisfaction was considered "*difficult if not impossible*" since there were no similar access to customer's resources and systems in a similar fashion as own internal systems.

4.4. Organizational obstacles

Personnel resistance to change was described as an obstacle that comes with integration in Cases A and D. The interviewees highlighted the need to carefully explain to the related personnel what the change means in practice:

"You should assure them that changes that have come up with integration does not mean that you are going to lose your job" –Case D, Head of IT department

Case C also faced personnel resistance to change and their unwillingness to take the new system into use when deploying the system to a new geographical location:

"They didn't really want to have that system […] or even willing to develop it to fit their needs in general." –Case C, Client organization representative

In addition, in Case A, change resistance was identified as a major barrier that terminated the attempts trying to simplify the complex systems landscape:

"System-specific groups have been established there […] they do not have the desire to make this (ERP system landscape) any simpler. And all the external players who enter this field, are excluded in one way or another." –Case A, Business-IT Negotiator

The importance of the **need for comprehensive training programs** were considered essential when trying to mitigate the change resistance caused by integration. The interviewee from Case A mentioned the necessity of training when deploying new systems, considering it as a "*major part of the ERP project"*. Similarly, integration with customers created a need for training due to the changed roles of the persons dealing with customers.

Lack of collaboration made the coordination of integration activities more difficult in various ways. In Case D, lack of teamwork was said to be a major inhibitor of integration. In Case A, despite the fact that the business units had different strategic interests, the representative of Sales noted that the services needed from the ERP system can still be the same. Because of lack of cooperation, duplicate development was sometimes done, which led to increased costs:

"Better tools for sales prediction may be an essential development requirement for both of these big business areas, and still these things may not be handled together. [...] Instead of doing one joint project, we may do two in parallel." –Case A, representative of Sales

The lack of inter-departmental cooperation caused that certain parts of the organization could not benefits from the services already developed in the other parts of the ERP system. Similarly in Case E, the communication between branches in different cities was considered as limited. Using improper tools added manual work, suggesting that the communication was not carried out in the desirable manner.

5. Discussion

The main contribution of this study is to increase understanding of integration in the context of ERP systems. The current literature on ERP challenges mainly focuses on the challenges encountered during the main ERP project and mostly highlight the technical issues when interfacing with legacy systems [2], incompatible existing systems [30], and data management and conversion [36]. Besides considering integration as purely technical challenge, our findings reveal the other (environmental, managerial and organizational) perspectives of integration. The identified integration obstacles are interrelated with all the 13 categories of ERP challenges derived from literature. This shows that integration should not be viewed as a separate task that is finished during an ERP project. Instead, integration is tightly coupled with ERP development and it is a continuous effort requiring attention during the entire life cycle of the system. We found some integration obstacles that have not been widely covered in the ERP literature before, such as political sanctions, management of product licenses, lack of measurements for integration projects, discovering a way to satisfy customers by integration, lack of previous experience on integration projects and lack of company-wide policies for integration.

Integration challenges and barriers in enterprise application integration and in e-government have been studied, e.g. in [21,23,37]. Themistocleus (2004) identified 12 application integration barriers. Our findings can be considered as an extension of this list. Similarly, we found that resistance to change, training, and lack of technical skills as barriers for integration. However, we did not see the costs as a major barrier. Another study about critical factors of adopting EAI revealed technical, organizational and environmental dimensions that majorly impact integration in a health care environment [21]. The authors found out that the top management support did not have a high impact on the EAI integration. We, however, found top management support as a critical barrier in three of our case organizations in manufacturing domain. Similar to healthcare domain, the external pressure from competitors appeared to introduce integration challenges in three of our case organizations in manufacturing domain.

5.1. Lessons learned

It is possible to derive from the findings some important considerations for practitioners to overcome the obstacles in integration:

- Integration should be regarded as a systematic and well planned activity that involves multiple systems, and stakeholders. Separate programs or projects are always needed to be established.
- Dedicated expertise is needed. There should be stakeholders with a full-time responsibility of integration issues. Coordination and communication among the stakeholders is crucial.
- Integration projects need to be managed from different levels. Besides the top management support, project and quality managers as well as change management is needed
- Due to the complex nature of integration, it is important to maintain the architectural descriptions of the interconnected systems to facilitate the identification of integration needs and requirements.
- Corporate-level integration strategies are needed to ensure that integration is aligned with organizational goals

5.2. Limitations

This study has its limitations. As in all qualitative studies, it is also impossible to make direct statistical generalizations from these five companies. We, however, believe that the classification of integration obstacles is valuable information to other researchers with similar objectives and also to practitioners that wish to manage integration in their organizations. Instead of statistical generalization we consider our generalization as theoretical [24], where we formed abstract categories out of specific and concrete observations. Another limitation is that at the time of data collection each enterprise was in a different phase of their ERP development life-cycle. Their challenges and problems were slightly different from each other. For instance, Case B faced challenges regarding parallel run and migration, because they were in the middle of implementation. Being at the beginning of the retirement phase, these challenges were not considered as the main problems in Case A. This difference is not only a limitation, but also enables richer categorization with variation in observation.

6. Conclusion

With this study we increase the understanding of the concept of integration in ERP development by examining its obstacles. As a result of the analysis of empirical data, we identified 31 integration obstacles. Issues in intra-organizational environment, such as complicated end product and inexperience are the barriers for integration. The pressure from competitors and customer commitment in integration projects impose challenges. Technical barriers are related to integration product selection, and system development and configuration. In addition, the characteristics of the existing systems and the complexity of the IT infrastructure can further complicate the integration efforts. Integration requires management in order to be realized. Management from four levels, organizational, project, quality, and change management is needed to overcome the barriers of integration. We also identified the common categories of ERP challenges from the literature. Our findings suggest that integration is tightly coupled with ERP development, and it should not be regarded as a single project activity, but rather as a continuous effort during the system life cycle. Finally, we provided practitioners with recommendations based on the lessons learned from our findings.

The future research on integration obstacles should consider different domains and include also other organizations involved in ERP development besides the ERP adopters, such as vendors, consultants and business partners. In the future we aim to investigate the solutions to overcome the integration obstacles in different settings.

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8. References

[1] Alanne, A., Kähkönen, T., and Niemi, E., "Networks of Pain in ERP Development", 16th International Conference on Enterprise Information Systems, 2014, pp. 257–266.
[2] Aloini, D., Dulmin, R., and Mininno, V. "Risk Management in ERP Project Introduction: Review of the Literature", Information & Management, 44(6), 2007, pp. 547–567.
[3] Barki, H. and Pinsonneault, A., "Explaining ERP Implementation Effort and Benefits with Organizational Integration", Cahier du GReSI no. 02-01, Ecole des Hautes Etudes Commerciales de Montreal, Montreal. 2002.
[4] Chalmeta, R., Campos, C., and Grangel, R., "References Architectures for Enterprise Integration", Journal of Systems and Software, 57(3), 2001, pp. 175–191.
[5] Chou, D.C., Tripuramallu, H.B., and Chou, A.Y., "BI and ERP Integration", Information Management & Computer Security, 13(5), 2005, pp. 340–349.
[6] Chowanetz, M., Legner, C., and Thiesse, F., "Integration: an Omitted Variable in Information Systems Research", Integration, 5, 2012, pp. 15.
[7] Corbin, J.M. and Strauss, A., "Grounded Theory Research: Procedures, Canons, and Evaluative Criteria", Qualitative Sociology, 13(1), 1990, pp. 3–21.

[8] Corbin, J. and Strauss, A., Basics of Qualitative Research: Techniques and procedures for developing grounded theory. Sage Publications, 2014.
[9] Dezdar, S. and Sulaiman, A., "Successful Enterprise Resource Planning Implementation: Taxonomy of Critical Factors", Industrial Management & Data Systems, 109(8), 2009, pp. 1037–1052.
[10] Elbanna, A.R., "Implementing an Integrated System in a Socially Dis-integrated Interprise", Information Technology & People, 20(2), 2007, pp. 121–139.
[11] Elragal, A. and Haddara, M., "The Impact of ERP Partnership Formation Regulations on the Failure of ERP Implementations", Procedia Technology, 9, 2013, pp. 527–535.
[12] Esteves, J. and Pastor, J., "Enterprise Resource Planning Systems Research: An annotated bibliography", Communications of the Association for Information Systems, 7(1), 2001, pp. 8.
[13] Fan, J.C. and Fang, K., "ERP Implementation and Information Systems Success: A test of DeLone and McLean's model", Technology Management for the Global Future, PICMET 2006, IEEE, 2006, pp. 1272–1278.
[14] Finney, S. and Corbett, M., "ERP Implementation: A Compilation and Analysis of Critical Success Factors", Business Process Management Journal, 13(3), 2007, pp. 329–347.
[15] Gericke, A., Klesse, M., Winter, R., and Wortmann, F., Success Factors of Application Integration: An exploratory analysis", Communications of the AIS, 27(1), 2010, pp. 677–694.
[16] Grant, D., Harley, B., and Wright, C., "Editorial Introduction: The Work and Organisational Implications of Enterprise Resource Planning Systems", New Technology, Work and Employment, 21(3), 2006, pp. 196–198.
[17] Gulledge, T., "What is Integration? Industrial Management & Data Systems", 106(1), 2006, pp. 5–20.
[18] Gupta, M. and Kohli, A., "Enterprise Resource Planning Systems and its Implications for Operations Function", Technovation, 26(5), 2006, pp. 687–696.
[19] Haddara, M., "Exploring ERP Adoption Cost Factors", Journal of Computer Technology & Applications (JCTA), 3 (3), 2012, pp. 250–261.
[20] Hui, P.C., Tse, K., Choi, T.-M., and Liu, N., "Enterprise Resource Planning Systems for the Textiles and Clothing Industry", In Innovative Quick Response Programs in Logistics and Supply Chain Management, Springer, 2010, pp. 279–295.
[21] Hung, W.-H., Chang, I.-C., Yen, D.C., and Lee, C.-M., "Critical Factors of Adopting Enterprise Application Integration Technology: An Empirical Study on Larger Hospitals", Communications of the Association for Information Systems 36 Article 31, 2015, pp. 619–641.
[22] Kähkönen, T., Maglyas, A., and Smolander, K., "The Life Cycle Challenge of ERP System Integration", Information Systems Development: Transforming Organisations and Society through Information Systems (ISD2014 Proceedings), 2014.
[23] Lam, W., "Barriers to E-government Integration", Journal of Enterprise Information Management, 18(5), 2005, pp. 511–530.
[24] Lee, A.S. and Baskerville, R.L., "Generalizing Generalizability in Information Systems Research". Information Systems Research, 14(3), 2003, pp. 221–243.
[25] Lee, J. and Myers, M., "The Challenges of Enterprise Integration: Cycles of Integration and Disintegration Over Time", ICIS 2004 Proceedings, 2004, pp. 75.
[26] Light, B. and Wagner, E., "Integration in ERP Environments: Rhetoric, Realities and Organisational Possibilities", New Technology, Work and Employment, 21(3), 2006, pp. 215–228.
[27] Loizos, C., "ERP: Is It the Ultimate Software Solution", Industry Week, 7, 1998, pp. 33.
[28] Momoh, A., Roy, R., and Shehab, E., "Challenges in Enterprise Resource Planning Implementation: State-of-the-art", Business Process Management Journal, 16 (4), 2010, pp. 537–565.
[29] Motiwalla, L.F. and Thompson, J., Enterprise Systems for Management, Pearson Education, 2012.
[30] Nah, F.-H., Lau, J.L.-S., and Kuang, J., "Critical Factors for Successful Implementation of Enterprise Systems", Business Process Management Journal, 7(3), 2001, pp. 285–296.
[31] Ngai, E.W., Law, C.C., and Wat, F.K., "Examining the Critical Success Factors in the Adoption of Enterprise Resource Planning", Computers in Industry, 59(6), 2008, pp. 548–564.
[32] O'Leary, D.E., Enterprise Resource Planning Systems: Systems, Life Cycle, Electronic Commerce, and Risk, Cambridge University Press, 2000.
[33] Parr, A.N., Shanks, G., and Darke, P., "Identification of Necessary Factors for Successful Implementation of ERP Systems", In New Information Technologies in Organizational Processes, Springer, 1999, pp. 99–119.
[34] Patton, M.Q., Qualitative Research & Evaluation Methods: Integrating Theory and Practice, Sage Publications Inc., 2015.
[35] Sarker, S. and Lee, A.S., "Using a Case Study to Test the Role of Three Key Social Enablers in ERP Implementation", Information & Management, 40(8), 2003, pp. 813–829.
[36] Shaul, L. and Tauber, D., "Critical Success Factors in Enterprise Resource Planning Systems: Review of the Last Decade", ACM Comput. Surv, 45(4), 2013.
[37] Themistocleous, M., Justifying the Decisions for EAI Implementations: A Validated Proposition of Influential Factors", Journal of Enterprise Information Management, 17(2), 2004, pp. 85–104.
[38] Themistocleous, M., Irani, Z., and O'Keefe, R.M., "ERP and Application Integration: Exploratory Survey", Business Process Management Journal, 7(3), 2001, pp. 195–204.
[39] Themistocleous, M., Irani, Z., O'Keefe, R.M., and Paul, R., "ERP Problems and Application Integration Issues: An Empirical Survey", IEEE Comput. Soc, 2001, pp. 10.
[40] Yusuf, Y., Gunasekaran, A., and Abthorpe, M.S., "Enterprise Information Systems Project Implementation: A Case Study of ERP in Rolls-Royce", International Journal of Production Economics, 87(3), 2004, pp. 251–266.

Publication III

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Understanding Obstacles in Enterprise Architecture Development

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UNDERSTANDING OBSTACLES IN ENTERPRISE ARCHITECTURE DEVELOPMENT

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Abstract

Today's enterprise environment is more sophisticated than ever and being able to manage this complexity is not possible without having a planned approach. Enterprise architecture (EA) has emerge as a planned approach to mitigate the organizational complexities and control the constant environmental changes. However, despite the numerous EA development step-by-step methods and approaches not all of the EA efforts end with success. In this study we aimed to identify the obstacles that endanger the EA projects. Employing the multiple case study research method we collected data from 14 large enterprises by interviewing 20 experts. In total, we identified 20 obstacles that we further categorized into four main themes. Compared to earlier literature we found five types of obstacles that have not been mentioned before: political issues of the government, EA consultant related issues, outdated organizational statutes, constant change of management, and inefficient human resource department. Further we discussed about the relationships among the identified obstacles and provide advice for managers to reduce the obstacles during EA development. Because this study is based on real world cases, provided understanding can benefit practitioners to alleviate obstacles during EA development.

Keywords: Enterprise architecture, Obstacles, Multiple case study, EA development.

1 Introduction

Enterprise architecture (EA) provides a holistic view of the enterprise business processes, information systems, and technological infrastructure to address this sophisticated environment (Jonkers et al., 2006; Kaisler et al., 2005). EA is believed to provide appropriate concepts, methods, models, and tools to facilitate business-IT alignment and integration (Vargas et al., 2014).

In academic research most of the studies have focused on developing EA frameworks and methods (Bernus and Noran, 2010; Erol et al., 2010; Fatolahi et al., 2007; Hoogervorst, 2004; Kilpeläinen, 2007; Kim et al., 2006; Lankhorst, 2013; Sowa and Zachman, 1992; Vargas et al., 2014). Also a considerable number of studies have focused on EA development issues and challenges (Isomäki and Liimatainen, 2008; Jahani et al., 2010; Kaisler et al., 2005; Lucke et al., 2010; Nakakawa et al., 2010; Seppänen et al., 2009; Ylimäki, 2008).

Despite the popularity of EA in the last decade, it is difficult to find a successfully developed EA in an organization (Iyamu, 2009). Theoretically, as a concept, EA has been well developed but in practice managers are faced with a lot of challenges to implement and manage EA in an organization (Armour et al., 2007). Not all EA implementations lead to cost and time reduction and quality improvement in the organization. To be successful in EA it is important to understand the issues that hinder EA development. Thus in this study, in addition to identifying new obstacles in EA development, we also address the obstacles after EA development; meaning the EA maintenance and update phase, which none of the previous studies had considered. We interviewed 20 EA professionals in 14 large enterprises to identify obstacles in EA development. Inspired by Themistocleous (2004) and Lucke et al. (2010) we categorized the identified obstacles based on four themes: environmental, technical, managerial, and organizational to increase the understandability of the issues. Further, we will discuss about the recommendations and advices of management to facilitate the identified issues.

This paper is organized as follows: first, we will go through the background of this study and previous literature on EA development issues, then in Section 3 the research process is described. After presenting the findings in Section 4 we will discuss the findings in the context of existing literature in Section 5, including the relationships between identified obstacles and management advice. Finally, conclusions, limitations and future directions of research is presented in section 6.

2 EA development issues in literature

EA can be defined as an approach to manage complexity in terms of organizational structure, technology, and business by providing a holistic view of the organization (Kaisler et al., 2005; Kamoun, 2013; Niemi and Pekkola, 2013). It can also be defined as the organizing logic for business processes and IT infrastructure of a company (Ross & al., 2006). It may describe the current or "as-is" status and the target or "to-be" structures in the company and it often includes a migration plan describing how to reach the target from the current (Josey, 2011). According to Cambridge dictionary, an obstacle means *"Something that blocks you so that movement, going forward, or action is prevented or made more difficult."* So we define EA obstacles as the factors that confronts the project with difficulties and loss of resources and cannot be solved easily and the risk of project termination exists.

EA frameworks and methodologies assist enterprise architects by providing guidelines through different steps of EA development (Hoogervorst, 2004; Lankhorst, 2013; Zachman, 1987). Practitioners face many challenges that need to be solved in EA development and in some cases they face obstacles that cause project termination and failure. Therefore, in order to mitigate these issues it is crucial for the practitioners to realize what challenges and obstacles they are going to face during EA development.

Lucke et al. (2010) proposed a classification of EA issues based on an extensive literature review. They describe the identified challenges by grouping them into 14 concepts and further grouped them into five categories: management, semantics, education & experience, knowledge management, and extent & dynamics.

In another study Roth et al. (2013) reported the EA challenges organizations are facing by conducting survey focusing on EA documentation. They identified "huge effort of data collection" and "bad quality of EA model data" as the most reported issues among 140 valid responses. "Insufficient tool support", "No management support", and "low return on investment" are the other important reported challenges.

Isomäki and Liimatainen (2008) investigated EA challenges in the Finnish government sector. They divided the most important identified EA challenges into three main categories. The most important challenges in terms of shared understanding were implementation ability, business-IT alignment, and governance. Also legislative boundaries and professionalism are structural issues that hinder an EA project. Further, they identified lack of shared IT infrastructure as an obstacle.

Other studies that have investigated EA challenges and issues include (Hauder et al., 2013; Kaisler et al., 2005; Lucke et al., 2010; Seppänen et al., 2009). We will discuss about them in section 5.2.

3 Research method

The aim of this study is to identify the obstacles during EA development projects from the practitioner perspective in large enterprises. A thematic, exploratory, and qualitative strategy using multiple case studies approach was conducted in order to identify the enterprise architecture obstacles within the selected large enterprises. In this study we analyzed our data using grounded theory techniques

Multiple case studies provide an extensive and complementary view on EA development obstacles in large enterprises. Figure 1 illustrates our research approach. In the data collection we interviewed 20 experts. Then we analyzed the interview transcripts and extracted obstacles during EA development. Further inspired by Themistocleous (2004) and Lucke et al. (2010) we categorized the identified obstacles into 4 main themes to increase the understandability of the context of the obstacles. Comparing our findings to previous studies we identified 5 new obstacles that have not been mentioned before in literature. Also, we investigated the relationships between the obstacles, the obstacles that have influence on the others and have cause and effect relationships with each other.

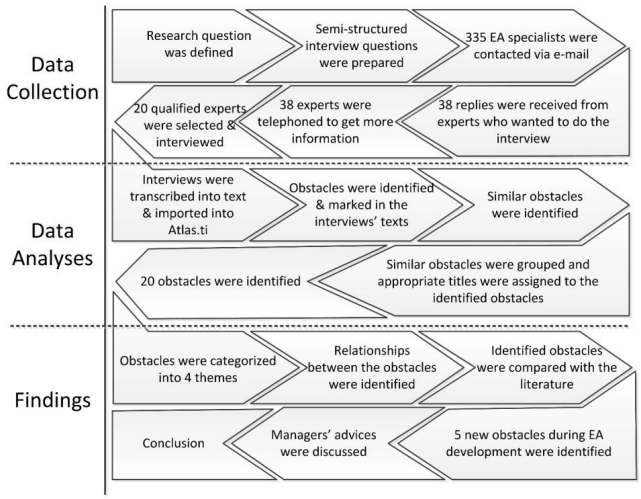

Figure 1 Overview of our research approach

3.1 Data collection

We carried out 20 semi-structured interviews to collect data in the period from May to July 2015. The interviewed companies were large, with sizes from 600 to 35000 employees. We deemed semi-structured interviews to be suitable for data collection, because of the complexity of EA practice and inductive approach (Myers and Newman, 2007).

We developed the interview questions for the purpose to identify the obstacles that practitioners face during EA development in large organizations. In interviews we asked questions regarding the interviewees' background and roles in the organization. Then we moved to questions regarding the background of EA in their organization and asked questions, such as "Can you tell us about the history behind EA development in your organization?" and "How and when did you feel that you need to develop EA for your organization?". Then based on the interviewees' answers we asked questions regarding the process of EA development. Based on their explanations we asked them further questions about the obstacles that they had faced in each phase of EA development. By asking "why" and "how" questions we encouraged them to elaborate more on the obstacles that they had mentioned. Employing semi-structured interview the interviewer makes sure that all the preplanned questions are covered and the interviewee can think and reflect about topic and link their experience and perception to the discussion (Lange and Mendling, 2011).

In the beginning of May 2015 we sent an email to an EA specialist group with 335 members to request from the qualified members of the group to assist us with interviews. We received 38 replies from the group members who were ready be interviewed. The interviewees were investigated beforehand to ensure about their qualification and experience. We telephoned them and explained the purpose of the interview and asked for more information about their background and their experience with EA development projects. From these 38 responses we selected 20 experts from large organizations who were intensely involved in EA development.

In the beginning we decided to conduct at least 15 interviews to ensure that we will reach to the point of data saturation mentioned by Yin (2013). According to Stake (1995), having a larger set would also help to reduce the risk of data bias and increase the reliability of the findings. Further, we reduced the risk of bias by selecting the interviewees from different industries with different kind of EA project experience (Lam, 2005).

In total we interviewed 20 experts including CEO, CIOs, project managers, IT managers, and head of related departments with the average duration of the interviews being 1 hour and 10 minutes. The main questions addressed obstacles that the interviewees faced during the EA development project, missions and goals of the project, and results and outcomes of the project.

We reached to the point of data saturation after 12 interviews. Further data did not to add any meaningful observations to what we already gained from the first 12 interviews. According to Yin (2013) we reached data saturation and the rest of the interviews' data repeated the points that had been already mentioned previously. Table 1 presents the information about the interviewed organizations.

Cases	**Industry**	**Company Size**	**#of interviews**	**Roles**
A	A government organization	1500	1	CIO
N	A government organization	1860	1	IT manager
G	A government organization	10000	3	CIO Head of systems analyze & design Head of business process development
D	A government organization	20000	1	IT manager
B	Banking industry	800	1	CIO
L	Banking industry	1000	2	Head of software development IT manager
C	IT consulting Company	2000	1	Project manager
F	IT consulting company	600	1	Project manager
H	Automotive industry	9700	3	CEO

				R&D director Head of business process development
I	Automotive industry	35000	1	CIO
J	Automotive industry	11000	2	CIO Head of R&D
K	Automotive industry	1570	1	CIO
M	Automotive industry	1600	1	Head of systems analyze & design
E	Cement industry	720	1	CIO
14			20	

Table 1 Information about conducted interviews and the organizations

3.2 Data analysis

We employed a coding technique based on the open coding in Grounded Theory to analyze our data (Glaser and Strauss, 1967). To analyze our data we transcribed the interviews as text and imported the texts into the Atlas.ti software that can be used for qualitative analyses.

One researcher employed the technique of open coding (Corbin and Strauss, 1990) and labeled the paragraphs and sentences based on their contexts. For instance, “Critical factor”, “obstacle” and “advice” are the examples of the first level of coding that we conducted. In this stage of analyses more than 300 codes that indicated the general ideas of paragraphs or sentences were generated. On the next step, the focus was only on the parts labeled as obstacles and more precise and meaningful phrases to each obstacle were assigned. The second level of coding with more than 90 codes that indicated different and mostly similar issues of EA obstacles had obtained. For instance, “unexperienced EA consultants”, “lack of innovation in EA consultants”, “consultants being inflexible”, and “inefficiency of EA consultants” were all grouped in on category named “EA consultant related issues”. After grouping similar issues 20 different obstacles that are presented in table 2 were established.

To increase the understandability of the identified obstacles and to be clear about their context we chose 4 themes inspired by Themistocleous (2004) and Lucke et al. (2010) for the identified obstacles in our study: environmental, technical, managerial, and organizational.

4 Results

We defined EA obstacles as the factors that confront the EA project with difficulties and loss of resources or factors that endanger the project and cannot be solved easily, which may potentially cause project termination. During our analyses, inspired by Themistocleous (2004) and Lucke et al. (2010), we identified four common themes from transcribed interviews related to the obstacles identified during EA development project: Environmental, Technical, Managerial, and organizational . Table 2 presents our proposed taxonomy of the obstacles during EA development. These are described below in detail.

Themes	**Identified EA obstacles**
Environmental*: issues related to the inter- and intra-organizational environment, such as organizational culture and experience on EA projects and issues related to vendors and consultants.*	- Political issues of the government - EA consultant related issues - Outdated organizational statutes - Restricted rules in governmental organizations
Technical*: issues related to EA tools, infrastructure, outputs, and configuration.*	- Old infrastructure - Lack of change management tools - Ineffective EA outputs
Managerial*: issues related to EA visions and goals, management and leadership, project team and human resource.*	- Lack of management knowledge - Lack of management support - Constant change of management - Unable to set a common goal and understanding - Setting too ambitious goals - Unclear organizational strategies - Budget provision

	- Organizational structure deficiencies
Organizational: *issues related to EA training and educating personnel, communication and collaboration in the organization.*	- Personnel change resistance - Lack of personnel knowledge - Lack of communication and cooperation - Inefficient human resource department - High costs of training personnel

Table 2 Taxonomy of identified obstacles during EA development

4.1 Environmental Obstacles

4.1.1 Political issues of the government

Confusion in government was mentioned as a common obstacle in governmental organizations. Both of the CIOs from Cases A and E mentioned that "*the inappropriate definition of business in the government"* and "*confusion in the government regarding the long term goals"* affected their EA development in the initial stages. Also **political changes of the country** were mentioned by Cases G and J. They imposed difficulties to the organizations "*for example when the government changes".* In this situation, "*the government changes, the cabinet will change, the industry minister will change. Therefore, [the organization's] boss will change".* Thus, it is so likely that the project will be terminated in the middle.

4.1.2 EA consultant related issues

The EA consultant of Case G was **unexperienced** with amateur members. This situation faced the EA project with difficulties as it took *"much longer than expected"* to finish and *"almost failed"*.

According to the CIO of Case A, **Lack of innovation** in consultant's team is another EA development obstacle. The interviewee mentioned that "*consultant team just wants to draw a diagram and to show that they have known and modeled processes"* without bringing any innovation to the job, which results in **consultant being inflexible**. Further, the interviewee mentioned that sometimes **EA consultants become inefficient** in a way that "*instead of consulting they were taking orders and acted like our employees."*

4.1.3 Outdated organizational statutes

Having old and forgotten statutes mentioned by the CIO from Case A to hinder their EA planning. The interviewee mentioned the statutes as an input for the EA development "*which indicates the establishment goals and aims of legislator or founder of [the organization]"*. However, they realized the obstacle when their EA consultant asked for these statutes and they realized that *"the organizational goals and objectives were different from what organization was doing."*

4.1.4 Restricted rules in governmental organizations

According to the Head of System Analysis and Design of Case G EA development in a governmental organization is more difficult than in private organizations because of **restricted rules and laws in governmental organizations**. It was stated that in governmental organizations "*there are managers, ministers, and president who impose rules and restrictions on the organization".* Case J faced with a situation in which **laws contradict with the EA results**. As a result of EA they realized that sales management in one of their divisions that should be removed. However, legislated laws of the county was against this EA result.

4.2 Technical obstacles

4.2.1 Old infrastructure

In Case C the project manager pointed out that because of having an **old infrastructure** they could not "*reach to the expected maturity."* It was also mentioned that in this situation even sometimes "*aligning with the organizational strategies is difficult"*. **Being function-oriented instead of process-oriented** also mentioned by IT managers in Cases L and D to be "*the fundamental problem with most of the organizations"* and it is

necessary to "*first fix this fundamental challenge to become process-oriented, then think about EA development.*"

4.2.2 Lack of change management tools

Lack of change management tools mentioned by the Case M hindered an EA project. It was difficult for the EA team of the company to manage changes as they had not have any *"monitoring tool".* Each unit in the company had a person who was responsible for the changes in the company, which was not acting efficiently. Further, as *"the environment changes rapidly and their time was limited"* lack of a tool to monitor and manage changes during EA development was challenging.

4.2.3 Ineffective EA outputs

IT Manager of Case C mentioned that their EA outputs were too abstract to be usable for systems developers. They had to interview the personnel again to get more details which *"bothered both personnel and managers".* Further, Insufficient use of the EA results caused Case K not to benefit from all the potential of EA development.

4.3 Managerial obstacles

4.3.1 Lack of management knowledge

The CIO of Case G mentioned that the managers' lack of knowledge *"make it so difficult to convince them about the usefulness of developing EA"*. Further, the interviewee mentioned that because of lack of knowledge the manager did not want to be *"involved"* in the project. Case B established a new unit for EA and assigned a manager for it. However, because the manager was unexperienced the EA effort did not succeed. Also, the representative from Case F mentioned that the management expected EA to implement a system and they wanted *"real and tangible results"*. However, according to Project Manager of Case F, the management must be realistic and realize that *"EA must remain in architecture level and system implementation is not in the realm of EA development".*

4.3.2 Lack of management support

The CIO of Case K mentioned management unsupportiveness as a problem. It took more than 6 months to argue with the CEO of the company to convince him about developing EA. Getting the CEO's approval and support was their *"biggest obstacle".* Similarly, it was mentioned by the Case A, that "*managers do not pay enough attention to EA when it is needed."* Cases K and A stated that managers just ask for the EA results without wanting to be involved in the project. However, "*Managers' supervision during the EA project motivates the personnel"* as they realize that the management is also involved in the project. Further, Case M complained about the managers being unsupportive during the EA project, although they supported the project initially. Also **favoritism in hiring new and unqualified personnel** by the high management to be in charge of EA project hindered EA development in Case M.

4.3.3 Constant change of management

In Case C, **constant change in management** affected *"policies and strategies of the organization".* Changes in the organization hindered the decisions that were needed in EA development. Similarly, Cases F, J, E, and M also mentioned this obstacle. In Case J, when the management changed, it was not clear that the new management "*approved to continue the previous manager's works and projects*." Therefore, during the development of a lengthy project like EA it is very probable that management changes several times during the project and the changes affect the strategies and priorities of the company. In Case M, the EA results were not accomplished, because the management changed constantly and sometimes the projects, which are initiated as the results of EA were terminated because *"the new manager did not approve the project".*

4.3.4 Unable to set common goals and understanding

The CIO of Case K stated that setting *"**a common desire and goal in the whole company**"* was their biggest obstacle. Similarly, IT Manager of Case L mentioned that *"to make the fundamental of EA"* in the organization depending on the level of the personnel's knowledge *"a short-term or a long-term time"* is required that everyone in the organization reach to a **common understanding** of EA. otherwise, EA project will be a *"total failure"*. Also, the representative of Case M mentioned that everyone in the organization *"must want"* EA to be developed.

4.3.5 Setting too ambitious goals

Setting too ambitious goals in the initial stage of EA project mentioned as an obstacle by the interviewee from Case F. In the initial stage of the EA project they were defining project goals "*too ambitiously and ideally"*. Thus, they faced with failure and they started again with a more realistic set of goals. Further, Case M started its EA development project with *"false assumptions"* because the personnel did not cooperate efficiently and costs increased as they had to *"redo everything"*. Thus, the EA development took much longer than what was expected.

4.3.6 Unclear organizational strategies

The CIO of Case A considered EA development as a total failure when the organization **did not have a clear organizational strategy**. In order to reach to the target situation the organization must know the *"mission and vision"* of the project with *"a clear and up to date strategy"*.

4.3.7 Budget provision

Too small budget is a common issue in big projects like EA development. As mentioned by the interviewee from Case F, the estimated budget was not sufficient to finish the project and "*EA costs could not be paid as planned."* In another situation pointed out by IT manager of Case L, due to lack of budget in the middle of the project they could not pay all consultant fees, which affected the EA project as the consultant's role was reduced. In Case G, *"budget provision"* was the biggest obstacle. The budget was too small to implement all the projects that were defined as the EA results and they were *"postponed each year"*. A limited budget also effects the selection of the consultant. As it was mentioned by Cases F and G, one of the important criteria in selecting a consultant was the cost.

4.3.8 Organizational structure deficiencies

The interviewee from Case B mentioned that although they have developed business processes perfectly, *"sometimes business does not go on smoothly"* and customers are not satisfied and in some situation they are *"faced with high costs"*. He continued that the reason for such obstacles is that they have a weakness in their organizational structure, which is lack of central EA governor *"to determine some criteria to control the performance."* Similarly, the interviewee from Case G mentioned that their *"biggest challenge"* is that *"there is not a central and powerful unit to govern [their] EA"* after development. The interviewee pointed out that when the **CIO is not directly managed by CEO,** big IT projects like EA develop slower with more obstacles because "*the manager of that department [which EA is a sub-set to it] does not have enough IT knowledge or resist to changes that IT brings by proposing new technologies and the CIO's proposal might never reach to the CEO."*

4.4 Organizational obstacles

4.4.1 Personnel change resistance

In Cases G, J, and M personnel resistance to change seemed to hinder EA development greatly. Although organizations tried to convince the personnel of their job safety, they still faced resistance. The high level management should "*reassure the personnel of their job safety by communicating and involving"*. According to the Cases H and C, the reason for personnel change resistance is that the employees are *"too attached to*

their desks and chairs". The employees think if the processes are improved and the tasks are performed automatically, they might lose their jobs.

4.4.2 Lack of personnel knowledge

In Cases E, J, L, and A **lack of personnel knowledge** about EA development was a challenge. In Case E EA development took more time than planned as they needed first to learn about EA. In spite of outsourcing the EA development, Case L faced difficulties during EA project because "*the organization had a very small and weak IT team".* They had heard about EA and its benefits and now they just wanted to have EA without having enough knowledge about it. The interviewee stated that when EA knowledge does not exist in the organization, *"do not start the project".* The CIO of Case A stated that because of personnel's lack of knowledge "*the data gathering and interview sessions became longer than what was expected".*

4.4.3 Lack of communication and collaboration

When Case E started the EA project they were "*assuming that the personnel of each unit was working with valid data",* meaning that they knew where the data came from and how exactly they should process this data. But they were wrong about this, because most of the personnel had no idea about the origin of their data, which was caused by the **lack of communication and collaboration** between different units and personnel. Further, Case L stated that lack of communication and cooperation between the EA consultant and the company caused project termination. In Case G, some employees felt threatened by the EA development and tried to*" jeopardize"* the project by giving wrong information to the EA consultant intentionally. Some of the employees wanted to *"hide truth"* about their processes because, *"they were afraid to lose their position in the company".* Additionally, the EA consultant did not have all the company's knowledge and therefore they could not verify the employees' answers regarding their processes. Consequently, the architecture became flawed and some analyses had to be redone.

4.4.4 Inefficient human resource department

The CIO of Case B mentioned that although they had developed EA successfully, the personnel was unsatisfied, because the human resource department did not set up any sessions for the personnel to educate them beforehand. **Forcing personnel to adopt EA** instead of educating them was identified as another obstacle that may hinder an EA project. The CIOs of Cases A and K mentioned the effect of **fluctuation in personnel's motivation** on the EA development process. For instance, as a governmental organization, the interviewee from Case A mentioned the difficulty of coping with higher level management. Also, the CIO of Case K stated that the personnel's motivation affects the progress of EA project as *"Sometime the employee is in a good spirit and the project progresses very well but sometimes the employee is not in the mood and then even continuing the project seems so difficult"*.

4.4.5 High costs of training the personnel

Changes in the organizational structure is usually one of the EA results. Therefore, implementing the results of EA development often involves hiring and training new employees or losing the trained ones. In Cases B and M, **high costs of hiring, training, and loosing personnel** was an obstacle. The CIO of Case B mentioned that as a result of EA development a part of organizational structure might change and then *"the problem of layoffs or job rotation of your trained personnel"* will occur. Adding new functions to the organizational structure as an EA result then leads to "*the issue of hiring and training new personnel"*. Both situations may involve high costs. The interviewee from Case M stated that training human resources to become experts in business process development is *"an investment and is expensive for the company"* and when *"[the trained employee] leaves the company or moves to another division"* the company loses its *"potential"*. Therefore, as the interviewee from Case B mentioned *"When you lose your trained human resource it is harmful for the organization. Because the organization is losing its knowledge and potential".*

5 Discussion

We identified 20 obstacles in EA development that we categorized into four themes: Environmental, Technical, Managerial, and Organizational. In this section we discuss the relationships between the identified obstacles. Then we compare our findings to previous studies and finally we present some recommendations based on the findings.

5.1 Possible relationships between the identified obstacles

We searched the data for possible cause and effect relationships between the identified obstacles. They are briefly described here:

- We noted that **confusion in government** is associated with the **political changes of the country** that has a direct impact on the management of governmental organizations, which results in **constant change of management**. Further we found out that **constant change of management** effects on the **cooperation and communication** of different units. In addition, **constant change of management** also influences the **personnel's motivation**. In a long project like EA development, management changes possibly many times and the new management does not have similar views of the project. The personnel may lose their motivation to the development if they know that management changes may also cause change of plans.
- **Management support** and involvement in the project raises the **personnel motivation**. The interviews included mentions that when managers supported the project, the personnel become more motivated and efficient.
- **Lack of management knowledge** and **unexperienced EA consultant** are two causes of **setting too ambitious goals**. When the management does not have enough knowledge, it may aim at unrealistic and wishful goals, which at the end of the day cannot be fulfilled. Being unexperienced, EA consultants also set unrealistic and ambitious goals in the initial stages of the project, which are hard to fulfill.
- **Management support** and **change in management** influence the EA project **budget**. When management changes during EA project, the new management may not be as supportive as the previous management and EA project priority will be reduced and the EA project budget will be cut. Therefore, this may cause **lack of budget** in the middle of the EA project. Due to the **lack of budget** organizations cannot update their **infrastructure**, therefore they cannot align themselves with their **strategies**.
- **Unclear organizational strategies** result in **improper definition of EA**, which may lead to **lack of budget** because of a wrong kind of an architecture. When the organizational strategy is not clear, organizations do not have a clear vision and mission. If the organization does not know where it wants to go and what it want to achieve, EA development will be a blurry thought. Therefore, EA will be defined improperly and the development will be started with false assumptions and following those assumptions the development ends up in a wrong architecture and waste of time and budget. Thus, if the organization wanted to compensate its loss and redo the project it so likely to face lack of budget and resources.
- When the **organizational strategy is unclear**, it is not possible to **set a common goal and understanding** in the organization. Because of **lack of communication** between different levels of managers and personnel, they cannot agree on a common goal and reach to a common understanding.
- When **EA knowledge does not exist in the organization**, the organization is unable to reach to a **common goal and understanding**. Reaching to a common understanding can be facilitated through personnel education and training.
- **Personnel's change resistance** and their **knowledge** are related to each other. If the personnel had enough EA knowledge then there would be less resistance to change. Further, if the personnel have enough knowledge, **communication and cooperation** will be facilitated. Also, **forcing personnel to adopt EA** instead of educating them, aggravates **personnel resistance to change**.
- Similarly, **lack of management knowledge** is associated with **lack of management support**. When the management does not have enough knowledge about EA or does not have IT knowledge, it is likely that the management does not support EA development and considers it as a *"luxury"* project.

- **Governmental organizations** seem to face more obstacles during their EA development than private organizations. One reason is that governmental organizations are more **restricted** because of the **rules and laws that are imposed by government**. Also governmental organizations are highly affected by the **governmental issues and changes**. Another reason that the EA projects in governmental organization are more vulnerable than private sector is that **personnel's motivation in governmental organizations** is lower due to lower salaries. The data suggested that people with high skills are not eager to work on governmental organizations.
- **Setting a common goal and desire** in the organization is also mentioned to be the determining factor in a successful EA development project. **Personnel's training and education** is influential in setting the common goal and understanding among employees in the organization.

5.2 Our findings in analogy to existing literature

To compare our findings with previous research we reviewed 9 articles related to EA development obstacles (Armour et al., 1999; Hauder et al., 2013; Isomäki and Liimatainen, 2008; Jahani et al., 2010; Kaisler et al., 2005; Lucke et al., 2010; Nakakawa et al., 2010; Seppänen et al., 2009; Ylimäki, 2008). We found that 15 out of 20 identified obstacles are documented in some of these studies. The five obstacles from our findings that none of the reviewed studies mentioned were political issues of the government, EA consultant related issues, outdated organizational statutes, constant change of management, and inefficient human resource department.

Kaisler et al. (2005) have very briefly mentioned political issues in their study without any explanation. In contrary to our findings, interviewing the governmental organization sector, Seppänen et al. (2009) mentioned that their interviewees were not appreciating the fact that the government or the ministries have left the organizations free to decide for their architectural directions. However, in our study the excessive governmental interferences and limitations were seen as obstacles during the EA development.

Similarly, none of the reviewed studies mentioned EA consultant issues. Jahani et al. (2010) stated briefly that employing experienced and educated consultants was a success factor of enterprise architecture planning. Armour et al.,(1999) suggest to employ good consultants that can offer expert advices, facilitate meetings and train the team. However, they did not mentioned anything about the challenges of employing the EA consultants. Also Lucke et al. (2010) pointed out "lack of experienced architects" as an issue in EA development. Nevertheless, they did not mention what they meant by architects; are they companies' trained personnel or consultants from outside.

Constant change of management was mentioned as an obstacle even in the post-development phase, because new management may not continue the agreed EA plans. This situation was mentioned by the interviewee in Case M. **Lack of budget** may also hinder EA in the post-development phase. Some managers may consider EA as a luxury project and terminate the projects due to lack of budget. In Case K **personnel's motivation** was also a problem in EA updates.

5.3 Lessons learned

In this section we will discuss about the lessons that management learned during EA development. This includes hopes, regrets and recommendations of managers after EA development. We discuss these issues by dividing these management advices into four categories.

I. Eliminating consultant related issues

IT Manager of Case L recommended to **choose an EA consultant that is easily reachable** so that the communication and cooperation will be easier. Another recommendation to eliminate consultant related issues is to **choose more experienced consultant**. As CIO of Case G mentioned if time goes back *"[they] would have chosen the most experienced EA consultant regardless of their wage"*. Additionally, stated by Head of System Analysis and Design of Case G, if she had the power to decide in consultant selection then the consultant's resume would have been the most important factor. The consultant must have had long experience in the development of EA for large enterprises. Also the interviewee of Case G mentioned that *"[she] would*

have also considered the foreign consultants who are more experienced and skillful than the national consultants".

Getting a free pilot test from consultants to check their work quality is another solution to eliminate consultant related issues in the future, mentioned by the Head of Business Process Development of Case G. The interviewee suggested that before making contract with an EA consultant it is necessary to ask the EA consultant to *"develop a pilot version"* on a small unit of the organization. In this way the organization can assess the consultant's work.

The Project Manager of Case F pointed out that **being more restricted on timetable with the EA consultant** is one way to eliminate future challenges with consultant. As the interviewee stated, if project timetable is flexible then the *"project will take much longer than expected to finish"*.

II. Eliminating change resistance issues

The CIO of Case J suggested that in order to eliminate the personnel change resistance, the **resisting entities should be involved more in EA development**. The interviewee mentioned that if he had the chance to redo the project he would have *"involved those resisting divisions more in the project, so they would have got along with EA gradually."* Similarly, the CIO of Case K regretted that he did not engaged enough with the personnel during EA development *"to have a close contact"* with them and to assure them about their *"job safety"* to eliminate their resistance.

Educating personnel instead of just making them familiar with EA is another way to eliminate personnel change resistance recommended by the CIO of Case G. The personnel need to understand that *"EA provides an infrastructure for better development and integration".* This would have facilitate the adoption of EA and EA would have been implemented with *"better quality and less resistance*".

Tighter cooperation of personnel and EA consultant was recommended by Cases G and F as another solution to personnel change resistance. Head of Business Process Development of Case G mentioned that if the personnel of the organization and the EA team would have had better cooperation the EA project should have been more successful and faced with less resistance. Similarly, Project Manager of Case F emphasized that *"working together with the consultants and learning from them"* makes the EA project more *"attractive"* to the personnel and eliminates their resistance to change.

Having a **powerful human resource department** can solve issues regarding personnel's motivation, change resistance and EA adoption. For instance, CIO of Case B stated that if they had a powerful human resource department, personnel would have been more satisfied and motivated by a reward system or performance assessment.

III. Eliminating the risk of failure

To avoid the risk of developing a wrong architecture organizations must provide prerequisites of EA development. One of the most important thing in EA development is to plan more accurately. According to CIO of Case I, if they had the chance to start over, they would have **planned the project as accurately as possible**. Case I realized many times that if something is not correct in the architecture, then they need to go back to their plans and identify the *"deficiencies"* that caused the failure.

The CIO of Case K wished that they would have **applied a more strategic plan**. The interviewee stated that it is crucial to first train oneself to *"think strategically"*. Instead of just doing routine works the personnel must also be trained to think strategically to produce the *"right output"*.

IT manager of Case N regretted that he should have increased his EA knowledge before EA development to **provide the EA consultant more accurate data**. The interviewee stated that *"more accurate data"* creates *"more accurate architecture"* and accordingly more *"added value"* for the company.

According to the Head of R&D in Case J, **organizations should develop EA at the right time**. The interviewee suggested that if the organization is not ready to adopt EA, *"development should be postponed"*. For instance, Case J encountered severe challenges during their EA development. At the time that they started the EA project they aimed at an integration with other divisions of the company. However, the economic

situation of other divisions was fragile. Therefore, the EA project with the integration objective was challenged by the economic crises of other divisions. According to the interviewee of Case J, at that time starting EA project with those divisions was a *"very wrong idea"*.

Another recommendation suggested by CIO of Case B is to **get consultants from EA experts outside of the company**. The interviewee stated that although they are an IT-based company but *"EA knowledge is different"* and to develop a successful EA, at least the companies must *"utilize EA specialist advices"*.

The CIO of Case A suggested the **IT department should directly be supervised by the CEO**. IT department should be a subset that *"directly communicate"* with the CEO. As the interviewee stated, there should not be any *"mediator"* between CIO and CEO. This way the EA project will have *"a strong support"* in the organization.

Employing motivated and creative personnel in the EA project is suggested by CIO of Case A in order to be successful. The interviewee mentioned that if they wanted to do the EA project again, they will be more *"sensitive"* in selecting personnel to work in the EA team, because the team members should be *"creative and eager to work in the team"*. Besides, EA should not be developed focusing only on one framework or standard, it requires *"element of creativity"* in order to be successful.

Another element of success in EA development, mentioned by the interviewee from Case M is that people involved in EA development must have **systems thinking**. The interviewee pointed out that if the units who were involved in the EA project had had systems thinking they would have had less challenges during EA development.

IV. Eliminating the risk of EA to be just documents dusting in the shelves

Regular updates to EA was suggested by the interviewee of Case G as a way to *"continuously utilize and improve"* EA in the company. According to Head of System Analyze and Design of Case G, EA documentation should be *"precise and realistic all the time"*. Similarly, Head of Business Process Development of Case G, pointed out that although updating EA is a crucial task for the organization, it is not updated regularly. It is crucial to have a regular update plan for the EA. The representative of Case G recommends that there should *"always"* be a consultant or a strong EA team in the company to carry out the EA tasks and updates.

Usually, the results of EA development comes in the form of proposals of new projects to reach to the target situation. As suggested by Cases G and L, it can be helpful if the **EA consultant participates and makes suggestions in the tender to select a vendor to implement EA results**. Because the EA consultant knows what is really needed to be implemented, they can assist in selecting a vendor to implements the proposed projects.

6 Conclusions

This study identified obstacles in EA development. The study was designed as a multiple case study and it collected empirical data by conducting 20 interview sessions in 14 large enterprises. The 20 identified obstacles were categorized into four main themes, environmental, technical, managerial, and organizational. We determined five new obstacles that have not been mentioned before: political issues of the government, EA consultant related issues, outdated organizational statutes, constant change of management, and inefficient human resource department.

We also collected and presented recommendations to mitigate the obstacles. Before actually developing EA, organizations should be aware of the obstacles. Examples of recommendations include eliminating consultant related issues by carefully choosing an experienced and qualified EA consultant. Eliminating change resistance issues by more involvement of personnel, educating them, and provide a situation for both personnel and consultant to cooperate and communicate better. Eliminating the risk of project failure by planning EA project accurately from initial stage, applying more strategic plans, providing more accurate data, and choosing the right personnel.

This study can assist practitioners to understand the obstacles that they are going to face in EA development. Also, by presenting the management regrets and recommendations, this study can help the practitioners to eliminate some of the obstacles identified.

One of the limitations of this study is the limited number of individuals that were interviewed. The study could be more reliable if we had more cases. Another limitation is that the cases were selected from one country and some of the mentioned obstacles may not apply to another country. Further, all the interviewees were from the management level of the organizations. Having other stakeholders' perspectives, such as EA consultants and personnel could clarify and explain some issues. Therefore generalization of these results should be made with caution. Further research using for example a survey on the topic is recommended to improve generalizability of the findings.

In the future we will consider also other EA project stakeholders and extend the scope of our research to other countries to increase the reliability of the research findings. Although various EA obstacles are widely addressed, not many solutions have been proposed in the literature. Therefore, in the future, studies that provide solutions to these obstacles are required.

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References

Armour, F., Kaisler, S., Bitner, J., 2007. Enterprise Architecture: Challenges and Implementations, in: System Sciences, 2007. HICSS 2007. 40th Annual Hawaii International Conference on. IEEE, pp. 217–217.

Armour, J., Kaisler, S.H., Liu, S.Y., 1999. Building an enterprise architecture step by step. IT Prof. 1, 31–39.

Bernus, P., Noran, O., 2010. A Metamodel for Enterprise Architecture, in: Bernus, P., Doumeingts, G., Fox, M. (Eds.), Enterprise Architecture, Integration and Interoperability, IFIP Advances in Information and Communication Technology. Springer Berlin Heidelberg, pp. 56–65.

Corbin, J.M., Strauss, A., 1990. Grounded theory research: Procedures, canons, and evaluative criteria. Qual. Sociol. 13, 3–21.

Erol, O., Sauser, B.J., Mansouri, M., 2010. A framework for investigation into extended enterprise resilience. Enterp. Inf. Syst. 4, 111–136.

Fatolahi, A., Jalalinia, S., Dabestani, Z., Eskandari, M., 2007. Extracting business process decomposition: A practical approach using the ISIran V methodology. Bus. Process Manag. J. 13, 214–222.

Glaser, B.G., Strauss, A.L., 1967. The discovery of grounded theory: Strategies for qualitative research. Transaction Publishers.

Hauder, M., Roth, S., Schulz, C., Matthes, F., 2013. An Examination Of Organizational Factors Influencing Enterprise Architecture Management Challenges., in: ECIS. p. 175.

Hoogervorst, J., 2004. Enterprise architecture: Enabling integration, agility and change. Int. J. Coop. Inf. Syst. 13, 213–233.

Isomäki, H., Liimatainen, K., 2008. Challenges of government enterprise architecture work–stakeholders' views, in: Electronic Government. Springer, pp. 364–374.

Iyamu, T., 2009. The factors affecting institutionalisation of enterprise architecture in the organisation, in: Commerce and Enterprise Computing, 2009. CEC'09. IEEE Conference on. IEEE, pp. 221–225.

Jahani, B., Reza Seyyed Javadein, S., Abedi Jafari, H., 2010. Measurement of enterprise architecture readiness within organizations. Bus. Strategy Ser. 11, 177–191.

Jonkers, H., Lankhorst, M.M., ter Doest, H.W., Arbab, F., Bosma, H., Wieringa, R.J., 2006. Enterprise architecture: Management tool and blueprint for the organisation. Inf. Syst. Front. 8, 63–66.

Josey, A., 2011. TOGAF® Version 9.1 A Pocket Guide. Van Haren.

Kaisler, S.H., Armour, F., Valivullah, M., 2005. Enterprise architecting: Critical problems, in: System Sciences, 2005. HICSS'05. Proceedings of the 38th Annual Hawaii International Conference on. IEEE, p. 224b–224b.

Kamoun, F., 2013. Rethinking the Role of Enterprise Architecture During Times of Economic Downturn: A Dynamic Capabilities Approach. J. Inf. Technol. Manag. 24, 26.

Kilpeläinen, T., 2007. Business Information Driven Approach for EA Development in Practice, in: The Proceedings of the 18th Australasian Conference on Information Systems. Australia. Citeseer, pp. 5–7.

Kim, J.-W., Kwon, J.-H., Kim, Y.-G., Song, C.-Y., Kim, H.-S., Baik, D.-K., 2006. EAFoC: Enterprise Architecture Framework Based on Commonality. J. Comput. Sci. Technol. 21, 952–964. doi:10.1007/s11390-006-0952-5

Lam, W., 2005. Barriers to e-government integration. J. Enterp. Inf. Manag. 18, 511–530. doi:10.1108/17410390510623981

Lange, M., Mendling, J., 2011. An experts' perspective on enterprise architecture goals, framework adoption and benefit assessment, in: Enterprise Distributed Object Computing Conference Workshops (EDOCW), 2011 15th IEEE International. IEEE, pp. 304–313.

Lankhorst, M., 2013. Enterprise Architecture at Work: Modelling, Communication and Analysis.

Lucke, C., Krell, S., Lechner, U., 2010. Critical Issues in Enterprise Architecting – A Literature Review. AMCIS 2010 Proc.

Myers, M.D., Newman, M., 2007. The qualitative interview in IS research: Examining the craft. Inf. Organ. 17, 2–26. doi:10.1016/j.infoandorg.2006.11.001

Nakakawa, A., Bommel, P. van, Proper, H.A., 2010. Challenges of involving stakeholders when creating enterprise architecture, in: 5th SIKS/BENAIS Conference on Enterprise Information Systems. pp. 43–55.

Niemi, E., Pekkola, S., 2013. Enterprise architecture quality attributes: A case study, in: System Sciences (HICSS), 2013 46th Hawaii International Conference on. IEEE, pp. 3878–3887.

Roth, S., Hauder, M., Farwick, M., Breu, R., Matthes, F., 2013. Enterprise Architecture Documentation: Current Practices and Future Directions., in: Wirtschaftsinformatik. p. 58.

Seppänen, V., Heikkilä, J., Liimatainen, K., 2009. Key issues in EA-implementation: case study of two Finnish government agencies, in: Commerce and Enterprise Computing, 2009. CEC'09. IEEE Conference on. IEEE, pp. 114–120.

Sowa, J.F., Zachman, J.A., 1992. Extending and formalizing the framework for information systems architecture. IBM Syst. J. 31, 590–616.

Stake, R.E., 1995. The art of case study research. Sage.

Themistocleous, M., 2004. Justifying the decisions for EAI implementations: a validated proposition of influential factors. J. Enterp. Inf. Manag. 17, 85–104. doi:10.1108/17410390410518745

Vargas, A., Cuenca, L., Boza, A., Sacala, I., Moisescu, M., 2014. Towards the development of the framework for inter sensing enterprise architecture. J. Intell. Manuf. 1–18. doi:10.1007/s10845-014-0901-z

Yin, R.K., 2013. Case study research: Design and methods. Sage publications.

Ylimäki, T., 2008. Potential critical success factors for enterprise architecture. Eval. Enterp. Softw. Archit. Crit. Issues Metr. Pract. Proj. 2005-2008Eetu Niemi Tanja Ylimäki Niina Hämäläinen Eds Jyväsk. Univ. Jyväsk. Inf. Technol. Res. Inst. 2008-Tietotekniikan Tutkimusinstituutin Julk. ISSN 1236-1615 18 ISBN 978-951-39-3108-7 CD-ROM.

Zachman, J.A., 1987. A framework for information systems architecture. IBM Syst. J. 26, 276–292.

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Lack of Communication and Collaboration in Enterprise Architecture Development

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Abstract Enterprise architecture (EA) is widely employed to reduce complexity and to improve business–information technology (IT) alignment. Despite the efforts by practitioners and academics in proposing approaches to smoothen EA development, it is not easy to find a fully successful EA. Because EA development is a complex endeavour, it is important to understand the obstacles that practitioners face during EA development. With the grounded theory, we studied how obstacles during EA development emerged from practitioners' point of view in 15 large enterprises. The study identifies lack of communication and collaboration as the core obstacle that can explain many other obstacles. Communication and collaboration were also harmed by other perceived EA development obstacles, including lack of knowledge and support inside organization and issues imposed by external parties, hesitation in training personnel, setting too ambitious goals, constant change of management, (lack of) clarity in EA development process, lack of budget, forcing personnel to adopt EA, lack of motivation, organizational culture, and organizational structure deficiencies. The lack of communication and collaboration caused several undesired effects to organizations, such as being unable to set common goals and achieve a shared understanding, personnel's distrust, endangered EA governance, lack of innovation capability, lost competitive edge, and ineffective EA outputs. The study highlights that organisations should improve their communication and collaboration before embarking on EA to encounter fewer obstacles. We provide four recommendations for practitioners to improve communication and collaboration in EA development.

Keywords Enterprise architecture · Enterprise architecture development · Obstacles · Communication and collaboration · Grounded theory · Large enterprises

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1 Introduction

Enterprise architecture (EA) manages the complexity of an organisation by providing a structured description of an enterprise and its relationships (Niemann 2006; Ross et al. 2006; Simon et al. 2014; Winter and Fischer 2006; Zachman 1987). Despite being considered a relatively young discipline (Boucharas et al. 2010; Bucher et al. 2006), people from both business and academia have become interested in EA and realised its importance. EA has been acknowledged to improve business and IT alignment, which is recognised to be critical for organisations' success (Alaeddini and Salekfard 2013; Löhe and Legner 2014; Schmidt and Buxmann 2011; Tamm et al. 2011; Winter and Schelp 2008; Wu and Lu 2007). According to recent surveys and studies, business and IT alignment is the most critical concern among CIOs (Guillemette and Paré 2012; Luftman and Ben-Zvi 2011; McGee 2008). EA has been reported to be used as a communication tool for business and IT alignment (Niemi and Pekkola 2015; Tamm et al. 2011). Organisations are increasingly initiating EA projects to achieve suitable business and IT alignment and EA is receiving more attention from industry as well as from academy due to its potential to gear IT to the needs of business (Wan and Carlsson 2012).

Many studies exist about the benefits of EA, for example reduce IT costs, more effective use of resources, improve agility and innovation, reduce complexity, and improve business

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and IT alignment (Boucharas et al. 2010; Foorthuis et al. 2010; Niemi 2008; Tamm et al. 2011; Wan et al. 2013; Foorthuis et al. 2016). Several studies addressed the significant role of EA in organisations (Alaeddini and Salekfard 2013; Kappelman and Zachman 2013), and EA frameworks and methods (Bernus and Noran 2010; Erol et al. 2010; Fatolahi et al. 2007; Hoogervorst 2004; Kilpeläinen 2007; Kim et al. 2006; Lankhorst 2013; Sowa and Zachman 1992; Vargas et al. 2014; Nogueira et al. 2013; Bernaert et al. 2016). Commonly, EA is adopted by organizations to facilitate enterprise integration issues and reduce complexities (Chen et al. 2008; Henderson and Venkatraman 1993; Banaeianjahromi and Smolander 2016b), to increase quality and responsiveness to the ever changing environment (Huysmans and Verelst 2013), for better institutionalization (Chung et al. 2009), for better decision making (Jensen et al. 2011), and to increase business performance (Boucharas et al. 2010; Van Steenbergen et al. 2011). Well implemented EA is both stable and flexible which assist an organization to innovate and change (Rouhani et al. 2014).

In the context of enterprise integration, EA can be utilized as a tool to determine the interconnections and technologies used between systems to evaluate the needs and impacts of integration. In our previous study, we identified the issue of inefficient architectural descriptions as a potential challenge in enterprise integration projects (Banaeianjahromi et al. 2016). EA is inefficient when it is not up to date, complete, understandable, nor in detail. Kähkönen et al. (2016), also mention the need of a complete, detailed and up to date EA in order to facilitate integration in the organizations and to ensure that integration is aligned with organizational goals and also to evaluate the integration needs, requirements, and impacts. The issue of inefficient EA not only hinders the integration projects but also puts the organization in chaos as there is no guideline or plan to determine the consequences of actions in the organization. Therefore, it is crucial to have an efficient EA in the organization.

Despite the popularity of EA in the last decade, it is not easy to find a successfully developed EA in an organisation (Iyamu 2009). According to Roeleven's (2010) white paper, 66% of EA projects did not fulfil the expectations of the surveyed organisations. Furthermore, the challenges that are faced during EA development are rarely technical but political, project management, and organisational issues (Kaisler et al. 2005). Although numerous studies have reported organisational experiences and best practices to develop EA (Hjort-Madsen 2006; Isomäki and Liimatainen 2008; Nakakawa et al. 2010; Seppänen et al. 2009), the ineffectiveness of EA development is present in many studies (Kähkönen et al. 2016; Bricknall et al. 2006; Ross et al. 2006).

In practice, EA development projects encounter different challenges, and not all of these projects end with success (Haki et al. 2012; Roeleven 2010; Schmidt and Buxmann 2011; Seppänen et al. 2009). Many studies have addressed the challenges and issues in EA development, but none of these have gone further than proposing taxonomies (Armour and Kaisler 2001; Bricknall et al. 2006; Chuang and van Loggerenberg 2010; Hauder et al. 2013; Isomäki and Liimatainen 2008; Iyamu 2009; Jahani et al. 2010; Kaisler et al. 2005; Löhe and Legner 2014; Lucke and Krell 2010; Nikpay et al. 2013; Roth et al. 2013; Saarelainen and Hotti 2011; Seppänen et al. 2009; Valtonen et al. 2011; Wan et al. 2014; Ylimäki 2008). Therefore, there is a need for research to move further than categorising the challenges of EA to a more theoretical direction.

We wanted to increase our understanding of obstacles in EA based on an empirical qualitative approach. Therefore, we investigated the process of EA development in 15 large enterprises using the grounded theory method (GTM). We made inquiries in three rounds through interviews and organisational documents. With this paper, first we aim to explain the EA development obstacles in the studied enterprises. Second, we look for core obstacles that can explain most of the other obstacles as their root cause. Finally, we investigate the causes and effects imposed by the core obstacle to the organizations. Additionally, we suggest recommendations to facilitate the removal of the core obstacle in EA development.

The paper is organised as follows. First, we review existing research on EA and its development obstacles. We then explain our choice of research methodology. Then we present the analyses and interpretations of the data, and we present our findings. In the discussion section, we compare our results to the literature and discuss the implications of the results on practice and research. We also discuss limitations and possible future study paths. Finally, we conclude with the key contributions.

2 Background

2.1 Enterprise Architecture

Goethals et al. (2006) referred to enterprises as 'living things', meaning that they need to be (re-)architected constantly to achieve their necessary agility, alignment, and integration. Taking all of the architecture of the entire enterprise into consideration, all enterprise entities, such as systems, stakeholders, relationships, dependencies and business strategies, can be architected in an EA effort (Goethals et al. 2006). EA is referred to as a holistic management of information systems in organisational approaches (Ross et al. 2006; Tamm et al. 2011; Winter and Fischer 2006). It describes how different entities in an organisation, such as systems, processes, organisations and people, work together as a whole to reduce costs

and respond to new business opportunities (Morganwalp and Sage 2004; Penttinen and Isomäki 2010; Ross et al. 2006).

There are different perspectives to EA (Niemann 2006; Ross et al. 2006; Simon et al. 2014; Winter and Fischer 2006; Zachman 1987) and there is no universally accepted definition of EA (Rohloff 2005; Ross et al. 2006; Zachman 1987). The Center for Information Systems Research (CISR) defines enterprise architecture as '*the organizing logic for business process and IT capabilities reflecting the integration and standardization requirements of the firm's operating model*'. They consider architecture as '*a strategic, rather than technical, exercise*'(MIT CISR 2016). EA has also been defined as '*the blueprint or the organizing logic that binds together aspects of (1) business planning, (2) business operations, (3) process rationalization, and (4) enabling IT infrastructure*' (Kamoun 2013).

Commonly, EA is considered as a '*bridge*' between strategy and implementation that aligns the business and IT (Hiekkanen et al. 2013). Bacon and Fitzgerald (2001) described the purpose of EA as a framework or method to align business and IT as well as cover both organisational and technical aspects. According to Tamm et al. (2011), EA's organisational role is positioned between IT and business strategy. Being similar to a strategy, EA aims to describe a long-term and organisation-wide vision of business processes and IT systems in great detail (Tamm et al. 2011). In an EA, the organisation is viewed as a complicated system that need to be broken down into manageable entities to improve the understandability of the organisation's complexity (Kamoun 2013). EA reduces the complexity of the current state and provides a mechanism for making decisions about the future state of the enterprise (Hiekkanen et al. 2013; Van Der Raadt et al. 2005). EA development is a planned process of evolution that is usually triggered by a business strategy shift, mergers and acquisitions, or when the current EA is not sufficient (Postina et al. 2010). EA development provides a long-term view by analysing the current status (As-Is) and determining the target status (To-Be) of the processes, systems, technologies, and strategies of an organization through a transition plan (Ross et al. 2006; Winter and Fischer 2006).

EA projects are continuous programmes that must be updated at different periods of time based on the enterprise's needs and changes (Jahani et al. 2010). Thus, in this paper, by EA project we mean a continuous project that cannot be done all at once and is developing continuously.

2.2 Enterprise Architecture Development Obstacles

According to Cambridge Dictionary, an obstacle is *'Something that blocks you so that movement, going forward, or action is prevented or made more difficult'*. We define EA obstacles as the factors confronting the EA project with difficulties and loss of resources that cannot be solved easily and therefore they create risks of project failure.

EA frameworks and methodologies assist enterprise architects by providing guidelines through different steps of EA development (Hoogervorst 2004; Lankhorst 2013; Zachman 1987; Medini and Bourey 2012). Many enterprises fail because they only focus on the framework, without considering how to implement and maintain the EA (Bricknall et al. 2006). Practitioners face many challenges that need to be solved in EA development, and in some cases, they face obstacles that cause project termination and failure. Therefore, in order to mitigate these issues, it is crucial to understand the challenges and obstacles that hinder EA development.

Several studies have addressed different EA challenges and obstacles. EA development challenges can be environmental, technical, managerial, or social (Banaeianjahromi and Smolander 2016a). Lucke and Krell (2010) categorise the EA issues into management, semantic problems, insufficient resources, complexity, and representation, while Bricknall et al. (2006) describe EA issues in terms of three categories: management, scope, and content. According to Isomäki and Liimatainen (2008), the three most pivotal challenges of EA are implementation ability and governance, structure of the state government and advancement of interoperability.

Management buy-in is mentioned as a critical factor in EA development to establish the documentation and the processes to keep the EA project ongoing (Bricknall et al. 2006). Insufficient management commitment during EA development is reported as a major issue in the literature (Lucke and Krell 2010; Seppänen et al. 2009; Valtonen et al. 2011; Ylimäki 2008). A lack of shared understanding of EA is another major issue that is frequently reported in the literature (Hjort-Madsen 2006; Iyamu 2009; Saarelainen and Hotti 2011; Seppänen et al. 2009; Ylimäki 2008). The issues of shared understanding and communication are related to each other. According to Saarelainen and Hotti (2011), communication and shared understanding have major roles in group working and decision-making. Communication and common understanding during EA facilitate information exchange between different EA stakeholders (Nikpay et al. 2013). Bricknall et al. (2006) mentioned communication as being an important and necessary component during EA implementation. Hjort-Madsen (2006) pointed out that a successful EA implementation requires constant communication and cooperation across different levels and functions.

Chuang and van Loggerenberg (2010) studied the challenges faced by enterprise architects. They identified five challenges: communication, obtaining buy-in from the stakeholders, ownership, perceptions of the enterprise architect, and organisational politics. In another study, Roth et al. (2013) reported the EA challenges faced by organisations by conducting a survey focussing on EA documentation. They identified 'huge effort of data collection' and 'bad quality of

EA model data' as the most reported issues among 140 valid responses. 'Insufficient tool support', 'No management support', and 'low return on investment' were the other important reported challenges.

Jahani et al. (2010) listed employing experienced and educated consultants as a success factor of enterprise architecture planning. Armour et al. (1999) suggested employing good consultants who can offer expert advice, facilitate meetings, and train the team. However, they did not mention anything about the challenges of employing EA consultants. Also, Lucke and Krell (2010) pointed out 'lack of experienced architects' as an issue in EA development. Nevertheless, they did not mention what they meant by architects: are they companies' trained personnel or consultants from outside? The literature suggests that the most common EA development challenges are not technical issues but human related. Insufficient management support, lack of shared understanding and lack of communication are among the most cited EA development issues. Although many scholars have identified communication and collaboration as a major issue during EA development, the explanation of why and how lack of communication and collaboration leads to a permanent or temporary EA project failure is incomplete and not grounded in theory (Nikpay et al. 2013; Schmidt and Buxmann 2011; Van der Raadt et al. 2010; Ylimäki 2008; Kang et al. 2010; R. Abraham et al. 2013; Niemietz et al. 2013). According to the literature, most EA development obstacles occur during the development stage of an EA project. Very little attention has been given to the issues raised in the pre-development and post-development stages of EA projects.

3 Research Method

We applied the interpretivist paradigm to understand the whole complex phenomenon and selected a qualitative strategy using the grounded theory methodology (GTM) to carry out this study. Glaser and Strauss outlined a research methodology to systematically derive theory from empirical data on social contexts (Glaser and Strauss 1967). In this study, GTM helped us to make sense of the obstacles that organisations faced during their EA development projects. In GTM, the systematic procedure of data collection and analysis is the major source of its effectiveness, which allows it to ground the created theory in reality (Corbin and Strauss 1990). We collected and analysed the data iteratively by investigating the obstacles perceived from each organisation at a time. To analyse our data, we used Strauss and Corbin's coding approach, which includes open, axial and selective coding. Coding represents 'the analytic processes through which data are fractured, conceptualised, and integrated to form theory' (Strauss and Corbin 1998).

One of the major strengths of GTM is that it has an 'open-minded' but not 'empty headed' attitude toward the empirical data to let empirical observations and theoretical insights influence the research interest (Goldkuhl and Cronholm 2010; McGhee et al. 2007). As we went forward in our research, the research questions developed according to our observations and insights, which we could note from the memos that we wrote during the research to keep track of our thoughts.

3.1 Data Collection

We collected the data in three rounds. In the first round of interviews, we employed snowball sampling (Corbin and Strauss 2008) to gather data from three organisations (Cases K, M, and P) in May and June 2014. In total, nine experts were interviewed, with the average duration of the interviews being 1 h and 15 min. The interviewed companies were large, with sizes from 1000 to 30,000 employees. In the second round, we gathered data from 14 organisations (Cases A to N) with purposeful sampling (Patton 2005) in the period from May to July 2015. In total, 20 experts were interviewed, with the average duration of the interviews being 1 h and 10 min. The interviewed companies were large, with sizes from 600 to 35,000 employees. All of these organisations had finished at least one round of EA development, and some of them were in the stage of updating their EA.

During the first round of interviews, we collected interviewees' feedback on the definition of EA, the utilization of EA in their work, the influence of EA in their company, Enterprise Integration (EI) challenges, and any concerns regarding EA development and maintenance. The aim of the first round of the interviews was to get a better understanding of the position of EA in the organizations and to identify any challenges regarding EA and EI. We deemed semi-structured interviews with open-ended questions to be suitable for data collection. Examples of the related interview questions are presented in Appendix 1. This way, the interviewer could ensure that all of the pre-planned themes were covered and the interviewees could think about and reflect on the topics as well as bring their experience and perceptions to the discussion (Lange and Mendling 2011). When required, more detailed questions were asked based on the interviewees' responses.

For the second round of data collection, we initiated our purposeful sampling in the beginning of May 2015 and sent an email to an EA specialist group with 335 members to request qualified members of the group to assist us with interviews. We received 38 replies from the group members who were ready to do the interviews. Then, we telephoned them, explained the purpose of the interview and asked for more information about their background and their experience with EA development projects. From these 38 responses, we selected the experts who were intensely involved with an EA development projects in a large organisation. In total, we

interviewed 20 experts including chief executive officers (CEO), chief information officers (CIOs), project managers, IT managers, and heads of related departments. All of the interviews took place in the interviewees' workplaces. The main questions addressed the obstacles, missions, and goals of the EA project in different EA development stages as well as the results and outcomes of the project. Examples of the related interview questions are presented in Appendix 1. Table 1 presents the information about the interviewed organisations.

For the third round of data collection, we sent emails to the interviewees and asked for their EA documents. Out of 14 organisations from the second round of the data collection, five organisations (Cases A, G, I, K and L) sent us documents regarding their EA development project. In total, we analysed nine documents (329 pages). Furthermore, during the analysis, we contacted some of the interviewees to get more information or clarification on an issue or topic that they had had mentioned during the interviews.

3.1.1 Case Descriptions

We collected data from 15 large organizations.

Case A: is a governmental organization with several branches in different cities. The interviewee was the CIO of the head branch of the organization with the educational background in business administration. In total the organization has 30 branches and 1500 employees. Their main goal to develop EA was to achieve organizational integration not only in the system level but also in processes and strategies. EA development was outsourced to an EA consultant company.

Case B: provides services to banks. Case B is a large organization with 800 employees in several branches. They developed EA to improve integration and standardization in their organization. The interviewee was the CIO of the organization and he had experience in the field of IT. B wanted to increase the level of maturity in their

Table 1 Case organisations and interviewees information

Cases	Industry	No. of employees	No. of interviews	Roles of interviewees
1st Round				
P	Global manufacturing enterprise	30,000	6	Business-IT negotiator IT manager of business area Manager of E-business and integration Head of E-business and integration Business support manager of a business area Director of business process development
K	Automotive industry	1570	2	CIO Head of IT department
M	Automotive industry	1600	1	Head of systems analysis and design
2nd Round				
A	Governmental organisation	1500	1	CIO
B	Banking industry	800	1	CIO
C	Consulting industry	2000	1	Project manager
D	Governmental organisation	20,000	1	IT manager
E	Cement industry	720	1	CIO
F	Consulting industry	600	1	Project manager
G	Governmental organisation	10,000	3	CIO Head of systems analysis and design Head of business process development
H	Automotive industry	9700	3	CEO R&D director Head of business process development
I	Automotive industry	35,000	1	CIO
J	Automotive industry	11,000	2	CIO Head of R&D
K	Automotive industry	1570	1	CIO
L	Banking industry	1000	2	Head of software development IT manager
M	Automotive industry	1600	1	Head of systems analyse & design
N	Governmental organisation	1860	1	IT manager

organization. They developed EA internally with minor help from external consultants.

Case C: provides IT consulting services to companies. Case C has about 2000 employees in different branches around the country. The interviewee was the one of the project managers of the organization and involved in the EA development project of the organization. The interviewee has experience in software development. Case C developed EA internally. Their goal was to reduce costs and improve integration within their organization.

Case D: is a governmental organization with several branches in different cities. In total Case D has 20,000 employees. The interviewee was the IT manager of one of the branches. The interviewee had experience in the field of IT. Case D outsourced their EA development. Their goal was to integrate business processes and information systems.

Case E: is in the cement industry with 720 employees. The interviewee was the CIO of the organization with IT experience. They developed EA internally. The goal was to reduce costs and improve decision making in the organization.

Case F: is a consulting organization with 600 employees. The interviewee was one of the project managers of the organization. The interviewee has experience in IT and business. They outsourced their EA development. Their goal was to provide information systems integration, have detailed and up to date documentation, improve business processes, and increase the maturity of the organization.

Case G: is a governmental organization with 10,000 employees. The interviewees were CIO with experience in IT, head of system analysis and design with experience in software engineering, and head of business process development with experience in business and industrial management. They outsourced their EA development. Their goal was to provide information systems integration, increase maturity of the organization, reduce costs, and improve business processes.

Case H: is in automotive industry with 9700 employees. The interviewees were the CEO of the organization with industrial management experience, R&D director with experience in innovation management, and head of business process design with experience in IT and business. They developed EA internally with getting minor help from an external consultant. Their goal was to provide information systems integration and reduce costs.

Case I: is in automotive industry with 35,000 employees. The interviewee was the CIO of the organization with experience in software development. EA was developed partly by EA consultant in the past but then they continued to develop EA internally. Their goal was to provide information systems integration and reduce costs.

Case J: is in automotive industry with 11,000 employees. The interviewees were the CIO of the organization with experience in industrial management and IT and the head of R&D with experience in IT. They developed their EA internally. Their goal was to provide information systems integration, reduce costs, and provide faster production.

Case K: is in automotive industry with 1570 employees. The interviewees were the CIO of the organization with experience in IT and business and the head of IT department with experience in software development. They developed their EA internally. Their goal was to provide information systems integration and reduce costs.

Case L: is in banking industry with 1000 employees. The interviewees were the head of software development with experience in software development and IT manager with experience in IT and business. They outsourced their EA development to an EA consulting company. Their goal was to provide information systems integration and have a detailed up to date documentation.

Case M: is in automotive industry with 1600 employees. The interviewee was the head of systems analysis and design with experience in software engineering and business. They developed EA internally. Their goal was to improve business processes and provide information systems integration.

Case N: is a governmental organization with 1800 employees. The interviewee was the IT manager of the organization with experience in IT. They outsourced their EA development. Their goal was to provide information systems integration and reduce costs.

Case P: is a global manufacturing enterprise with 30,000 employees. We interviewed six persons from this organization. They all had experience in IT and business. They developed their EA internally.

3.2 Data Analysis

We analysed the data by adopting the interpretivist paradigm (Easterbrook et al. 2008). All the interviews were transcribed to text format and then analysed with the qualitative data analysis tool Atlas.ti. Also the organisational documents were imported to Atlas.ti for analysis. Based on 'open coding', 'axial coding' and 'selective coding' principles from the grounded theory method (Strauss and Corbin 1998), we analysed our dataset as we collected them. Open coding is defined as 'the analytic process through which concepts and categories are identified and their properties and dimensions are discovered in data' (Strauss and Corbin 1998). The key activities of this phase are naming, comparing, and memo writing (Locke 2001). Axial coding is 'the process of relating the categories to their subcategories. It is termed "axial" because the coding occurs around the axis of a category, linking the category at the level of properties and dimensions' (Strauss and Corbin 1990). The final step of the analysis process was

selective coding. Determining the central category that all other major categories are related to is a part of selective coding (Strauss and Corbin 1998). Figure 1 presents the process of data analysis in this study.

3.2.1 Phase 1 and 2– Open Coding and Axial Coding

In the open coding, we read all of the interview transcripts and conceptually labelled words, sentences, and paragraphs through constant comparison (Strauss and Corbin 1998). 'Budget', 'teamwork', 'organization and consultant relationship', 'EA updates' and 'infrastructure' are the examples of open codes that we created. For example, we assigned the code 'training personnel' to the following interview quotation: *'When you lose your trained human resource, it is harmful for the organisation because the organisation is losing its knowledge and potential'* –Case B, CIO. Then, we grouped the conceptually similar ones to form categories and subcategories using theoretical comparison (Strauss and Corbin 1998).We also used the interview questions and themes to lead us in conceptually categorising the data.

We also provided a categorisation level to increase the understandability of the codes during the coding process. For example, we identified 'hesitation in training personnel' as a pre-development EA obstacle, which we coded as 'EA::obstacle::hesitation in training personnel'. During the open coding, we constantly compared the codes and merged similar codes. For instance, 'confusion in government' and 'political changes of the country', were merged into one category: 'EA::obstacle::government-related political issues'.

Open coding and axial coding processes happened in parallel. During the axial coding, we dug into the data to identify the relationships, such as the conditions, cause-and-effect relationship, and interactions, between the categories and subcategories. For instance, we noted that confusion in government is associated with the political changes of the country that has a direct impact on the management of governmental organisations, which results in constant change of management.

According to Bowen (2008), it is challenging for qualitative researchers to recognise the theoretical saturation point. This is a milestone that should be met in a grounded theory study to prove that the data categories are well established and validated (Bowen 2008; J. M. Corbin and Strauss 1990). Corbin and Strauss (2008) explains saturation as the situation 'when no new categories or relevant themes are emerging'(p.148). We believe that we reached the point of data saturation or theoretical saturation, as new data did not add new insights and we faced data replication and redundancy. According to Pandit (1996), theoretical saturation has been met when the marginal value of new data is minimal. For instance, during the second round of interviews, we noticed that codes in the data started to repeat after the 12th interview. We reached the point of theoretical saturation as (1) no new and relevant data created any new categories; (2) the properties and dimensions of the EA obstacles were being assigned to the already established categories, and no new categories

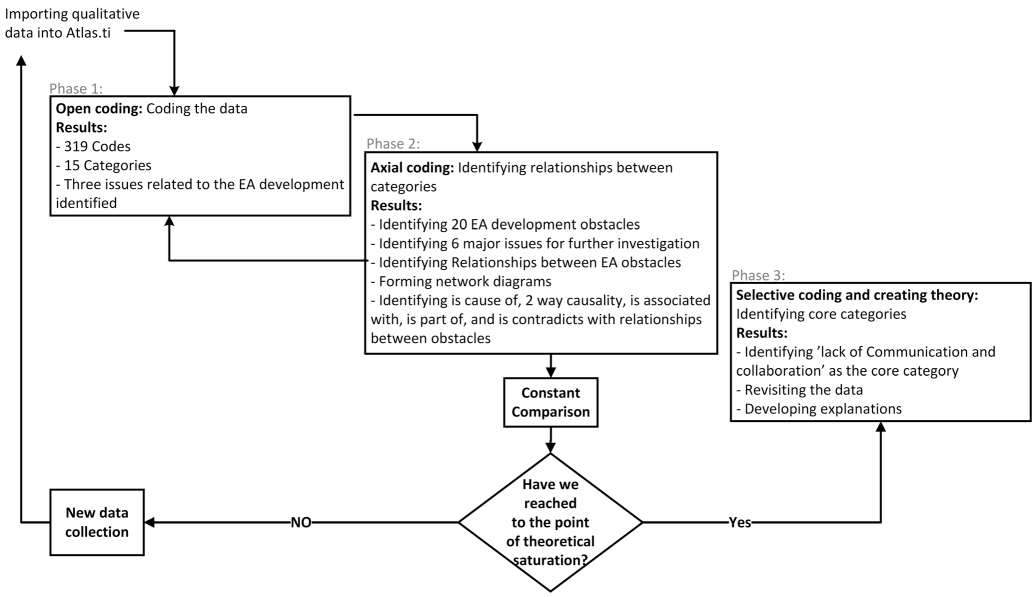

Fig. 1 Phases of data analysis

were added; and (3) the patterns in data were repeated and the relationship among categories were well established (Duchscher and Morgan 2004; Morse 1995). We ended up with 319 codes and 15 categories in the initial phase of analysis. Appendix 3 Table 5 presents the categories and their descriptions as well as examples of codes in each category and their relationships to other categories.

After open and axial coding of the first round of interviews, we identified three EA obstacles:

(1) Lack of collaboration in different forms, such as lack of collaboration between other personnel and architects, and lack of collaboration between members of a team.
(2) Lack of management support to prioritize the EA development and to assign enough budget and resources
(3) Personnel resistance to change due to several reasons, such as lack of knowledge, lack of trust, and fear of losing jobs

Interestingly, while the organisations knew about the issues of collaboration, resistance and support in their organizations, they still started the EA development and hoped that these issues will be eliminated after EA development. However, this did not happen, because these issues constantly hindered the quality of EA. Based on these observations, obstacles such as personnel resistance to change, lack of collaboration, and lack of management support, which had already appeared before EA development, seemed to continue during and after EA development when they were not addressed properly. So, besides further investigation of EA obstacles we also got interested in understanding how obstacles appeared in different EA development stages (pre-development, development, post-development).

Investigating the EA Obstacles We continued the process of data collection and analysis and moved to the second round of data collection. This included the identification of the relationships between EA obstacles and related concepts. We investigated especially how the mentioned three EA obstacles that we identified initially have emerged and what are the causes and effects of these obstacles in an EA development project. With regard to axial and selective coding (Corbin and Strauss 2014), we wanted to understand the possible relationships between the identified obstacles to identify the core category. We made a table (Appendix 2 Table 4) that presents all of the identified obstacles and their relationships (Is cause of, Is associated with, Contradicts, Is part of, and Two-way causality) with other obstacles. Using Atlas.ti we constructed network diagrams to illustrate the relationship between the codes. Figure 2 presents the network diagram of all the identified EA obstacles and their relationships.

We identified five types of relationships between the elements of interest in the data. For example, we used the 'is part of' relationship when denoting that several obstacles—'EA consultant being inflexible', 'EA consultant being inefficient', 'Lack of EA consultant innovation', and 'Inexperienced EA consultant'—were parts of a higher-level category named 'EA consultant–related issues'. 'Is cause of' is another type of relationship. For example, 'political changes in the country' is a cause of 'constant change of management'. Another

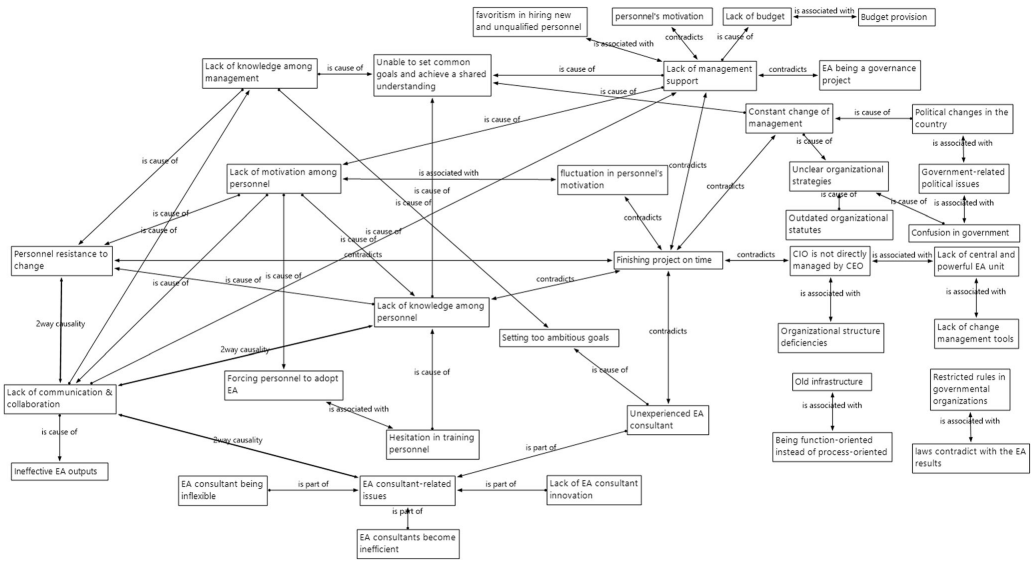

Fig. 2 Network diagram of the identified obstacles and their relationships

identified type of relationship is referred to as 'is associated with'. For example, 'Forcing personnel to adopt EA' and 'Hesitation in training personnel' are associated with each other. 'Contradicts' is another type of relationship. For instance, we identified several obstacles during EA development that prevented the project from being finished on time, like constant change of management, lack of management support and lack of knowledge among personnel.

Besides identifying the EA development obstacles, we also wanted to see how the obstacles appeared in different stages of EA development. We employed semi-structured and theme-based interview questions that focused on obstacles observed during pre-development, development, and post-development in EA projects.

We defined EA obstacles as factors that confront the EA project, slowing progress or diminishing resources. Such problems cannot be solved easily and may potentially cause project failure.

The interview questions were based on three EA development stages, and we used these stages to conceptualize the identified obstacles. Appendix 4 Table 6 presents the identified obstacles in EA development assigned to the three stages, which we define for this study as follows:

1) **Pre-development**: the stage in which the organisation is in the process of deciding to implement EA, form an EA team, select the EA consultant and set the mission and vision of the EA project.
2) **Development**: this stage consists of analysing the current situation of the organisation, planning the transition stage to reach to the target situation and proposing the necessary projects to reach the target situation.
3) **Post-development**: the stage in which the organisation starts the projects defined in the previous stage to develop the EA outputs. Also, it is in post-development stage that the EA updates occur.

From our analysis, we identified six obstacles that occurred more often across the stages than others. These obstacles are:

(1) Lack of communication and collaboration
(2) Lack of management support
(3) Lack of knowledge among management
(4) Lack of motivation among personnel
(5) Lack of knowledge among personnel
(6) Personnel resistance to change
(7) EA consultant-related issues
(8) Government-related political issues

Appendix 4 Table 6 shows how the obstacles appeared in different stages of EA development. To simplify the network diagram presented in Fig. 2, we decided to move to a higher level of abstraction (Table 2).

For each of the above four obstacles we drew diagrams to present their emergence with the most relevant obstacles related to them. The diagrams are presented in Appendix 5 Figs. 5, 6, 7, and 8. In these figures the circles represent the higher level of abstraction for the most frequently repeated obstacles and the rectangle boxes are the obstacles related to the most frequently repeated obstacles. The arrows shows Is cause of, Is part of, and Two-way causality relationships identified using both Fig. 2 and Appendix 2 Table 4.

3.2.2 Identifying the Core Category

In the third phase of analysis we identified the core category for selective coding. We used the diagrams presented in Appendix 5 Figs. 5, 6, 7, and 8 that illustrate the main EA development issues: (1) Lack of support inside organizations, (2) Lack of knowledge inside organizations, (3) Issues imposed by external parties, and (4) Lack of communication and collaboration.

These diagrams show how lack of communication and collaboration was present in all four diagrams. Therefore, we considered lack of communication and collaboration as the core obstacle (Fig. 3). At this point of the research we asked the following research questions:

(1) What are the causes that hindered communication and collaboration in EA development projects?
(2) What are the effects of the lack of communication and collaboration in EA development projects?

Table 2 Providing higher level of abstraction

Higher level of abstraction	Most frequently repeated obstacles
Lack of support inside the organization	Lack of management support
	Lack of motivation among personnel
	Personnel resistance to change
Lack of knowledge inside the organization	Lack of knowledge among personnel
	Lack of knowledge among management
Issues imposed by external parties	EA consultant-related issues
	Government-related political issues
Lack of communication and collaboration	Lack of communication and collaboration

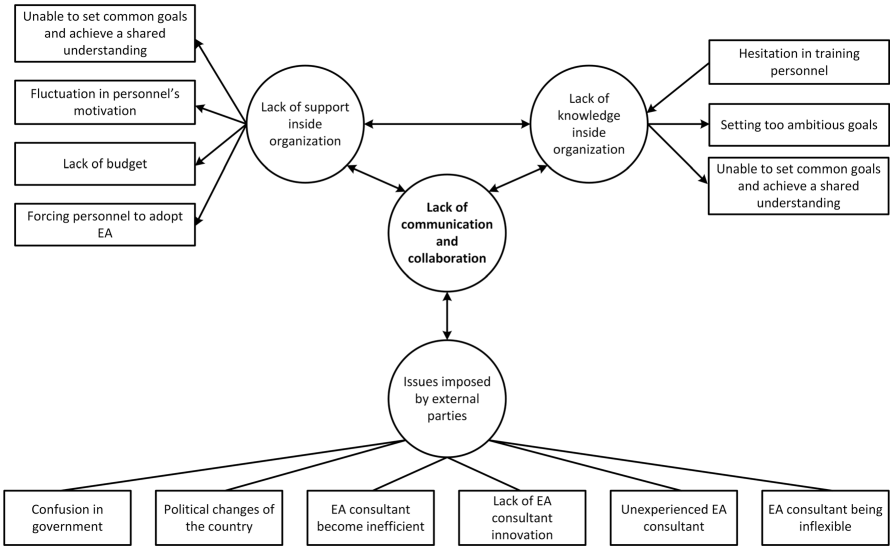

Fig. 3 The emergence of core category

3.2.3 Determining the Causes and Effects of Lack of Communication and Collaboration

We identified lack of communication and collaboration as the core category and explained the relationships of other major issues with this category. We could explain the emerging theory by revisiting the data from the core category perspective. We noticed that lack of communication and collaboration is the obstacle that can explain other obstacles.

Besides the three general obstacles (lack of knowledge inside the organization, lack of support inside the organization and issues imposed by external parties), we aimed to understand more specific causes and effects that are related to these three general obstacles. Figure 4 illustrates the causes and effects of lack of communication and collaboration in EA development projects. Besides lack of knowledge and support inside organization and issues imposed by the external parties, we identified 11 causes (white boxes) and 6 effects (grey boxes) of lack of communication and collaboration in EA development. Most of the obstacles presented in Fig. 4 were already identified during axial coding. In selective coding we were able to reveal more causes and effects of lack of communication and collaboration in EA development, 'Organizational culture' and 'clarity in EA development process' as causes and 'Personnel's trust' and 'organization loses its competitive edge' as effects. We were also able to determine the relationships between causes and effects, how they affect each other and how the effects reflect to the EA development effort. We also changed the code names to more abstract ones. For example, 'lack of motivation among personnel' was renamed to 'lack of motivation'.

4 Findings

In this section, we explain our findings from the research phases. We also explain the line of thought that we followed in order to find the core obstacle in EA development and construct our theory. First, we will describe the three major obstacles that hinder communication and collaboration in EA development: Lack of knowledge inside organization, lack of support inside organization, and issues imposed by external parties. Then we will also explain our observations of the organizational documents and, finally, we will present our theoretical conclusion of the causes and effects of lack of communication and collaboration in EA development.

4.1 Lack of Knowledge and Support Inside Organization

Knowledge and support inside organization are two connected concepts; being supportive is because of having enough knowledge and lack of knowledge causes unsupportiveness. Thus, we decided to describe these two issues in one section. We identified lack of knowledge inside organization and lack of support inside organizations as two of the four major EA development obstacles. Figures 5 and 6 in Appendix 5 present the obstacles related to the lack of knowledge and lack of support inside organization. We understood that lack of knowledge and support could be among personnel as well as managers. Some examples of these issues are discussed in the follow.

In Case E the CIO pointed out that, because of the lack of management knowledge, the EA development project did not have enough support from the management. Similarly, the CIO

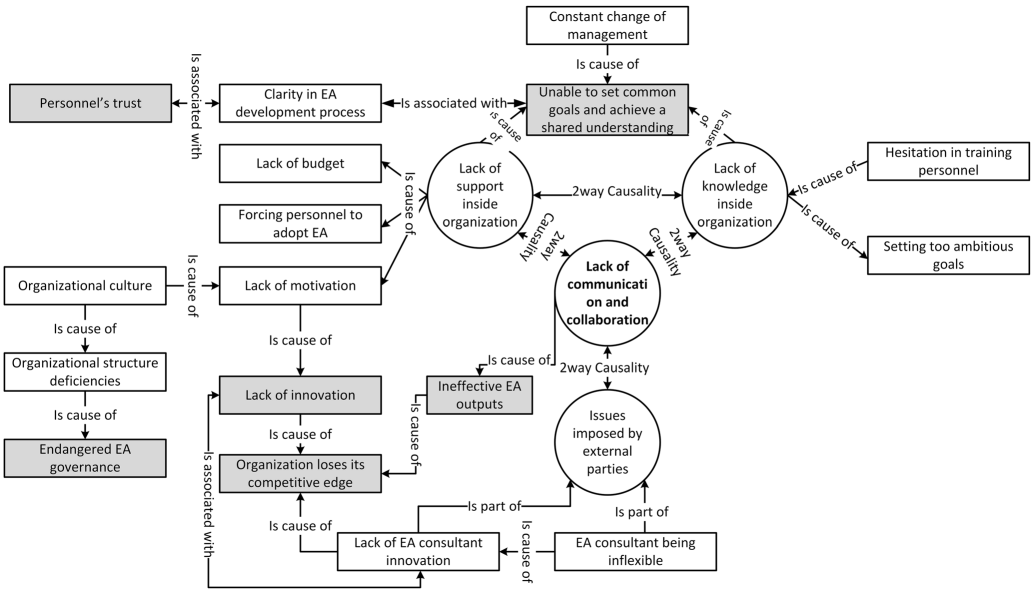

Fig. 4 Causes and effects of lack of communication and collaboration

of Case G mentioned that, *'because high-level managers' education background usually is in human sciences, they don't have any knowledge of EA […] and they don't understand the benefits of EA'*. Thus, they did not support the project. The Head of Systems Analysis and Design of Case M and the CIO of Case K mentioned that, because of the constant change of management, the organisations were faced with difficulties in developing the EA as the new management did not approve the continuation of the previous management's approach. So, the EA projects did not get enough support from the management. The severity of this was mentioned by the CIO of Case K: *'I remember that we were arguing the about 6 months with the CEO to convince him to do the EA. There was no other option, EA had to be developed […] we had a lot of discussions with the CEO to assure him that we could not continue doing our routine work if we wanted to reach to our goals. We needed his approval and support; that was our biggest obstacle'*. The CIO of Case E explained the constant change of management as a '*terrifying situation for EA development, as managers with different strategies and priorities constantly came and went'*. Furthermore, the CIO of Case B mentioned that, usually, '*the high-level managers do not have enough IT-related knowledge to understand the necessity of developing EA'*. This situation hindered the EA project in Case B in all the stages of development.

Regarding the personnel-resistance-to-change issue, the Business Support Manager of Case P mentioned, *'You are keen to like what you are used to and you are not always very open to change'*. Furthermore, the Manager of E-business and Integration of Case P also mentioned, '*Sometimes that is kind of hard for the people to understand and to change the way they are used to working*'; it is not '*roses and sunshine all the time'* as they encountered human issues in the background. Also in Case K, when the personnel were told that the organisation was going to develop EA and their tasks might change, they resisted the changes by not collaborating with the EA developers. As was pointed out by the Head of the IT Department of Case K, *'everyone understands the changes that are caused by EA development, but they are not knowledgeable enough to understand how these changes will improve the maturity of the organisation, […] and maybe this is partly because they are forced to adopt EA and consequently they show resistance to changes'*.

High-level management support seems to play a major role during EA development. The IT Manager of Case K mentioned, 'one of our biggest challenges was to convince the high-level manager that developing EA would be beneficial for the organisation, […] even though the high manager says that EA is beneficial, but in practice the manager does not fully support the project'. The high-level manager was against EA development, but the CIO and IT Manager of the organisation tried hard to convince him and get his approval to start the EA project. However, as they went on with the project, the manager showed less interest in the EA project, and at some point the EA development even stopped as the high-level management refused to assign more resources to continue the project.

The CIO of Case A mentioned personnel resistance to change as an obstacle in the pre-development stage, and he pointed out that the organisation addressed this issue by taking actions such as educating their personnel, conducting seminars and info sessions and involving personnel in the EA development progress report meetings. Furthermore, the CIO of Case G mentioned that, *'During EA development, most of the personnel were concerned about losing their jobs. We told them don't be concerned, developing EA just means correcting our views and models; it does not mean that someone else will get your job and you will lose your job. But still, we could see the resistance'*.

The CIO of Case B mentioned that they started the EA project without considering personnel resistance to change as an issue. They thought that developing EA was something that only managers should be concerned with, and so they did not involve the personnel in any of the decision-making sessions or meetings regarding EA development. They assumed that the personnel would adapt to the changes that the EA would bring to the organisation without asking questions. So they started to develop the EA without providing any training or offering information sessions on how EA can improve jobs while keeping them secure. But later, in the development and post-development stages, they noticed that the personnel did not collaborate as planned and sometimes even gave '*wrong information'* to the architecture team. Later, in the post-development stage, there was personnel dissatisfaction regarding the changes that EA had brought to their jobs.

'Lack of motivation among personnel' was another obstacle that hindered EA projects during the development and post-development stages. In order to keep personnel motivated and collaborating with the EA project, the human resource department should work efficiently to educate them beforehand about EA and its influence on their jobs and assure them of their job security. Failing to do so brings difficulties during the EA development and post-development stages. For instance, in Case B the personnel were forced to adopt EA without the management asking their opinion or involving them more in the project. Thus, they lost their motivation to adapt to the new procedures brought by EA development. In Case K the personnel lost motivation as they realised that the high-level management was not very supportive of the EA project, and hence they did not like to get involved in it.

4.2 Issues Imposed by External Parties

In Cases A, F, G, I, J, L and M, 'government-related political issues' appeared in all stages of development. This issue is beyond the scope of the organisations' authorities, and it sometimes hindered the process of EA development, especially in governmental organisations. This issue cannot be solved easily by the organisations themselves (Banaeianjahromi and Smolander 2016a).

'Confusion in government' was mentioned as a common obstacle in governmental organizations. Both of the CIOs from Cases A and E mentioned that 'the inappropriate definition of business in the government' and 'confusion in the government regarding the long term goals' affected their EA development in the initial stages. Also 'political changes of the country' were mentioned by Cases G and J. They imposed difficulties to the organizations, for example when the government changes. In this situation, *'the government changes, the cabinet will change, the industry minister will change. Therefore, [the organization's] boss will change'*. Thus, it is so likely that the project will be terminated in the middle.

Another obstacle that was mentioned in the two stages of development and post-development was 'EA consultant–related issues', which was mentioned in Cases A, B, G, I, L and N. For the organisations that outsourced their EA development, one of the activities in the pre-development stage was to select the best EA consultant based on their budget and the consultant's reputation. So, in the pre-development stage, organisations usually did not have any problems with the EA consultants, since the consultant companies showed their bright side and made promises to win the tender. The EA consultant of Case G was inexperienced with amateur members. This situation faced the EA project with difficulties as it took '*much longer than expected'* to finish and *'almost failed'*.

According to the CIO of Case A, 'Lack of innovation in consultant's team' is another EA development obstacle. The interviewee mentioned that *'consultant team just wants to draw a diagram and to show that they have known and modelled processes'* without bringing any innovation to the job, which results in consultant being inflexible in their job. Further, the interviewee mentioned that sometimes EA consultants become inefficient in a way that *'instead of consulting they were taking orders and acted like our employees'*. EA development in this situation brought no innovation to the organization.

'Restricted rules in governmental organisations' was also repeated in both the development and post-development stages. The organisations faced rules imposed by the government that restricted their freedom in EA development, such as rule involving changes in organisational hierarchies and roles. In governmental organisations (Cases G and J), this obstacle was mentioned as being more influential. According to the Head of System Analysis and Design of Case G EA development in a governmental organization is more difficult than in private organizations because of 'restricted rules and laws in governmental organizations'. In governmental organizations *'there are managers, ministers, and president who impose rules and restrictions on the organization'*. Case J faced with a situation of laws contradicting with the EA results. As a result of

EA they realized that sales management in one of their divisions should be removed. However, the laws of the county made this impossible.

4.3 Lack of Communication and Collaboration

'Lack of communication and collaboration' has both direct and indirect relationships with most of the other obstacles. This obstacle repeated in all three development stages in most of the interviewed cases. In the following, we will describe how the obstacle 'Lack of communication and collaboration' functioned on a case-by-case basis.

Case A's organization outsourced their EA development to an EA consulting company. The lack of communication was clear between the high-level management and the personnel, and the little communication that existed was characterised as formal. The personnel did not want to make a bad impression on the management because of the fear of losing their jobs. Consequently, they did not make their opinions clear to the management. This lack of communication caused personnel not to have enough knowledge about the ongoing projects in the organisation, and this probably resulted in resistance to change. Furthermore, the CIO of Case A mentioned that *'managers do not pay attention to EA when it is needed; they prefer to do their everyday routine tasks'*. The CIO pointed out that, when high-level managers did not show support for the EA project, the *'personnel's performance decreased and they lost motivation'*. It was also mentioned that, when developing the EA, the *'personnel should have reached a level of maturity and knowledge that they could collaborate with the EA consultant and could provide accurate and correct information about the processes'*. However, they were faced with the *'immaturity of the personnel'*, which caused delays in the data gathering and interview sessions, making these processes take *'longer than what was expected'*.

The CIO of Case A also mentioned that EA consultants sometimes did not collaborate efficiently as they were supposed to do. The CIO of Case A pointed out, *'Sometimes we contract with an EA consulting company, but in the middle of the work we see that, instead of consulting, they are taking orders and acting like our employees'*. It seemed that the EA consultant had an established structure and that they were only acting based on that. '*They have a framework and they just want to perform it and leave'*. The consultant's '*flexibility, agility, and innovation'*, which are determining factors in a successful EA project, did not exist. According to the CIO of Case A, *'the [EA consultant] must be innovative to efficiently integrate processes and create harmony and integration in architecture'*.

Case B's organization did not outsource the EA development project. However, they sometimes had an outside consultant for various tasks. One of their biggest challenges was '*ineffective use of human resources during EA development'*. As the CIO of Case B mentioned, they hired the wrong people for the new positions created as a part of the EA development and failed to produce results. We also noticed an issue with communication and collaboration, as the interviewee mentioned that the *'personnel do not need to know about the EA project; […] they should only adopt EA in their job'*. However, this attitude did not succeed, as the personnel resisted changes and were unsatisfied with the EA results. The CIO of Case B believed that the root of the organisation's problem lay in their organisational structure, as they did not have '*an official central and powerful EA unit in [their] organisational structure that was responsible for business processes design and re-engineering and monitoring these tasks to check the performance and ensure the quality'*.

Case C's organization developed the EA internally without any consulting help. Having an old infrastructure, establishing communication between different information systems and departments was challenging in the beginning of the EA development project. The Project Manager of Case C mentioned that, because '*employees are attached to their desk, they think that if the processes improve they might lose their jobs'*. The Project Manager continued: '*If the personnel do not get enough knowledge about EA development and how EA will benefit them, they will resist adopting the EA and endanger the project'*. Furthermore, the interviewee mentioned that '*teamwork'* was an issue in his organisation and that the personnel did not communicate or collaborate effectively during EA development. Due to the lack of communication and collaboration in Case C, *'the outputs provided by the EA team were not usable for the system developer's team. […] EA outputs were so abstract and not up to date that [they] had to interview the personnel again to get more details that bothered both personnel and managers'*.

Case D's organization outsourced their EA development. Similar to Case C, this organisation also faced the issue of old infrastructure in the beginning of the EA development. The IT Manager of Case D mentioned that, due to the lack of communication and collaboration, different divisions did not know about the processes that were happening in other divisions, and this caused problems in initiating a big project like EA development in which everyone in the organisation should be involved. Furthermore, the interviewee pointed out that the systems were not integrated and that the communication between systems sometimes had to be done manually, and the risks of data manipulation and cheating were high.

Case E's organization developed EA internally without consultants' help. Besides the unsupportiveness of the management, the personnel of Case E did not have enough EA knowledge, and the EA team and personnel could not communicate efficiently. When Case E started the EA project, they were '*assuming that the personnel of each unit was working with valid data'*, meaning that they knew where the data came from and exactly how they should process the data. But they

were wrong, because most of the personnel had no idea about the origin of their data, which was caused by the lack of communication and collaboration between different units and personnel. Additionally, the constant change of management was another obstacle that was mentioned by the interviewee as being *terrifying* during the EA development project, '*as managers with different strategies and priorities constantly came and went*'.

Case G's organization outsourced their EA development to a consulting company. The Head of Systems Analysis and Design in Case G pointed out that the '*academic background of the high-level managers is in social sciences';* therefore, they did not have any knowledge of EA, IT or industry, and they could not understand the results or benefits of EA. The high-level managers did not have enough IT knowledge, and '*convincing them of the usefulness of adopting EA*' for the organisation was difficult. Furthermore, the CIO of Case G mentioned that *'it is crucial that* the *CIO is directly under the CEO in order to get more support, especially for the big projects like EA development'*. Afraid of losing their jobs, the personnel sometimes '*jeopardised*' the EA development project by '*hiding the truth or giving wrong information to the EA consultant'*. According to the Head of Business Process Development of Case G, the personnel did not always understand what the consultants were asking from them, and the answers they provided were sometimes unreliable or false. When errors were detected, sometimes '*the whole thing had to be redone'*. Furthermore, the CIO of Case G mentioned that sometimes, because of lack of resources, EA development was considered to be a *'luxury project'*, and the management lost interest in allocating a budget to continue the project.

The Head of Systems Analysis and Design of Case G also mentioned that, at first, the consultant had a professional team that knew what they were doing. However, *'in the middle of the project, suddenly the EA consultant team changed to an inexperienced team; […] collaboration and coordination became difficult, the project faced almost certain failure and the consultant company hardly managed to finish the project'*. Furthermore, the CIO of Case G mentioned that '*our contract with the [consulting company] was to develop EA in 9 months, but it took one and half years […] because [the consulting company] was not employing experienced persons to do the job'*.

Case J's organization developed EA internally without getting help from EA consultants. The CIO of Case J believed that outsourcing had its *difficulties* and that it would have taken too much time for the consulting company to become familiar with their business. The CIO of Case J mentioned, *'We know our organisation and this was our trump card'*. Although they knew their organisation and business, they did not have the necessary EA knowledge. They formed a group internally and studied EA development. The CIO of Case J also mentioned that their organization had the issue of constant change in high management due to the economic crisis. The CIO of Case J mentioned that new management usually meant new management principles: *'Therefore, a change in management highly affects a project like EA that takes several years to develop in a large enterprise, and it needs constant updates and improvements'*.

As in Case G, the personnel of Case J also sometimes gave false information to the EA team because they were afraid of losing their jobs. Additionally, Case J recently merged with other organisations, and they still were not able to unify their organisation. Organizations involved in the merger were also acting competitively toward each other. This situation made the EA development harder as the merged organisations did not like to collaborate or communicate with each other.

Case K's organization developed EA internally without any external consultancy. According to the CIO of Case K, '*getting the CEO's approval to start the EA development project was the biggest obstacle'*. As the CEO did not have any EA knowledge, he did not want to get involved or spend resources on the EA project. The CIO of Case K mentioned, *'I remember that we were arguing for about 6 months with the CEO to convince him to do the EA; there was no other option, EA must be developed. […] We had a lot of discussions with the CEO to assure him that we could not continue doing our routine work. If we wanted to reach to our goals, we needed his approval and support. That was our biggest obstacle'*. Because of the CEO's lack of knowledge about EA, he was not eager to collaborate during the project or provide the required resources. Thus, the communication and collaboration between the mid-level managers and the CEO was not at a desirable level during EA development. Lack of personnel motivation was another issue during the EA development project, as the CIO of Case K mentioned: '*Sometimes the employee is in a good spirits and the project progresses very well, but sometimes the employee is not motivated, and then even continuing the project seems difficult'* The results of the EA project included project proposals in order to reach the target situation, and according to the CIO of Case K, they did not benefit from all of the EA results because they did not have enough knowledge or innovation to carry out the proposed projects.

Case L's organization outsourced their EA development to a consulting company. According to the IT Manager of Case L, they had a small IT team, and the IT department was weak. The team did not have much EA knowledge: *'they had heard about EA and now they wanted to have it without knowing what it was'*. In this situation, communication and collaboration between the organisation's personnel and the EA consultant team was difficult, as they could not understand each other. Furthermore, as the management of the organisation changed constantly during the EA development project, new managers were not supportive of the project.

Several problems hindered the communication between the EA consultant and the company in the middle of the project. According to the IT Manager of Case L, one of the problems was that *'the organisation couldn't pay [the consultant's] wages on time, and it affected the EA project. […] The consultant's performance reduced'*. Furthermore, in the middle of the EA project, the company and the EA consultants were *'arguing about some issues that affected their communication, and the company did not like to cooperate with the EA consultant'*. Also, on the consultant's side, some people left the team, which practically halted the EA project.

Case M's organization developed EA internally without external consultants. Some of the IT personnel received EA education. According to the Head of Systems Analysis and Design of Case M, *'managers do not really know what EA is, they just say that they must have it, but in practice they do not support the project'*. Furthermore, Case M's management changed several times during EA development, and some of the managers were against developing EA because of their lack of knowledge about EA and also the budget. Case M did not develop all of the EA results because the management changed constantly and, sometimes, a project terminated in the middle because the new manager did not want the project to continue. The Head of Systems Analysis and Design of Case M mentioned that, for *'the survival of projects such as EA development, which involves the whole organisation and takes more time to finish, it is crucial to choose someone from inside of the organisation who knows about the business and background of the organisation as a manager'*.

The Head of Systems Analysis and Design of Case M also mentioned that, although the personnel of each unit knew what was going on in their units, they did not know *'the effect that a change would have on other units; [they] could not align [themselves] with each other'*. This was because of a lack of communication and collaboration between different units. In this situation, developing EA was a tough task as there was a lack of knowledge of the effects and interdependencies between the units.

4.4 Causes and Effects of Lack of Communication and Collaboration in EA Development

In this section, we explain about the causes and effects of lack of communication and collaboration in EA development that presented in Fig. 4. During selective coding we identified six additional items that hinder communication and collaboration in EA development.

The organizational culture turned out to be an issue that influence communication and collaboration in EA development. In Cases B and G personnel got used to old procedures and therefore they did not like to change their habits and they resisted to change and jeopardized the EA project by giving wrong information to the EA team. Moreover, different cultures in different departments and divisions caused communication and collaboration issues. For example the CIO of Case J mentioned that *'[…] the organizational culture in [division x] was very different from the culture of [division y]. During EA development different culture of divisions caused difficulties as personnel in [division y] did not believe in the positive changes that EA development brings […]'*. Furthermore, the CIO of Case J mentioned that *division y* still resists to the changes that are happening as the result of EA development, *'[…] because EA has reduced their independency in decision making and they were not motivated at all to collaborate with us'*. The difference in organizational culture between divisions in Case J was obvious as *division y* was merged with the organization few years ago.

Case I started five years ago to develop EA with the help of an EA consultant from another country but due to several organizational and political reasons their collaboration failed and later they continued to develop EA internally. The CIO of Case I pointed out that *'[…] although our collaboration with the foreign EA consultant was unsuccessful but the positive point of this effort was that our organizational culture changed and the road to develop EA in future was facilitated as we succeeded at that time to reach to a common point between different units that we need EA to be developed'*. Case I's initial unsuccessful EA development attempt affected the organizational culture and triggered their motivation to continue EA development internally.

Being clear about the EA development process is one of the requirements of EA development that most organizations stated in the pre-development but gradually this clarity faded away in the development phase. For example, Case B started to develop EA without explaining to the personnel about what is EA and how it will affect their jobs and how they are going to develop it. Consequently Case B was not able to gain their personnel's trust which results in personnel dissatisfaction. Also in Case A we understood the issue of clarity during their EA development caused by EA consultant. The interviewee mentioned that *'sometimes it seemed that the EA consultant did not want us to know how they are progressing or what steps they are taking to develop EA […] because they wanted us to be dependent on them in future […]'*. In such a situation the personnel lost their trust and collaboration with the EA consultant became difficult.

Losing personnel's trust is one of the effects of lack of communication and collaboration in EA development. Clarity and trust are associated with each other. According to the CIO of Case K *'It is important to be clear about the steps that we are going to take during EA development and being able to explain it to the personnel so that personnel can accept changes easier. If personnel does not understand why he/she has to answer to the detail questions about his/her job, the employee will feel threatened and not collaborate well'*. Thus, Case K arranged several meetings and educational

seminars to make sure that employees understand the positive effects of EA on their jobs and everyone has a common understanding of EA. Same thing also happened in Case J. They conducted several seminars, and meetings before starting EA development for their personnel to explain to them about EA development in their organization and gain their trust to facilitate their resistance to change. In Case G the personnel was worried about losing their jobs as they did not trust their managers who tried to ensure them about their job security. The personnel tried to jeopardize the EA development project by giving wrong information to the EA team. Furthermore, we also realized that when management shows its support towards EA development project it will influence the personnel's trust.

To remain competitive is one of the EA development goals. Before initiating EA development in Case J, the company studied how their competitors have developed EA and what were their results and how EA could benefit the organization. Through benchmarking and best practices they tried to imitate the big successful companies in the same industry. In Case A the issue of lack of innovation in EA consultant's team was an obstacle (explained in sections 4.2 and 4.3). Case L wanted to remain competitive and be among the best in their industry. They decided to develop EA to improve their business process, bring innovation to the organization and compete with their competitors. However, due to the constant change of management and lack of management support in Case L, people lost their motivation to collaborate with the project and consequently no innovation occurred in the organization and the organization lost its competitive edge as time passed.

Ineffective EA outputs also hinders the organization's competitiveness. For example in Case M the result of EA development was not effective for the organization because the documents produced by the EA team were not understandable by developers. This situation hindered the organization's competitiveness as they were not able to continually improve their business. For example, when a new integration project initiated in the organization, the integration team was not able to properly identify the project requirements. One of the reasons was that documents which were produced as part of the EA development outcome were not understandable and utilizable by the integration team. This situation caused the integration project to take more time than what was planned and increased the risk of customers' dissatisfaction.

The EA governance was endangered in Case B as their organizational structure had deficiencies. Case B did not have a central powerful EA unit defined in their organizational structure. There was no governance on their business process design and re-engineering to check and monitor their performance and quality. Similarly, in Case G there was no unit defined in their organization that would have been responsible for EA governance and therefore EA was not effective in the organization. We understood that EA must be defined on the highest level of the organization management in order to be effective and successful.

4.5 Findings from Organizational Documents

Identifying 'Lack of communication and collaboration' as the core obstacle during EA development projects, we contacted the interviewees via email to seek more information. In this third round of data collection, we sent an email to the interviewees requesting their EA documents in order to look for new information about anything related to communication and collaboration. Out of 14 organisations from second round of data collection, five organisations (Cases A, G, I, K and L) answered, and we received nine documents (329 pages) regarding the EA development projects. Using the open coding technique (Strauss and Corbin 1998), we analysed the organisational documents, specifically looking for indications of communication and collaboration during EA development.

The documents showed that an architect plays a major role in EA development and maintenance. The organisations considered architects to be persons who should be able to predict an organisation's needs, resources and priorities before anyone else. The documents also suggested that architects should coordinate between the business and the IT team. Thus, architects play a major role in establishing communication and providing coordination between the business and the IT team.

The documents suggested that one of the major goals of the EA in the organisations was to improve collaboration and communication. However, having communication and collaboration problems before starting EA development seemed to lead to several obstacles in the EA development process itself. The documents provided by Case A expressed this issue explicitly and showed that 35% of their problems were rooted in organisational and communication issues, such as resistance to change, deficiency in organisational structure, constant change in policies from upstream, lack of communication and collaboration between departments and lack of standardization in project plans.

4.6 Summary of Findings

Table 3 summarizes the steps that we took in this study and the results that we obtained. In the first round we focused on the enterprise integration issues and asked some general questions about EA development in those organizations. We identified lack of communication and collaboration as a major issue in EA development. This finding led us to the next phase of data collection focusing on the obstacles in EA development based on three development stages.

In the second round we focused on EA obstacles in different EA development stages. We understood that the obstacles

Table 3 Overview of research process and findings

Data analysis/collection	Focus of the study	Results
Data collection and analysis from first round of interviews	Focused more on enterprise integration issues and asked general questions about EA in the organizations	- Lack of collaboration as a major issue in EA development - The obstacles remain even after EA development
Data collection and analysis from second round of interviews	Focused on EA obstacles in different development stages to understand the reasons behind the inefficiency of architectural descriptions	- Identifying obstacles in different EA development stages - EA obstacles remain through EA development stages if they are not addressed properly in the initial stage of development - Understanding the relationships between EA obstacles - Determining lack of communication and collaboration as the core obstacle that can explain other obstacles
- Revisiting the data (first and second round of interviews) - Data collection and analysis from organizational documents	Focus on communication and collaboration during EA development	- Revealing organizational culture and clarity in EA development process as additional causes of lack of communication and collaboration in EA development. - Revealing 'personnel's distrust' and 'organization loses its competitive edge' as other effects of lack of communication and collaboration in EA development. - Improving communication and collaboration as one of the main goals of EA development - Enterprise architect has a significant role in enhancing communication and collaboration during EA development

remain through EA development stages if they are not addressed properly in the initial stage of development. We followed the relationships between different obstacles and identified lack of communication and collaboration as the core obstacle that can explain most of the other obstacles. We revisited the data and investigated the causes and effects of lack of communication and collaboration in EA development. The research process and its findings are summarized in Table 3.

5 Discussion

This study contributes to the field of EA research and practice. Our work focused on the obstacles that practitioners experienced during EA development. Our contribution provides an empirical foundation for EA development obstacles and emphasises the importance of communication and collaboration. A lack of communication and collaboration may also explain other EA obstacles. Thus, organisations should solve their communication and collaboration issues before embarking on EA development initiatives. Lack of knowledge and support inside organization as well as issues imposed by external parties are three general obstacles that hinder communication and collaboration in EA development. Furthermore, organizational culture, personnel's motivation, and clarity in EA development process are among several causes of lack of communication and collaboration. Personnel's (dis)trust, endangered EA governance, lack of innovation, organization losing its competitive edge, ineffective EA outputs, and unable to set common goals and achieve a shared understanding are the effects of lack of communication and collaboration in an EA development project.

5.1 Relation to Earlier Research

Communication and collaboration have always been challenging in organisations. Yuhashi and Iijima (2010) define communication as *'the interactive processes employed by human beings in order to communicate their psychological content (including knowledge, emotions and will) between one another, using symbols such as body language, words, text, images, and so on, as mediational means'*. Collaboration can be defined as *'an activity that leads to an emergent result, which takes place alongside an act of communication within a group that has a mutually beneficial relationship'* (Yuhashi and Iijima 2010). Collaboration is also referred to as lasting relationships and a strong commitment to a common goal (Kvan 2000). According to Yuhashi and Ijima (2009), communication precedes collaboration, or as Evans and Wolf (2005) mention, communication creates an organisation in which it is easy to produce collaboration.

It is believed that *'Communication calls organisation into being'* (Bisel 2009a). According to Bisel (2009a), '*organisations are not fixed and stable but are rather called into being by interacting and sensemaking persons who attempts to coordinate their behaviours to accomplish goals*', meaning that organisations function through members' communication and sensemaking. Furthermore, empirical observations indicate that poor workplace talk causes inefficiencies, errors, and an

inability to interact (Bisel 2009b). Among organisational communication scholars, the above explanations are called the communicative constitution of organisations (CCO) theory (Bisel 2009a). This theory emphasizes the importance of communication in organisations.

Our findings share commonalities with the earlier findings (Armour and Kaisler 2001; Kaisler et al. 2005; Bricknall et al. 2006; Hjort-Madsen 2006; Kappelman and Zachman 2013) that highlighted the importance of communication and collaboration in EA development. Armour and Kaisler (2001) and Kaisler et al. (2005) mention communication networks as one of the main components that architects require in order to communicate with others and with systems, and failing to establish this communication is a challenge in an EA effort. Bricknall et al. (2006) also mention communication as an important and necessary component in EA implementation. A successful EA implementation requires constant communication and cooperation across different levels and functions in an organization (Hjort-Madsen 2006). The importance of communication is also emphasized by Kappelman and Zachman (2013), who concluded that *'the enterprises that survive and thrive in the next few generation will consist of people able to communicate efficiently and effectively in order to quickly achieve a shared vision[…]'*.

The impact of cultural diversity on the effectiveness of EA has been studied by Faller and De Kinderen (2014). Their study indicated that communication defects are an important intermediary factor between an organisational subculture and the EA function's effectiveness. This complies with our finding that organizational culture is one of the causes of a lack of communication and collaboration in EA development. In their previous study, Niemietz et al. (2013) identified three levels of communication defects in EA-guided enterprise transformations: lack of communication, inappropriate communication and over-communication (Niemietz et al. 2013). Furthermore, a lack of EA effectiveness is partly because of the problematic interaction between architects and other stakeholders. Establishing shared understanding among diverse organisational communities during EA-driven enterprise transformation enables and supports collaborative efforts (Abraham et al. 2015; Bisel and Kevin Barge 2010; Nicolini et al. 2012; Stensaker et al. 2008). Based on our findings, lack of common understanding among EA stakeholders can be associated with their trust and dissatisfaction in EA development, which are the effects of lack of communication and collaboration. According to Abraham et al. (2013), communication is a key success factor in coordinating collaborative efforts during EA-driven enterprise transformation.

Löhe and Legner (2014) studied EA implementation challenges to develop a design theory for overcoming the implementation challenges in EA. They identified a number of EA implementation challenges, including old and low-quality documents, low usage of existing EA artefacts, a lack of EA acceptance in the organisation and coordination problems. However, as they focused only on the information technology (IT)-driven EA perspective, their design theory may not be able address EA development challenges beyond the four challenges they identified. In another study about issues that organisations face while documenting EA, Roth et al. (2013) studied the key EA challenges that organisations face during EA development. Besides the 'bad quality of EA model data' as one of the key challenges, other challenges that they found comply with our list of obstacles. For instance, data collection, insufficient tool support and no management support have similarities with our findings.

Based on a literature review Lucke and Krell (2010) studied the critical issues in enterprise architecting and created a list of EA challenges. Our findings can be considered an extension of this list. Similarly, we found insufficient management commitment, a lack of communication and collaboration, difficulty in establishing a common understanding, a lack of experienced architects, complexity, a rapidly changing environment, a lack of knowledge and insufficient tool support to be obstacles in EA development.

Jahani et al. (2010) studied effective factors in evaluating EA readiness, and they included a list of EA obstacles that complies with our findings. They concluded that because EA is a continuous and permanent programme in organisations, it is crucial that organisations be aware of their weaknesses before embarking on EA. This aligns with our findings. We also posited that organisations should address their communication and collaboration issues before starting EA projects. Van der Raadt et al. (2010) studied the relationship between EA effectiveness and stakeholder satisfaction with a case study. Their findings align with ours, that active participation and communication between EA stakeholders is one of the main critical success factors for EA.

Based on empirical data and literature, Ylimäki (2008) proposed a list of critical factors for EA. She referred to communication as an important means of gaining commitment to an EA effort. This complies with our finding that management support and personnel's commitment and trust is a result of good communication and collaboration in the organisation. Similarly, Chuang and van Loggerenberg (2010) studied the challenges in enterprise architecting using qualitative data. They considered communication issues to be one of the biggest challenges. They further divided communication during EA development into internal communication and communication with stakeholders.

Our findings share commonalities with the findings of Nakakawa et al. (2010), who studied the challenges of involving stakeholders when creating EA. Considering collaboration to be a core thread in EA development, Nakakawa et al. (2010) studied

factors that hinder effective collaboration. Time, organisation politics, a lack of communication, a lack of common understanding, a lack of architecture governance, a lack of the architect's knowledge, a constrained project budget and a lack of documentation are factors hindering collaboration. Successful EA development requires planning, training and communication along with other elements, and training should be carried out not only during development but also in the EA initiatives (Bricknall et al. 2006). This aligns with our findings, which emphasised the importance of communication and collaboration and of training EA stakeholders before EA development begins.

In this paper, we have divided the EA development process into the three stages of pre-development, development and post-development. Based on our definitions of these three development stages the majority of earlier research on EA development obstacles focused only on the development stage of the process (Chuang and van Loggerenberg 2010; Hauder et al. 2013; Löhe and Legner 2014; Nakakawa et al. 2010; Nikpay et al. 2013; Seppänen et al. 2009; Van der Raadt et al. 2010; Ylimäki 2008), along with a few studies on the pre-development stage (Jahani et al. 2010; Lucke and Krell 2010). In this study, we extended the body of knowledge by also identifying pre-development and post-development EA obstacles and increased the understanding of EA obstacles in the three stages of development.

Comparing our findings with the previous research in this area we understood that:

(1) Organizational culture influences personnel's motivation in EA development.
(2) Clarifying the EA development process to the personnel will result in their trust and collaboration.
(3) Instability of the organization, which is caused by constant change of management and their lack of support causes the personnel to lose their motivation to collaborate with the EA project. Consequently, the organization faces with lack of innovation and loses its competitive edge.
(4) EA must be defined on the highest level in the organization in order to be successful and effective.
(5) It is crucial that organizations address their communication and collaboration issues before initiating EA development, because obstacles, such as lack of communication and collaboration will remain through all the development stages and constantly hinder the project.

5.2 Recommendations to Improve Communication and Collaboration in EA Development

This section provides recommendations for practitioners to improve communication and collaboration in EA development. The current way of communication and collaboration should be reconsidered before initiating an EA development project, since the major part of EA development is about communication and collaboration between different stakeholders. However, some of the obstacles, such as organizational culture or the issues that are caused by government cannot be easily addressed.

Be Clear and Precise About EA Development Process to Increase Personnel's Trust One of the reasons that employees resist to collaborate with the EA project is because they feel threatened and insecure about their job and the reassurances by managers are not sufficient. Lack of personnel's knowledge about EA is also a major reason for the resistance to collaborate. Employees may be told that EA will improve their job and they have to collaborate with the EA team. However, based on our findings things do not progress as expected. Sometimes personnel gave wrong information to the EA team intentionally because they were thinking that if they give all the information about their tasks and jobs they will lose their job. Improve personnel's knowledge in educational seminars and courses could add trust and reduce resistance. It is important that the EA team can clarify the EA development processes and steps, benefits, and effects for each employee before initiating EA. Each employee should understand the benefits that he/she will get from EA development and what are the challenges of not adopting EA.

Motivate Personnel to Communicate and Collaborate in Order to Bring Innovation to the EA Development Organisations should be able to motivate and encourage their personnel to become more cooperative with the project and EA consultants. According to Boster et al. (2000), motivation is a big part of an EA effort. Individuals and organisations will not adopt changes unless they are encouraged. A strong leader can increase personnel's motivation through communication and collaboration. Employees will become motivated to embrace an EA project when they see that their manager is supportive of and involved in it. Also, if personnel have enough knowledge about the process of EA development and how EA can positively influence their jobs, they will become motivated to collaborate as part of the project as well.

EA must be Placed on the Highest Level of the Organization To become successful in EA development, EA must be positioned on the highest level of organization. The decisions related to the EA should be directly come from the high-level management of the organization, with the full support of the management. EA should not be defined only as a part of IT or business departments. Issues related to the EA development should be discussed directly with the high-level management without any mediators.

EA Team should Consist of not only EA Experts but also non-EA Expert People from other Departments If EA is developed only by EA experts, it may be difficult to understand by the other people in the organization who are not experts in the models and documents produced by EA experts. For instance, in one of our cases after the EA expert team developed EA, the result was not very useful, because the IT people could not understand the documentation. It is not necessary to use a specific well-known methodology in EA development to be successful. It is important to use descriptions that are understandable by the majority of the organization. It could be useful to have at least one people from each department of the organization in the EA team.

5.3 Limitations

This study has limitations. One of the limitations is the limited number of individuals interviewed. The study would be more reliable if we had more cases. Another limitation is that the cases from the second and third rounds of data collection were selected from one country, and some of the mentioned obstacles may not apply to another country. Obstacles such as the government-related political issues and restricted rules in governmental organisations might not appear as obstacles in other countries' large organisations. Another limitation of this study is the limited number of gathered organizational documents. We got only nine EA-related documents from five out of 17 organizations. Therefore, we were not able to double-check the interviewees' statements with what had actually been documented during their EA development. The documents that we received from the five organizations (Cases A, G, I, K and L) revealed more information and increased our understanding about the process of EA development in those cases. For example, in Cases A, G and L that outsourced their EA development, the documents revealed how EA was developed from the EA consultant perspective.

Moreover, we investigated only large enterprises. Meanwhile, EA development obstacles in medium-sized or small organisations may not be the same, as these organisations are less complex. Furthermore, all of the interviewees were from the management levels of their organisations. Having other stakeholders' perspectives, such as those of EA consultants and personnel, could clarify and explain some issues. Therefore, the generalisation of these results should be made with caution.

6 Conclusions and Future Research

In this study, we identified EA development obstacles in 15 organisations. We investigated the obstacles that kept appearing in the different stages of EA development: pre-development, development and post-development. By looking at cause-effect relationships and dividing EA development into the three stages of pre-development, development and post-development, we further analysed the obstacles and their repetitions. We pointed out that lack of communication and collaboration is the core obstacle that could explain other obstacles. Lack of knowledge inside organization, lack of support inside organization and issues imposed by the external parties were identified as the general obstacles that can be both causes and effects to the lack of communication and collaboration. Further investigation of causes and effects of lack of communication and collaboration revealed organizational culture as an important issue in communication and collaboration during EA development. Organizational culture effects people's motivation to persuade them to communicate and collaborate actively. Clarity in the process of EA development will improve common understanding in the organization, which may consequently increase trust and satisfaction among employees and motivate them to communicate and collaborate better in EA development.

To reduce issues in EA development, organisations should at least address their existing communication and collaboration problems before starting EA development. An architect plays a major role in facilitating communication and collaboration in an EA development project. We provided four recommendations to facilitate communication and collaboration in EA development. Being clear and precise about the EA development process will increase personnel's trust and satisfaction. Organizations should be able to motivate personnel to communicate and collaborate in order to bring innovation to the EA development. EA must be placed on the highest level of organization and the decisions related to the EA must be discussed and approved by the highest level of organization, meaning that EA should have the high management support and attention all the time. EA development team should consist of EA experts as well as non-EA experts across the departments of an organization.

Our findings partly converge with the existing literature but also increase the understanding of the obstacles that practitioners face in EA development. The recommendations made in this paper can help practitioners in facilitating communication and collaboration in EA development. The findings of this study not only contribute to the field of EA but also can be useful in the context of complex information systems projects in large enterprises. In turn, this study advances the theoretical and empirical understanding of EA development obstacles. This benefits both academia and industry by providing an accurate and pragmatic perspective on EA development.

In the future, we will expand the scope of this study to get other stakeholders' perspectives as well. We will

specifically focus on communication and collaboration among the different stakeholder groups involved in EA development. Also, as enterprise integration is one of the most desired goals of EA development, it is important to study the role of integration in relation to EA development. Further research is required to provide a better answer to the question how to mitigate the effects of lack of communication and collaboration in EA development. Also the question of how to improve communication and collaboration in EA development deserves a further inquiry.

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Appendix 1

Interview questions:

1st round of interviews (May and June 2014):

Can you tell us about your job?

1. What is your job position/title?

Integration questions

1. IT architecture: Can you briefly summarise the most important
   a. internal and
   b. external systems the Enterprise Resource Planning (ERP) system is integrated with?
2. Can you tell us about the key technologies and standards that are used in integration?
3. When developing the ERP system, how do you determine when to integrate the ERP system with another system?
4. Who states the requirements for integration (think about the roles of the business and IT departments of your organisation, the role of the vendor and the role of external consultants)?
5. Integration projects: Can you identify different types of integration projects—for example, when integrating the ERP system with
   a. another internal system?
   b. an external system?
6. Who are involved in integration projects (business, IT, vendor, consultants)? Can you tell us especially about the vendor's role?
7. Can you think of any common challenges that are always present in integration projects?
8. Let's say you realise that the ERP system has to be integrated with an external system of the supply chain. What kind of approach is used? How do things progress after the decision to integrate has been made?
9. How do you measure the success of an integration project?

EA questions

1. What is EA, in your opinion?
2. Who are involved in the creation/development of EA in your organisation? Do you have your own full-time architecture team?
3. Are you involved with EA in your work? How is EA related to your work?
4. Can you tell us about the history of EA development in your organisation? (From when did you realise the need for EA in your company, or has it always been there?)
5. What standard methodologies and frameworks do you use in EA development (such as The Open Group Architecture Framework [TOGAF], Zachman…)? (Regarding readymade practices, are they useful at all, and if not, why?)
   a. Why did you choose to use this specific framework?
   b. Have you customised the framework, or have you used it as it is?
6. What are the challenges you have faced during EA development? (EA is often considered a difficult thing; why do you think it is difficult to create and manage EA?)
7. Can you describe how EA is used or how it can be used in your organisation? In which situations is EA needed?
8. When you are making investments, is EA considered in the decision-making process (for example, when you think about the current Business-to-Business [B2B] project)?
9. Is your EA meeting your expectations? Does it match the needs of your company?
10. How about managing knowledge about EA? Is this knowledge always documented? How do you train people on EA?

Concluding questions

1. Can you name other persons whom we should interview based on the topics we have been discussing?

2. Can we interview you again next year?

2nd round of interviews (May to July 2015):

General questions

1. What is your current position?
2. How long have you been working at this company?
3. How many people are working at your company?

4. How many people are working in the IT department of your company?
5. Do you have a permanent IT team at your company, or do vendors from outside of the company meet your IT needs?

   a. With which companies do you have contracts, and what do they do for you?

EA questions

1. What is EA, in your opinion?
2. Do you employ EA in your daily work? How?
3. Please tell us the story behind EA development at your company?

   a. When did you realise your need for EA (reasons for developing EA)?
4. Who makes decision regarding EA at your organisation?
5. Have you provided any education for your personnel regarding EA?

   a. In which development stage are you, and who has received training?

EA team

1. How many people are employed on the EA team at your organisation?
2. In general, what are the EA team's responsibilities at your organisation?
3. How does the EA team at your organisation take action on a project?
4. When does the EA team usually engage in projects at your organisation?

Pre-implementation stage

1. What actions did you take before starting your EA project? How did you make you organisation ready to adopt EA?
2. What were your primary goals for EA development?
3. What were the challenges you faced during this stage?

Development stage

1. How did you implement EA (insourcing or outsourcing)?

   a. How did you choose your consultant?
   b. How satisfied are you with your EA consultant?
   c. How is the cooperation between your EA consultant and IT personnel? Is it satisfactory?
   d. Do you have any problems with your EA consultant?
2. What standard methodologies and frameworks do you use in EA development (such as TOGAF, Zachman…)?

   a. How did you choose to use this specific framework?
   b. Have you customised the framework or used it as it is?
3. How long did it take to implement EA at your organisation?
4. Has the EA had any influence on your company's investments? How?
5. What are the challenges you faced during EA development?

EA results

1. What results have you gotten from EA development? What are the outcomes of this development?
2. How have these results been determined?
3. To what extent are you satisfied with the results obtained from the implementation of EA?

   a. If you are not satisfied with the results of your EA, what are the reasons for this dissatisfaction?
4. In your opinion, what are the challenges in the results obtained from EA development?
5. How many of your initial goals were fulfilled?

Post-implementation stage

1. Does your organisation have any programme for reviewing and updating its EA?

   a. Has it been performed yet?
   b. How often does your organisation update its EA?
   c. How important is the EA update? What challenges are faced in updating EA?
2. If you had the chance to redo the EA development at your organisation, what might you do differently, and why?
3. What were the challenges you faced after EA implementation?

   a. What solutions did you adopt to eliminate these challenges?
4. How do you evaluate the EA's success and effects at your organisation?
5. In your opinion, what is the role of EA in enterprise integration?

Final questions

1. Is there anything else you would like to mention regarding this topic?
2. Can you name other persons whom we should interview based on the topics we have been discussing?
3. Can we interview you again in the future?

Appendix 2

Table 4 Identified obstacles and their relationships with one another

Identified obstacle	Is Cause of	2way Causality	Is associated with	Is Part of	Contradicts with
Confusion in government	-Unclear organisational strategies		-Government-related political issues -Political changes in the country -Confusion in government		
Government-related political issues					
Unclear organisational strategies					
Inexperienced EA consultants	-Setting too ambitious goals			-EA consultant–related issues	-Finishing the project on time
Outdated organisational statutes	-Unclear organisational strategies				
Political changes in the country	-Constant change of management		-Government-related political issues		
Restricted rules in governmental organisations			-Laws contradict with the EA results		
EA consultant's becoming inefficient				-EA consultant–related issues	
EA consultant's being inflexible				-EA consultant–related issues	
Lack of EA consultant innovation				-EA consultant–related issues	
EA consultant–related issues		-Lack of communication and collaboration			
Laws' contradicting the EA results			-Restricted rules in governmental organisations		
Organisational-structure deficiencies			-CIO is not directly managed by CEO		
Being function oriented instead of process oriented			-Old infrastructure		
Old infrastructure			-Being function oriented instead of process oriented		
Lack of change-management tools			-Lack of central and powerful EA unit		
Ineffective EA outputs					
Lack of knowledge among management	-Personnel resistance to change -Unable to set common goal and achieve shared understanding -Setting too ambitious goals				
Lack of management support	-Lack of motivation among personnel -Unable to set common goal and achieve shared understanding -Lack of budget		-Favouritism in hiring new and unqualified personnel		-EA's being a governance project -Finishing the project on time -Personnel's motivation
CIO is not directly managed by CEO			-Organisational-structure deficiencies		-Finishing the project on time
Setting too ambitious goals					
Unable to set common goal and achieve shared understanding					
Favouritism in hiring new and unqualified personnel			-Lack of management support		

Table 4 (continued)

Identified obstacle	Is Cause of	2way Causality	Is associated with	Is Part of	Contradicts with
Constant change of management	-Unable to set common goal and achieve shared understanding				-Finishing the project on time
Lack of budget			-Budget provision		
Lack of central and powerful EA unit			-Lack of change management tools -Organizational structure deficiencies		
Personnel resistance to change		-Lack of communication and collaboration			-Finishing the project on time
Lack of knowledge among personnel	-Unable to set common goal and achieve shared understanding -Personnel resistance to change	-Lack of communication and collaboration			-Finishing the project on time
Fluctuation in personnel's motivation			-Lack of motivation among personnel		-Finishing the project on time
Lack of communication and cooperation	-Lack of knowledge among management -Lack of management support -Ineffective EA outputs	-Personnel resistance to change -EA consultant–related issues -Lack of knowledge among personnel			
Hesitation in training personnel	-Lack of knowledge among personnel		-Forcing personnel to adopt EA		
Forcing personnel to adopt EA			-Hesitation in training personnel		
Lack of motivation among personnel	-Personnel resistance to change -Lack of communication and collaboration -Forcing personnel to adopt EA -Lack of knowledge among personnel		-Fluctuation in personnel's motivation		

Appendix 3

Table 5 Codes, categories, and their relationships created as the result of open coding and axial coding

Category	Description	Example of codes	Relationships to other categories
EA::team	Individuals who are part of EA development team	- Highly knowledgeable persons - Advisors during integration project - Consists of IT and business people - Virtual EA team - Consists of people from different departments	- Carries out the EA development process - Maintains the EA
EA::goals	Includes the primary goal and expectations of the organizations from EA	- Cost reduction - Establishing a new department to manage the organizational processes - Putting all the enterprise entities in their right places - Forecasting the market needs - Finishing project on time - Gaining higher level of maturity - Having a detailed documentation about organizational processes - Improving business processes - To remain competitive among competitors - Improve communication - EA governance	- Is determined by the organization - Is done in the pre-development stage
EA::obstacle	Consists of different obstacles that observed during EA development that classified into pre-development, development, and post-development	- Change of management - Change resistance - Inadequate budget - Lack of monitoring equipment - Lack of cooperation - Consultant inflexibility - Inexperienced consultant - Lack of knowledge - Invalid data - Old infrastructure - Unrealistic goals - Lack of team work - Unclear organizational strategy - CIO is not directly managed by CEO - Personnel's training	- Can have relationship with any of the codes and categories
EA::benefits	Includes benefits that organizations gained through EA development	- Filled the gap between CIO and CEO - Reduced redundancy - Reduced costs - Customers' satisfaction - Less error in managerial decisions - Increased agility - Improved business processes - Help in finding the right solutions - Improve organizational competitive advantage	- Can have relationship with any of the codes and categories
EA::CriticalFactors	Factors or actions that is considered critical during EA development	- CEO directly track the development process - Being innovative - Being realistic - CEO has IT knowledge - Receiving consultancy from successful experienced people in EA development - Team work - Separating business IT and organizational IT - Regular updates of EA - Selecting motivated persons for EA team - High level management support - Previous experience on EA - Gaining personnel's trust	- Can have relationship with any of the codes and categories
EA::development	The process of EA development from pre-development to post-development stage	- Pre-development: - Being clear about the development process - Development: - Organizational culture	- Aimed to develop EA and facilitate EI

Table 5 (continued)

Category	Description	Example of codes	Relationships to other categories
		- Post-development: -EA updates	
EA::regrets	Things that practitioners might had done differently if they had the opportunity to go back in time	- More realistic goals - More strict on timetable - More experienced consultant - Pilot test before making contract with the consultant company - More accurate plans - More accurate data	- Is determined by the EA team and managers - Is associated with EA obstacles
EA::consultants	The EA consulting company that provides consultancy or develops EA for the organization	- Outsourcing EA development - Getting consultant - Educating personnel - Communication and collaboration - Previous experience	- Is associated with the EA project
EI::benfits	Consists of benefits that are gained through integration	- Reduce complexity - Reduce redundancy - Reduce costs - Improve communication	- Can have relationship with any of the codes and categories
EI::obstacle	Consists of different obstacles that practitioners faced during an integration project	- Inexperienced consultant - Lack of budget - Lack of corporation - Systems incompatibility - Different interests of stakeholders - Wrong architecture - Lack of architectural descriptions - Change resistance - Change of management - Lack of knowledge - Lack of management support	- Can have relationship with any of the codes and categories - Is associated with the
EI::CriticalFactors	Factors or actions that is considered critical during an integration project	- Accurate planning - Assigning enough budget - Testing before deploying - Experienced consultant - Enough knowledge - Manager's support and knowledge	- Can have relationship with any of the codes and categories
EI::consultants	The consulting company that provides consultancy or solutions for integration projects	- Previous experience - Flexibility - Availability	- Is associated with integration project - Is part of external parties
EI::goals	Includes the primary goal and expectations of the organizations from integration project	- Cost reduction - Customers' satisfaction - Facilitating business processes - Remain competitive - Improve collaboration	- Is determined by the organization
EnterpriseSystems	Enterprise systems existing in organizations, such as ERP, CRM, sales, and logistics.	- Internal - External - Messaging	- Is part of organization
ExternalParties	Partners, suppliers, customers, and other external parties of the organizations.	- Consultants - Customers - Agencies - Shareholders - Government - Suppliers - Vendors	- Is associated with the organization

Appendix 4

Numbers in the table refer to the three development stages. 1: Pre-development, 2: Development and 3: Post-development.

Table 6 Identified obstacles in EA development categorised based on cases and the development stages

Obstacle/Case	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Government-related political issues	1					2	1		1	1		1	1	
	2					3	2		2	2		2	2	
	3						3		3	3		3	3	
Outdated organisational statutes	1													
Lack of knowledge among management	1	1			1	1	1				1		1	
	2	2			2	2	2				2		2	
	3	3			3	3	3						3	
Lack of management support	1				1	1	1				1	1	1	
	2				2	2	2					2	2	
	3				3	3	3					3	3	
Unable to set common goals and achieve a shared understanding	1		1					1			1	1	1	
Unclear organisational strategies	1													
Personnel resistance to change	1	2		1			1	1						1
		3		2			2	2						2
				3			3	3						3
Lack of knowledge among personnel	1	1			1		1			1	1	1	1	
	2	2			2		2			2		2	2	
		3			3		3					3		
Lack of communication and collaboration	1	1	1	1			1			1	1	1	1	
	2	2	2	2			2			2	2	2	2	
	3	3	3	3			3			3	3	3	3	
EA consultant–related issues	2						2		2			2		2
	3						3		3			3		3
Organizational structure deficiencies	1	3			1		3							
	2													
	3													
Lack of motivation among personnel	2	2												
	3	3												
Inappropriate budget provision		2				2	2							
		3				3	3							
Lack of central and powerful EA unit		3					3							
Hesitation in training personnel		1												
Old infrastructure			1	1					1			1		1
Ineffective EA outputs			3								3		3	
Constant change of management			3		1	2	2			1	1	1	1	
					2	3	3			2	2	2	2	
					3					3	3	3	3	
Setting goals that are too ambitious						1						1	1	
Restricted rules in governmental organisations							2			2				
							3			3				

Appendix 5

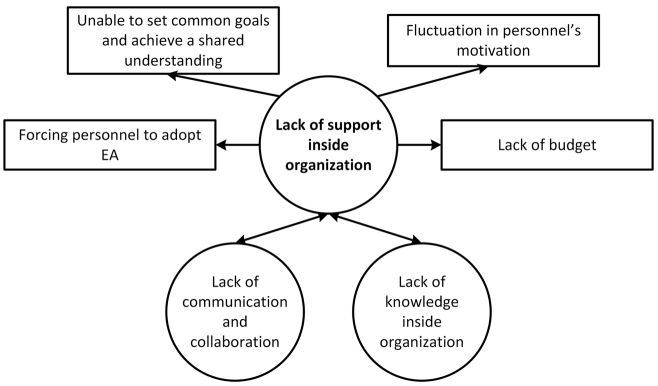

Fig. 5 Lack of support inside organization

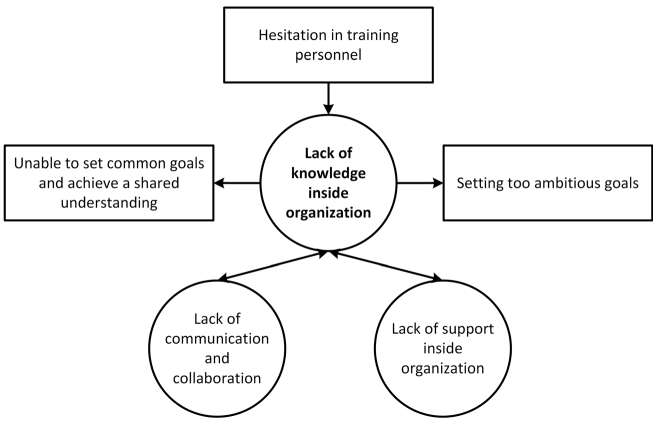

Fig. 6 Lack of knowledge inside organizations

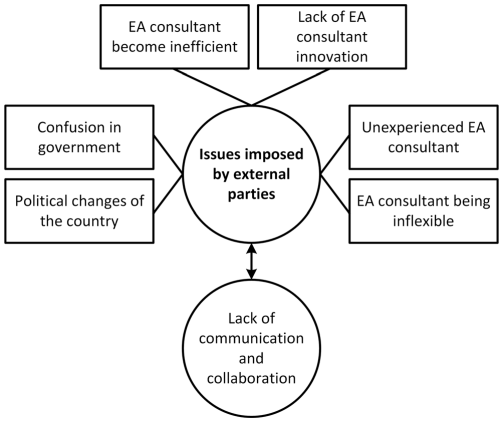

Fig. 7 Issues imposed by external parties

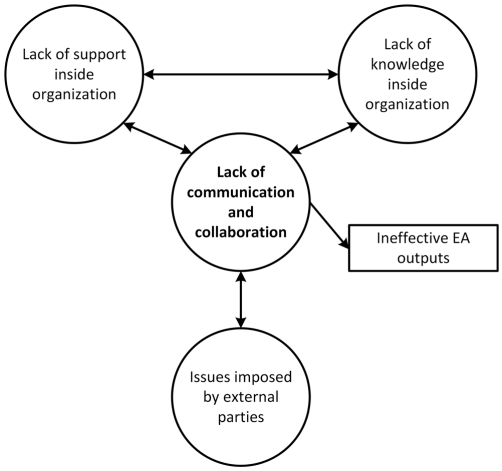

Fig. 8 Lack of communication and collaboration

References

Abraham, R., Niemietz, H., De Kinderen, S., & Aier, S. (2013). Can Boundary Objects Mitigate Communication Defects in Enterprise Transformation? Findings from Expert Interviews.' In *EMISA* (pp. 27–40).

Abraham, D.-W.-I. R., Aier, S., & Winter, R. (2015). Crossing the line: Overcoming knowledge boundaries in Enterprise transformation. *Business & Information Systems Engineering, 57*(1), 3–13.

Alaeddini, M., & Salekfard, S. (2013). Investigating the role of an Enterprise architecture project in the business-IT alignment in Iran. *Information Systems Frontiers, 15*(1), 67–88.

Armour, F., & Kaisler, S. (2001). Enterprise architecture: Agile transition and implementation. *IT Professional, 3*(6), 30–37.

Armour, J., Kaisler, S. H., & Liu, S. Y. (1999). Building an Enterprise architecture step by step. *IT Professional, 1*(4), 31–39.

Bacon, C. J., & Fitzgerald, B. (2001). A systemic framework for the field of information systems. *ACM Sigmis Database, 32*(2), 46–67.

Banaeianjahromi, N., & Smolander, K. (2016a). Understanding obstacles in Enterprise architecture development. In *ECIS 2016*.

Banaeianjahromi, N., & Smolander, K. (2016b). What do we know about the role of Enterprise architecture in Enterprise integration? A systematic mapping study. *Journal of Enterprise Information Management, 29*(1), 140–164. doi:10.1108/JEIM-12-2014-0114.

Banaeianjahromi, N., Alanne, A., Smolander, K., et al. (2016). Integration obstacles during ERP development. In *2016 49th Hawaii International Conference on System Sciences (HICSS)* (pp. 4697–4706). IEEE. http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=7427769.

Bernaert, M., Poels, G., Snoeck, M., & De Backer, M. (2016). CHOOSE: Towards a Metamodel for Enterprise architecture in small and medium-sized enterprises. *Information Systems Frontiers, 18*(4), 781–818. doi:10.1007/s10796-015-9559-0.

Bernus, P., & Noran, O. (2010). A Metamodel for Enterprise architecture. In P. Bernus, G. Doumeingts, & M. Fox (Eds.), Enterprise Architecture, Integration and Interoperability (pp. 56–65). IFIP advances in information and communication technology 326. Springer Berlin Heidelberg. http://link.springer.com/chapter/10.1007/978-3-642-15509-3_6.

Bisel, R. S. (2009a). A communicative ontology of organization? A description, history, and critique of CCO theories for organization science. *Management Communication Quarterly*. http://mcq.sagepub.com/content/early/2009/12/03/0893318909351582.full.pdf.

Bisel, R. S. (2009b). On a growing dualism in organizational discourse research. *Management Communication Quarterly*. http://mcq.sagepub.com/content/early/2009/02/03/0893318908331100.short.

Bisel, Ryan S., and J. Kevin Barge. 2010. 'Discursive Positioning and Planned Change in Organizations'. *Human Relations*, 0018726710375996.

Boster, M., Liu, S., & Thomas, R. (2000). Getting the most from your Enterprise architecture. *IT Professional, 2*(4), 43–51.

Boucharas, V., van Steenbergen, M., Jansen, S., & Brinkkemper, S. (2010). *The contribution of Enterprise architecture to the achievement of organizational goals: A review of the evidence*, *In Trends in Enterprise Architecture Research (Vol. 70, pp. 1–15)*. Berlin Heidelberg: Springer.

Bowen, G. A. (2008). Naturalistic inquiry and the saturation concept: A research note. *Qualitative Research, 8*(1), 137–152. doi:10.1177/1468794107085301.

Bricknall, R., Darrell, G., Nilsson, H., & Pessi, K. (2006). Enterprise architecture: Critical factors affecting modelling and management. In *ECIS* (pp. 2349–2361). http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1064&context=ecis2006.

Bucher, T., Fischer, R., Kurpjuweit, S., & Winter, R. (2006). Enterprise architecture analysis and application. An Exploratory Study. In *EDOC Workshop TEAR*. https://www.alexandria.unisg.ch/publications/230014.

Chen, D., Doumeingts, G., & Vernadat, F. (2008). Architectures for Enterprise integration and interoperability: Past, present and future. *Computers in Industry, Enterprise Integration and Interoperability in Manufacturing Systems, 59*(7), 647–659. doi:10.1016/j.compind.2007.12.016.

Chuang, C.-H., & van Loggerenberg, J. (2010). Challenges facing Enterprise architects: A south African perspective. In *2010 43rd Hawaii International Conference on System Sciences (HICSS)* (pp. 1–10). doi:10.1109/HICSS.2010.449.

Chung, L., Song, H.-K., Song, Y.-T., & Subramanian, N. (2009). Understanding the role of Enterprise architecture towards better institutionalization. In *Software Engineering, Artificial Intelligences,*

Networking and Parallel/Distributed Computing, 2009. SNPD'09. 10th ACIS International Conference On (pp. 316–320). IEEE. http://ieeexplore.ieee.org/abstract/document/5286648/.

Corbin, J. M., & Strauss, A. (1990). Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative Sociology, 13*(1), 3–21.

Corbin, J., & Strauss, A. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (3rd ed.). London: Sage.

Corbin, J., & Strauss, A. (2014). *Basics of qualitative research: Techniques and procedures for developing grounded theory*. Sage Publications http://books.google.com/books?hl=en&lr=&id=MaKWBQAAQBAJ&oi=fnd&pg=PP1&dq=the+basics+of+qualitative+research&ots=QrC9vMd-N0&sig=Q4o-Uz1kRu4zbZTHDDH0fmkrK1U.

der Raadt, V., Bas, M. B., Schouten, S., & Van Vliet, H. (2010). The relation between EA effectiveness and stakeholder satisfaction. *Journal of Systems and Software, 83*(10), 1954–1969.

Duchscher, J. E. B., & Morgan, D. (2004). Grounded theory: Reflections on the emergence vs. forcing debate. *Journal of Advanced Nursing, 48*(6), 605–612. doi:10.1111/j.1365-2648.2004.03249.x.

Easterbrook, S., Singer, J., Storey, M.-A., & Damian, D. (2008). Selecting empirical methods for software engineering research. In *Guide to Advanced Empirical Software Engineering* (pp. 285–311). Springer. http://link.springer.com/10.1007/978-1-84800-044-5_11.

Erol, O., Sauser, B. J., & Mansouri, M. (2010). A framework for investigation into extended Enterprise resilience. *Enterprise Information Systems, 4*(2), 111–136.

Evans, P., & Wolf, B. (2005). Collaboration rules. *IEEE Engineering Management Review, 33*(4), 50–57.

Faller, H., & De Kinderen, S. (2014). The impact of cultural differences on Enterprise architecture effectiveness: A case study. *In 8th MCIS Conference, Verona, Italy, 3–5*, (September 2014) http://orbilu.uni.lu/handle/10993/18157.

Fatolahi, A., Jalalinia, S., Dabestani, Z., & Eskandari, M. (2007). Extracting business process decomposition: A practical approach using the ISIran V methodology. *Business Process Management Journal, 13*(2), 214–222.

Foorthuis, R., van Steenbergen, M., Mushkudiani, N., Bruls, W., Brinkkemper, S., & Bos, R. (2010). On course, but not there yet: Enterprise architecture conformance and benefits in systems development. In *ICIS* (p. 110). https://tunguska.home.xs4all.nl/Publications/Docs/EA%20Conformance%20and%20Benefits%20in%20Systems%20Development%20(ICIS%202010)%20-%20Foorthuis%20et%20al.pdf.

Foorthuis, Ralph, Marlies van Steenbergen, Sjaak Brinkkemper, and Wiel A. G. Bruls. 2016. 'A theory building study of Enterprise architecture practices and benefits'. Information Systems Frontiers 18 (3): 541–564. doi:10.1007/s10796-014-9542-1.

Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Transaction Publishers http://books.google.com/books?hl=en&lr=&id=rtiNK68Xt08C&oi=fnd&pg=PP1&dq=The+Discovery+of+Grounded+Theory,&ots=UVvSTkXLWO&sig=MzcNz8FcLGSiZTPYUwLK0o55eoA.

Goethals, F. G., Snoeck, M., Lemahieu, W., & Vandenbulcke, J. (2006). Management and Enterprise architecture click: The FAD(E)E framework. *Information Systems Frontiers, 8*(2), 67–79. doi:10.1007/s10796-006-7971-1.

Goldkuhl, G., & Cronholm, S. (2010). Adding theoretical grounding to grounded theory: Toward multi-grounded theory. *International Journal of Qualitative Methods, 9*(2), 187–205. doi:10.1177/160940691000900205.

Guillemette, M. G., & Paré, G. (2012). Toward a new theory of the contribution of the IT function in organizations. *MIS Quarterly, 36*(2), 529–551.

Haki, M. K., Legner, C., & Ahlemann, F. (2012). Beyond EA frameworks: Towards an understanding of the adoption of Enterprise architecture management. In *ECIS* (p. 241). http://www.researchgate.net/profile/Mohammad_Kazem_Haki/publication/271762576_Beyond_EA_Frameworks_towards_an_Understanding_of_the_Adoption_of_Enterprise_Architecture_Management/links/54d219b30cf25ba0f0425887.pdf.

Hauder, M., Roth, S., Schulz, C., & Matthes, F. (2013). An examination of organizational factors influencing Enterprise architecture management challenges. In *ECIS* (p. 175). http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1398&context=ecis2013_cr.

Henderson, J. C., & Venkatraman, N. (1993). Strategic alignment: Leveraging information Technology for Transforming Organizations. *IBM Systems Journal, 32*(1), 4–16.

Hiekkanen, K., Korhonen, J. J., Collin, J., Patricio, E., Helenius, M., & Mykkanen, J. (2013). Architects' perceptions on EA use–an empirical study. In *Business Informatics (CBI), 2013 I.E. 15th Conference On* (pp. 292–297). IEEE. http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6642890.

Hjort-Madsen, K. (2006). Enterprise architecture implementation and management: A case study on interoperability. In *System Sciences, 2006. HICSS'06. Proceedings of the 39th Annual Hawaii International Conference On* (Vol. 4, pp. 71c–71c). IEEE. http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=1579432.

Hoogervorst, J. (2004). Enterprise architecture: Enabling integration, agility and change. *International Journal of Cooperative Information Systems, 13*(03), 213–233.

Huysmans, P., & Verelst, J. (2013). Towards an engineering-based research approach for Enterprise architecture: Lessons learned from normalized systems theory. In *International Conference on Advanced Information Systems Engineering* (pp. 58–72). Springer. http://link.springer.com/chapter/10.1007/978-3-642-38490-5_5.

Isomäki, H., & Liimatainen, K. (2008). Challenges of government Enterprise architecture work–stakeholders' views. In *Electronic Government* (pp. 364–374). Springer. http://link.springer.com/chapter/10.1007/978-3-540-85204-9_31.

Iyamu, T. (2009). The factors affecting institutionalisation of Enterprise architecture in the organisation. In *Commerce and Enterprise Computing, 2009. CEC'09. IEEE Conference On* (pp. 221–225). IEEE. http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5210794.

Jahani, B., Javadein, S. R. S., & Jafari, H. A. (2010). Measurement of Enterprise architecture readiness within organizations. *Business Strategy Series, 11*(3), 177–191.

Jensen, C. T., Cline, O., & Owen, M. (2011). *Combining business process management and Enterprise architecture for better business outcomes*. IBM Redbooks http://books.google.com/books?hl=en&lr=&id=E6nEAgAAQBAJ&oi=fnd&pg=PP1&dq=Combining+Business+Process+Management+and+Enterprise+Architecture+for+Better+Business+Outcomes&ots=fS-iFfbMa4&sig=rkHjPddOZNZeqPSrm7Vym8VYmkg.

Kähkönen, T., Smolander, K., & Maglyas, A. (2016). Lack of integration governance in ERP development: A case study on causes and effects. *Enterprise Information Systems, 11*(8), 1173-1206. doi:10.1080/17517575.2016.1179347.

Kaisler, S. H., Armour, F., & Valivullah, M. (2005). Enterprise architecting: Critical problems. In *System Sciences, 2005. HICSS'05. Proceedings of the 38th Annual Hawaii International Conference On* (pp. 224b–224b). IEEE. http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=1385698.

Kamoun, F. (2013). Rethinking the role of Enterprise architecture during times of economic downturn: A dynamic capabilities approach. *Journal of Information Technology Management, 24*(1), 26.

Kang, D., Lee, J., Choi, S., & Kim, K. (2010). An ontology-based Enterprise architecture. *Expert Systems with Applications, 37*(2), 1456–1464. doi:10.1016/j.eswa.2009.06.073.

Kappelman, L. A., & Zachman, J. A. (2013). The Enterprise and its architecture: Ontology & Challenges. *Journal of Computer Information Systems, 53*(4), 87–95.

Kilpeläinen, T. (2007). Business information driven approach for EA development in practice. In *The Proceedings of the 18th Australasian Conference on Information Systems. Australia* (pp. 5–7). Citeseer. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.88.8418&rep=rep1&type=pdf.

Kim, J.-W., Kwon, J.-H., Kim, Y.-G., Song, C.-Y., Kim, H.-S., & Baik, D.-K. (2006). EAFoC: Enterprise architecture framework based on commonality. *Journal of Computer Science and Technology, 21*(6), 952–964. doi:10.1007/s11390-006-0952-5.

Kvan, T. (2000). Collaborative design: What is it? *Automation in Construction, 9*(4), 409–415. doi:10.1016/S0926-5805(99)00025-4.

Lange, M., & Mendling, J. (2011). An experts' perspective on Enterprise architecture goals, framework adoption and benefit assessment. In *Enterprise Distributed Object Computing Conference Workshops (EDOCW), 2011 15th IEEE International* (pp. 304–3130). IEEE. http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6037633.

Lankhorst, M. (2013). Enterprise architecture at work: Modelling, Communication and Analysis. http://library.wur.nl/WebQuery/clc/2004404.

Locke, K. (2001). *Grounded theory in management research*. Sage http://books.google.com/books?hl=en&lr=&id=OcDWB-rWvWUC&oi=fnd&pg=PR7&dq=grounded+theory+in+management+research&ots=XpJKgN-74o&sig=-TyCttfGr7qRou_Vj0YUzDqFvJA.

Löhe, J., & Legner, C. (2014). Overcoming implementation challenges in Enterprise architecture management: A design theory for architecture-driven IT management (ADRIMA). *Information Systems and e-Business Management, 12*(1), 101–137.

Lucke, C., Krell, S., & Lechner, U. (2010). Critical Issues in Enterprise Architecting – A Literature Review. *AMCIS 2010* PRO http://aisel.aisnet.org/amcis2010/305.

Luftman, J., & Ben-Zvi, T. (2011). Key issues for IT executives 2011: Cautious optimism in uncertain economic times. *MIS Quarterly Executive, 10*(4), 203–212.

McGee, M. K. (2008). IT and business alignment remains CIO's top concern. *InformationWeek*. http://www.informationweek.com/wireless/it-and-business-alignment-remains-cios-top-concern/d/d-id/1071597?

McGhee, G., Marland, G. R., & Atkinson, J. (2007). Grounded theory research: Literature reviewing and reflexivity. *Journal of Advanced Nursing, 60*(3), 334–342. doi:10.1111/j.1365-2648.2007.04436.x.

Medini, K., & Bourey, J. P. (2012). SCOR-based Enterprise architecture methodology. *International Journal of Computer Integrated Manufacturing, 25*(7), 594–607.

MIT CISR. (2016). Enterprise architecture Center for Information Systems Research - MIT Sloan School of Management. *Access*, (8 June) http://cisr.mit.edu/research/research-overview/classic-topics/enterprise-architecture/.

Morganwalp, J. M., & Sage, A. P. (2004). Enterprise architecture measures of effectiveness. *International Journal of Technology, Policy and Management, 4*(1), 81–94.

Morse, J. M. (1995). The significance of saturation. *Qualitative Health Research, 5*(2), 147–149.

Nakakawa, A., van Bommel, P., & Proper, H. A. (2010). Challenges of involving stakeholders when creating Enterprise architecture. In *5th SIKS/BENAIS Conference on Enterprise Information Systems* (pp. 43–55). http://ceur-ws.org/Vol-662/EIS2010_proceedings.pdf#page=57.

Nicolini, D., Mengis, J., & Swan, J. (2012). Understanding the role of objects in cross-disciplinary collaboration. *Organization Science, 23*(3), 612–629.

Niemann, K. D. (2006). *From Enterprise Architecture to IT Governance* (Vol. 1). Springer. http://link.springer.com/content/pdf/10.1007/978-3-8348-9283-6.pdf.

Niemi, E. (2008). Enterprise architecture benefits: Perceptions from literature and practice. *Evaluation of Enterprise and Software Architectures: Critical Issues, Metrics and Practices:[AISA Project 2005-2008]/Eetu Niemi, Tanja Ylimäki & Niina Hämäläinen (Eds.). Jyväskylä: University of Jyväskylä, Information Technology Research Institute, 2008.-(Tietotekniikan Tutkimusinstituutin Julkaisuja, ISSN 1236-1615; 18). ISBN 978-951-39-3108-7 (CD-ROM)*. https://jyx.jyu.fi/dspace/handle/123456789/41370.

Niemi, E., & Pekkola, S. (2015). Using Enterprise architecture artefacts in an organisation. *Enterprise Information Systems, 11*(3), 313-338. doi:*10.1080/17517575.2016.1179347*.

Niemietz, H., De Kinderen, S., & Constantinidis, C. (2013). Understanding the role of subcultures in the Enterprise architecture process. In *ECIS* (p. 129). http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1352&context=ecis2013_cr.

Nikpay, F., Selamat, H., Rouhani, B. D., & Nikfard, P. (2013). A review of critical success factors of Enterprise architecture implementation. In *Informatics and Creative Multimedia (ICICM), 2013 International Conference On* (pp. 38–42). IEEE. http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6702779.

Nogueira, J. M., Romero, D., Espadas, J., & Molina, A. (2013). Leveraging the Zachman framework implementation using action–research methodology–a case study: Aligning the Enterprise architecture and the business goals. *Enterprise Information Systems, 7*(1), 100–132.

Pandit, N. (1996). The creation of theory: A recent application of the grounded theory method. *The Qualitative Report, 2*(4), 1–15.

Patton, M. Q. (2005). Qualitative research. Wiley Online Library. http://onlinelibrary.wiley.com/doi/10.1002/0470013192.bsa514/full.

Penttinen, K., & Isomäki, H. (2010). Stakeholders' views on government Enterprise architecture: Strategic goals and new public services. In *Electronic Government and the Information Systems Perspective* (pp. 1–8). Springer. http://link.springer.com/chapter/10.1007/978-3-642-15172-9_1.

Postina, M., Rohjans, S., Steffens, U., & Uslar, M. (2010). Views on service oriented architectures in the context of smart grids. In *Smart Grid Communications (SmartGridComm), 2010 First IEEE International Conference On* (pp. 25–30). IEEE. http://ieeexplore.ieee.org/abstract/document/5622009/.

Roeleven, S. (2010). Why two thirds of Enterprise architecture projects fail - whitepaper. *CIO*. http://www.cio.com.au/whitepaper/370709/why-two-thirds-of-enterprise-architecture-projects-fail/?type=other&arg=0&location=featured_list.

Rohloff, M. (2005). Enterprise architecture-framework and methodology for the Design of Architectures in the large. *ECIS 2005 Proceedings* (p. 113).

Ross, J. W., Weill, P., & Robertson, D. C. (2006). *Enterprise architecture as strategy: Creating a Foundation for Business Execution*. Harvard Business Press http://books.google.com/books?hl=en&lr=&id=5MVcnOyJ2bEC&oi=fnd&pg=PR7&dq=Enterprise+Architecture+As+Strategy:+Creating+a+Foundation+for+Business+Execution.&ots=qS0or7s0t7&sig=ypWdYtdFifzGZvXOa-gZFGSHOHc.

Roth, S., Hauder, M., Farwick, M., Breu, R., & Matthes, F. (2013). Enterprise architecture documentation: Current practices and future directions. In *Wirtschaftsinformatik* (p. 58). http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1057&context=wi2013.

Rouhani, B. D., Mahrin, M. N., Nikpay, F., & Rouhani, B. D. (2014). *Current issues on Enterprise architecture implementation methodology*, *In New Perspectives in Information Systems and Technologies (Vol. 2, pp. 239–46)*. Cham: Springer. doi:10.1007/978-3-319-05948-8_23.

Saarelainen, M.-M., & Hotti, V. (2011). Does Enterprise architecture form the ground for group decisions in EGovernment Programme? Qualitative study of the Finnish National Project for IT in social services. In *Enterprise Distributed Object Computing Conference Workshops (EDOCW), 2011 15th IEEE International* (pp. 11–17). doi:10.1109/EDOCW.2011.26.

Schmidt, C., & Buxmann, P. (2011). Outcomes and success factors of Enterprise IT architecture management: Empirical insight from the international financial services industry. *European Journal of Information Systems, 20*(2), 168–185.

Seppänen, V., Heikkilä, J., & Liimatainen, K. (2009). Key issues in EA-implementation: Case study of two Finnish government agencies. In *Commerce and Enterprise Computing, 2009. CEC'09. IEEE Conference On* (pp. 114–120). IEEE. http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5210807.

Simon, D., Fischbach, K., & Schoder, D. (2014). Enterprise architecture management and its role in corporate strategic management. *Information Systems and e-Business Management, 12*(1), 5–42. doi:10.1007/s10257-013-0213-4.

Sowa, J. F., & Zachman, J. A. (1992). Extending and formalizing the framework for information systems architecture. *IBM Systems Journal, 31*(3), 590–616.

Stensaker, I., Falkenberg, J., & Grønhaug, K. (2008). Implementation activities and organizational Sensemaking. *The Journal of Applied Behavioral Science*. http://jab.sagepub.com/content/early/2008/03/05/0021886307313794.short.

Strauss, A., & Corbin, J. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. Sage Publications.

Strauss, A., & Corbin, J. (1998). *The basics of qualitative research: Techniques and procedures for developing grounded theory* (1st ed.). London: Sage.

Tamm, T., Seddon, P. B., Shanks, G., & Reynolds, P. (2011). How does Enterprise architecture add value to Organisations? *Communications of the Association for Information Systems, 28*(1), 141–168.

Valtonen, K., Mäntynen, S., Leppänen, M., & Pulkkinen, M. (2011). Enterprise architecture descriptions for enhancing local government transformation and coherency management: Case study. In *Enterprise Distributed Object Computing Conference Workshops (EDOCW), 2011 15th IEEE International* (pp. 360–69). doi:10.1109/EDOCW.2011.39.

Van Der Raadt, B., Hoorn, J. F., & Van Vliet, H. (2005). Alignment and maturity are siblings in architecture assessment. In *Advanced Information Systems Engineering* (pp. 357–371). Springer. http://link.springer.com/chapter/10.1007/11431855_25.

Van Steenbergen, M., Foorthuis, R., Mushkudiani, N., Bruls, W., Brinkkemper, S., & Bos, R. (2011). Achieving Enterprise architecture benefits: What makes the difference? In *Enterprise Distributed Object Computing Conference Workshops (EDOCW), 2011 15th IEEE International* (pp. 350–359). IEEE. http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6037638.

Vargas, A., Cuenca, L., Boza, A., Sacala, I., Moisescu, M. (2014). Towards the development of the framework for inter sensing Enterprise architecture. *Journal of Intelligent Manufacturing, 27*(1), 55-72. doi:10.1007/s10845-014-0901-z.

Wan, H., & Carlsson, S. (2012). Towards an understanding of Enterprise architecture analysis activities. In *European Conference on Information Management and Evaluation; Reading* (pp. 334–XII). Reading, United Kingdom: Academic conferences international limited. http://search.proquest.com/docview/1326437913/abstract/40D6D6E7584B4FC9PQ/1.

Wan, H., Luo, X., Johansson, B., & Chen, H. (2013). Enterprise architecture benefits. *ICISO 2013* (p. 62).

Wan, H., Luo, A., & Luo, X. (2014). How Enterprise architecture formative critical success facets might affect Enterprise architecture success: A literature analysis. In *Service Science and Knowledge Innovation* (pp. 197–209). Springer. http://link.springer.com/chapter/10.1007/978-3-642-55355-4_20.

Winter, R., & Fischer, R. (2006). Essential layers, artifacts, and dependencies of Enterprise architecture. In *Enterprise Distributed Object Computing Conference Workshops, 2006. EDOCW'06. 10th IEEE International* (pp. 30–30). IEEE. http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=4031290.

Winter, R., & Schelp, J. (2008). Enterprise architecture governance: The need for a business-to-IT approach. In *Proceedings of the 2008 ACM Symposium on Applied Computing* (pp. 548–552). ACM. http://dl.acm.org/citation.cfm?id=1363820.

Wu, R. C.-Y., & Lu, J. (2007). Enterprise integration strategy of interoperability. In *Advances and Innovations in Systems, Computing Sciences and Software Engineering*, edited by Khaled Elleithy (pp. 369–74). Springer Netherlands. http://link.springer.com/chapter/10.1007/978-1-4020-6264-3_64.

Ylimäki, T. (2008). Potential critical success factors for Enterprise architecture. *Evaluation of Enterprise and Software Architectures: Critical Issues, Metrics and Practices:[AISA Project 2005-2008]/Eetu Niemi, Tanja Ylimäki & Niina Hämäläinen (Eds.). Jyväskylä: University of Jyväskylä, Information Technology Research Institute, 2008.-(Tietotekniikan Tutkimusinstituutin Julkaisuja, ISSN 1236-1615; 18). ISBN 978-951-39-3108-7 (CD-ROM).* https://jyx.jyu.fi/dspace/handle/123456789/41369.

Yuhashi, H., & Iijima, J. (2010). The power to activate a creative Core in Enterprise. *Power, 6*, 1–2010.

Yuhashi, H., & Ijima, J. (2009). How can we manipulate a communication network to create collaboration? *AMCIS 2009 Proceedings* (p. 97).

Zachman, J. A. (1987). A framework for information systems architecture. *IBM Systems Journal, 26*(3), 276–292.

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