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The Concept of Enterprise Architecture in Academic Research

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Abstract

Background and Purpose – In the last two decades, enterprise architecture (EA) has become a common approach for the management of information systems in organizations. However, the academic development of the field has not paralleled this turn of events. There is considerable divergence among researchers as to the very definition of EA. The present project seeks to clarify the concepts of EA, drawing relevant examples from the academic literature and addressing different perspectives in EA research community. The study aims to reveal the ontological arguments about the nature of EA and the related notions and to take one step towards developing theoretical foundations of the field.

Design/methodology/approach –The present project first critically reviews the competing, predominant academic definitions of EA and identifies major research circles in the field. Based on an analysis of recent doctoral dissertations and of key academic publications, it then reviews the perspectives of the various research circles regarding different notions related to the concept of EA. Template analysis (thematic coding) of the data (eleven doctoral dissertations, as well as articles and books cited as the principle references in the dissertations) is performed to critically review and analyze the concept of enterprise architecture.

Findings – A critical review of the previous work examining EA research communities in isolation shows that even articles claiming to provide a big picture of the EA research community are ultimately focused on one narrow research circle. In the current project, a novel categorization of the current EA research circles is presented, and their views on the concept of EA and the related notions are discussed.

Keywords – Enterprise Architecture, Research Communities, Academic Research, Perspectives

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Thank you!

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Mohammad Ahmadi Achachlouei

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Acronyms

CIMOSA	Computer Integrated Manufacturing Open System Architecture
CIO	Chief Information Officer
EA	Enterprise Architecture
EI	Enterprise Integration
GERAM	Generalized Enterprise Reference Architecture and Methodology
ICT	Information and Communication Technology
IFAC	International Federation of Automatic Control
IFIP	International Federation for Information Processing
IS	Information Systems
ISP	Information Systems Planning
IT	Information Technology
JEA	Journal of Enterprise Architecture
MIT-CISR	Massachusetts Institute of Technology, Sloan School of Management, Center for Information Systems Research
PERA	Purdue Enterprise Reference Architecture
TEAR	Trends in Enterprise Architecture Research

1. Research Design

1.1. Introduction and Research Problem

Enterprise architecture (EA) is model-based, in the sense that formal descriptions of systems and their environment constitute the core of the approach. EA helps describe and manage changes in enterprises so as to enhance their consistency and agility (Noran, 2005). Enterprise architecture is a "challenging but still confusing" concept (Chen et al., 2008). It is defined in many different ways reflecting various concerns and ambitions. Studying the ever increasing writings about EA usage, modeling and design principles since 1999, Ross (2003) and others have interestingly recorded that a universally accepted definition of EA does not exist, neither in the research community, nor the industry (Hjort-Madsen 2009, p.22). Moreover, research on enterprise architecture has taken place in relatively isolated communities (Aier et al., 2009). Depending on which dimension one wants to focus on – the modeling, analysis, communication, integration, organizing logic, technical or strategic dimension – different attributes are used to describe EA. Langenberg and Wegmann (2004) have evaluated eighty papers all referencing explicitly the term "enterprise architecture." Chen et al. (2008) sought to define and clarify basic concepts of enterprise architectures in light of a generalized reference architecture. Both of these, however, are conducted using different theoretical frameworks, which do not include the other framework. In the present project, I seek to collect and compare all the academic definitions of EA under a modular concept of EA. Reviewing doctoral dissertations on EA, I compile the various definitions and review the articles and books cited as the principle references in the dissertations, noting similarities and differences. Then I identify three major research circles in the relatively isolated community of EA research and seek to review their perspectives regarding the concept of the EA and related notions, drawing relevant examples from the literature to demonstrate them.

1.2. The Research Questions

The central research question is formulated as follows: *what are the different views in academic research on the concept of enterprise architecture?*

Questions that stem from this question are:

- Who are these key academic researchers or research groups?
- What are the views of these research groups about the concept of enterprise architecture and the related notions?
- What are the similarities and dissimilarities in these views?

1.3. The Research Purpose and Delimitations

The research purpose is to clarify the concepts of enterprise architecture, drawing relevant examples from the academic literature and addressing different perspectives in EA research community. The study aims to reveal the ontological arguments about the nature of EA and the related notions and to take one step towards developing theoretical foundations of the field.

The review of EA research in the present project is deliberately selective and critical, rather than exhaustive. I select the publications based on their citation importance in doctoral dissertations on EA as well as their role as an exemplar of identified EA research circles.

Given that the focus of this project is analyzing academic researchers' understanding of the concept of EA, practitioner sources like classic books by Spewak (1992) and Finkelstein (2006) have been excluded from this analysis.

This research focuses on the WHAT question about enterprise architecture in academia (ontological focus) and does not address the WHY question about this approach. In other words, this thesis does not review the challenges to which EA is a response.

It should be noted that this study is only one step forward in the treatment of differences and commonalities among isolated EA research communities regarding the EA concept. There are many themes related to the EA concept, which were identified through the analysis of academic research. Considering the time constraint on this project, I provide a relatively comprehensive categorization of major perspectives in the field of EA research and then I choose to present further analysis for only two notions. The comparative analysis of the other themes and notions is suggested as future research.

1.4. Selecting the Research Methods

1.4.1. Accepted Research Methods

a)   Template Analysis

The present study uses template analysis (Crabtree and Miller, 1999, King, 1998) to understand how scholars define the concept of enterprise architecture and other related notions in order to achieve a better understanding of their meaning and structure. For example, Heeks and Bailur (2007) have used this method to better understand e-government research, analyzing eighty-four papers in e-government-specific research outlets. Their analytical focus took in five main aspects: perspectives on the impacts of e-government, research philosophy, use of theory, methodology and method, and practical recommendations. Drawing particularly on the notion of template analysis, their approach "occupies a somewhat uneasy middle ground between positivism and interpretivism" (Heeks and Bailur, 2007).

Considering the similarity of the analysis in the present project with the research conducted by Heeks and Bailur, I employ template analysis as a methodological guidance in my study to analyze the selected publications and to address the research questions. King (1998) sees the template approach "as occupying a position between content analysis, where codes are all predetermined and their distribution is analysed statistically, and grounded theory, where there is no *a priori* definition of codes" (p.118). Within this

middle ground, there is scope for wide variation in analytical techniques, which is more convenient with the purpose of my project.

The term "template analysis", also known as "codebook analysis" or "thematic coding", refers to a particular way of thematically analyzing qualitative data (King, 1998). According to King (1998), the data involved in template analysis are usually interview transcripts but may be any kind of textual data. Template analysis involves the development of a coding template which summarizes themes identified by the researcher as important in a data set and organizes them in a meaningful and useful manner. Once a template is developed, hierarchical coding is emphasized. Analysis often, though not always, starts with *a priori* codes, which identify themes hypothesized to be relevant to the analysis. However, these codes may be modified or dispensed with altogether if they do not prove useful or appropriate to the actual data examined. Once any *a priori* themes are defined, the first step of the analysis proper is to begin reading through the data, marking any segments that appear to tell the researcher something of relevance to the research question. Where such segments correspond to *a priori* themes, they are coded as such. Otherwise, new themes are identified to include the relevant material and organized into an initial template. Normally this is done after the initial coding of a sub-set of the data. This initial template is then applied to the whole data set and modified in light of careful consideration of each text. Once a final version is defined and all transcripts have been coded to it, the template serves as the basis for the researcher's analysis of the data set and the findings (King, 1998, King, 2008).

b) Critical Literature Review

The critical literature review uses a descriptive/interpretive research approach (Galliers and Land, 1988). It attempts not only to review the definitions of enterprise architecture, but also to interpret them using a consistent terminology as well as to identify their perspective within a larger scope. Critical literature review has been perceived to yield better results and be more efficient for this research project compared to, for example, survey research. However, care should be taken as to clearly state the researcher biases and assumptions and to assert (and limit if at all possible) their influence on the interpretation.

In the present project, the review of the selected publications is intended to be critical. Eva (2008) describes a good research literature review as follows: it presents a critical synthesis of a variety of literatures, identifies knowledge that is well established, highlights gaps in understanding, and provides some guidance regarding what remains to be understood. "The result should give a new perspective of an old problem, rather than simply paraphrasing what all other researchers and scholars in the field have shown or said in the past. The author of the critical review should feel bound by a moral code to try to represent the literature (and the various perspectives therein) fairly, but need not adopt a guise of absolute systematicity"(Eva, 2008).

1.4.2.　Rejected Research Methods

a)　Content Analysis

Content analysis is a common approach in the analysis of literature (e.g. (Todd et al., 1995)). As a form of textual analysis, content analysis allows that the text may stand alone and that the words or idiomatic expressions themselves speak its meaning. The general assumption in content analysis is that intention and meaning are discoverable in the frequency with which words, phrases, idioms, or ideas occur. Based on the characteristics of traditional content analysis as described in Krippendorff's book (1980), in the present project, not all of the codes are predetermined, and I do not intend to statistically analyze the distribution of the codes; thus, I reject content analysis in my project.

b)　Grounded theory

Cronholm and Ågerfalk (1999) have conducted research with a purpose similar to my project. They examined the "concept of method and other related notions in order to achieve a better understanding of their meaning and structure" (Cronholm and Ågerfalk, 1999). To develop a conceptual model describing how the method concept and other related notions relate, their work has been inspired by the Grounded Theory approach for qualitative analysis (Strauss and Corbin, 1998). Therefore, grounded theory could be a candidate research method for this project.

However, using grounded theory approach for my project was rejected: Grounded theory "is an inductive, theory discovery methodology that allows the researcher to develop a theoretical account of the general features of a topic while simultaneously grounding the account in empirical observations or data" (Orlikowski, 1993). As we see, in this approach, *empirical observations* of the researcher for iterative theory-building is necessary, while in my project the knowledge is developed through textual analysis of selected publications.

1.5. Research Strategy

As previously stated, in the context of the present study, template analysis and critical review are perceived as research approach. Based on this approach, the research steps in the current study are as follows:

1- Selection of EA definitions
2- Critical review of the definitions
3- Definition of *a priori* themes
4- Initial coding of data
5- Production of the initial template
6- Applying the template to the full data set
7- Employment of the "final" template to help interpret the findings
8- Quality Check

1.6. Data Collection

1.6.1. Selection of Doctoral Dissertations

There is a substantial body of literature on EA research (for reviews, see (Langenberg and Wegmann, 2004, Schelp and Winter, 2009, Schonherr, 2009). These reviews proved a useful resource for locating article titles from different research communities. Lund University's ELIN system—which provides access to electronic resources such as articles, journals, e-books, and databases—was utilized to secure copies of

these texts; moreover, it was queried for the keyword "enterprise architecture," which yielded some papers not included in the previous reviews.

   Throughout the research process, I took careful notes on the educational and professional background of authors of EA articles. This information directed me to the various researchers' university departments and, in most cases, affiliated EA research groups. Furthermore, a search of Lund University's Lovisa system for dissertations with the keyword "enterprise architecture" yielded several dissertations, namely those belonging to the EA research group at Royal Institute of Technology (KTH), Sweden.

   The acknowledgment sections of these dissertations also provided valuable information regarding the research groups and, in turn, led to other dissertations on EA. For example, Pulkkinen's dissertation (2008) helped me find the dissertation authored by Hirvonen (2005).

   In the end, I found eleven published doctoral dissertations on EA (Noran, 2005, Ekstedt, 2004, Balabko, 2005, McDonald, 2005, Peristeras, 2006, Khoury, 2007, Pulkkinen, 2008, Hjort-Madsen, 2009, Plazaola, 2009, Namba, 2005, Hirvonen, 2005). Table 1 shows the list of collected doctoral dissertations on EA. Researchers' degree-granting university departments are also shown as a means to provide information about the connections of these dissertations to various EA research circles, which I will discuss in the current project.

Table 1 Doctoral Dissertations on Enterprise Architecture

Author	Year	Dissertation Title	University	Department
Noran, Ovidiu	2004	A Meta-methodology for Collaborative Networked Organisations (Noran, 2004)	Griffith University, Australia	School of Computing and Information Technology
Ekstedt, Mathias	2004	Enterprise Architecture for IT Management: A CIO Decision Making Perspective on the Electric Power Industry (Ekstedt, 2004)	KTH, Sweden	Dept. of Industrial Information and Control Systems
Hirvonen, Ari	2005	Enterprise Architecture Planning in Practice: The Perspectives of Information and Communication Technology Service Provider and End-User (Hirvonen, 2005)	University of Jyväskylä, Finland	Faculty of Information Technology
Namba, Yukio	2005	City Planning Approach for Rebuilding Enterprise Information Systems (Namba, 2005)	Tokyo Institute of Technology, Japan	Graduate School of Decision Science and Technology
Balabko, Pavel	2005	Situation-Based Modelling Framework for Enterprise Architecture (Balabko, 2005)	EPFL, Switzerland	School of Communication and Computer Science
McDonald, Mark Patrick	2005	Architecting the Enterprise: An Approach for Achieving Performance, Integration, Consistency and Flexibility (McDonald, 2005)	TU Delft, Netherlands	Faculty of Technology, Policy and Management
Peristeras, Vassilios	2006	The Governance Enterprise Architecture - GEA - for Reengineering Public Administration (Peristeras, 2006)	University of Macedonia, Greece	Department of Business Administration
Khoury, Gerald R.	2007	A Unified Approach to Enterprise Architecture Modelling (Khoury, 2007)	University of Technology, Sydney, Australia	Faculty of Information Technology
Pulkkinen, Mirja	2008	Enterprise Architecture as a Collaboration Tool: Discursive Process for Enterprise Architecture Management, Planning and Development (Pulkkinen, 2008)	University of Jyväskylä, Finland	Information Technology Research Institute
Hjort-Madsen, Kristian	2009	Architecting Government: Understanding Enterprise Architecture Adoption in the Public Sector (Hjort-Madsen, 2009)	IT University of Copenhagen, Denmark	
Plazaola Prado, José Leonel	2009	Strategic Business and IT Alignment Assessment: A Modeling Approach Associated with Enterprise Architecture (Plazaola, 2009)	KTH, Sweden	Dept. of Industrial Information and Control Systems

I was able to obtain these dissertations in most cases by going directly to the library websites of the universities that granted the degrees, downloading digital copies of the dissertations. Some libraries required registration and user account creation. In one case—Peristeras (2006)—I was unable to obtain the dissertation through his university's website; however, through email communication with the author I managed to secure a copy.

1.6.2. Selection of Major Academic Publications on EA

After collecting these doctoral dissertations, I began reading and reflecting on their various definitions of EA and their perceptions of the concept of EA. A summary of their views on the concept of EA is provided in the discussion sections below. Similarly, citations of EA definitions in the dissertations led me to a group of academic publications which have contributed to the theoretical understanding of the concept of EA. For example, Noran's dissertation (2004) and its account of the concept of EA directed me to a standard developed by International Organization for Standardization (ISO), which, it turns out, many scholars rely on in their definition to EA. Scholars who cite this standard tend toward a similar understanding of the concept of EA. As such, I recognized several research groups with the same frame of reference to understand and define the concept of EA (e.g. GERAM circle). In sum, the analysis of EA definitions set forth in doctoral dissertations led me to other academic publications, which inspired me to order the EA scholarly research groups in three major circles.

1.7. Developing a Template

1.7.1. Creating the initial template

Following King (1998), I have sought to identify those parts of the dissertations that are relevant to my research questions. It should be noted that at this step, I used only the dissertations, not the other publications, to create the initial template.

Applying template analysis, I have sought to identify themes through a close reading of the text, thereafter organizing them into a coding template. The themes are related to

each other hierarchically, with the highest-level codes representing broad themes in the text, and the lower levels identifying more narrowly focused themes.

Table 2 shows an initial template created based on my *a priori* themes, as well as my understanding of the research questions of the present project after the first reading of the EA dissertations (Further details of the codes identified through the analysis of dissertations are illustrated in Table 4. I used these codes to create the initial template, shown in Table 2). Two points in the initial template should be noted. First, in this template I have tried to apply the three guiding questions (Who?, What?, How?) employed by John Zachman in his seminal article about information systems architecture (Zachman, 1987). Zachman used these three questions about information systems to provide answers from different perspectives. I have sought to apply these questions to the concept of EA itself, providing a framework to organize the different perspectives. Second, the codes appearing under Related Notions have been produced based on the first-round analysis of the doctoral dissertations as well as my *a priori* themes about the notions related to the concepts of EA.

1.7.2. Creating the final template

In this section, I discuss my experience revising the template, including insertion, deletion, changing scope, and changing higher-order classifications.

The central focus in this analysis is the concept of enterprise architecture as described in academic research. In line with my constructivist approach, I seek to do this within the specific context of particular EA research circles and their associated doctoral dissertations and publications, highlighting both the commonalities and the differences within and between these research circles.

For all sections of dissertations and academic publications encompassed by one of my *a priori* themes, I attached the relevant code from the initial template. In instances where there was no relevant theme, I modified an existing theme or devised a new one.

As stated above, an initial coding template was produced on the basis of summaries of main issues apparent in the data from dissertations; this template was then modified in response to a careful reading and re-reading of those parts of the key academic publications

and dissertations that are relevant to my research questions, thus developing the final template (see Table 3). For purposes of this research, I concentrate on two of the highest-level themes and their sub-themes, which were especially relevant to the topic of the EA concept and its related notions. (They are shown in Table 3.)

Table 2 Initial Coding Template

1. Dimensions of EA definitions
   - Who?
   - What?
   - How?
2. Related Notions
   - Integration, models, communication, analyses, planning, decision-making, design, systems thinking

Table 3 Final Template

1. Circles in EA research community
   a. TEAR Circle
   b. GERAM Circle
   c. Circles in Management Schools
      i. JEA Circle
      ii. MIT-CISR Circle
2. Critical review of definitions of EA
   a. How different circles define EA
   b. Ambiguities and critiques of the concept of EA
3. Related notions
   a. Architecture
   b. Enterprise
   c. Enterprise Integration
   d. IT/IS Planning
   e. Enterprise Engineering
   f. Architectural Analyses
   g. Enterprise Models/Modeling
   h. Enterprise Ontology
   i. Information flow and material flow
   j. Managing Change
   k. Standardization
   l. Business and IT Alignment
   m. Visualization
   n. Communication
   o. Coherence and Consistency
   p. Agility and Flexibility
4. Metaphors of EA
   a. Building Plan/Blueprint
   b. City Plan/Urban Design
   c. Language
   d. Dashboard
   e. Politics
   f. Archeological Excavation (an alternative)

1.7.3. Presentation

In this section, I explain the approach I have chosen to present my findings and its suitability to my project.

According to King (1998), as with other stages of template analysis, "it is impossible to define one single correct or ideal way to present findings. The researcher needs to consider the nature of the data, the type of document to be produced (including its word length) and, critically, the intended readership" (p.132) King stresses the importance of using direct quotes from the text being studied, as well as producing a coherent "story" of the findings. Specifically, the three common approaches to presentation of findings in a template analysis recommended by King, any of which could be employed by my project, are as follows: (1) A set of research circles' views, followed by a discussion of differences and similarities between the views; (2) an account structured around the main themes identified, drawing illustrative examples from each circle's view as required; (3) a thematic presentation of the findings, using a different research circle's views to illustrate each of the main themes, which is a synthesis of approaches 1 and 2 above. The findings and discussions of the current project are presented following the third approach.

2. The Concept of EA in Doctoral Dissertations

According to Hjort-Madsen (2009), the first book that used the term "enterprise architecture" was published in 1992 by Spewak (1992). According to Raphael Malveau (2004), the term "enterprise architecture" was first used in government by the US Federal government in 1999 when the Federal Enterprise Architecture Framework was published in 1999.

Almost all of the dissertations reference The Open Group's account of EA concept and its benefits. The Open Group is a vendor- and technology-neutral consortium, which pursues integrated information within and between enterprises based on open standards and global interoperability (Open Group, 2008). The Open Group Architecture Framework (TOGAF) explains the concept of EA as follows(Open Group, 2008):

> "The purpose of enterprise architecture is to optimize across the enterprise the often fragmented legacy of processes (both manual and automated) into an integrated environment that is responsive to change and supportive of the delivery of the business strategy. Today's CEOs know that the effective management and exploitation of information through IT is a key factor to business success, and an indispensable means to achieving competitive advantage. An enterprise architecture addresses this need, by providing a strategic context for the evolution of the IT system in response to the constantly changing needs of the business environment. Furthermore, a good enterprise architecture enables you to achieve the right balance between IT efficiency and business innovation. It allows individual business units to innovate safely in their pursuit of competitive advantage. At the same time, it ensures the needs of the organization for an integrated IT strategy are met, permitting the closest possible synergy across the extended enterprise.
> …the business operating model concept is useful to determine the nature and scope of the enterprise architecture within an organization." (Open Group, 2008)

In Table 4, I illustrate several of the perspectives available on the concept of EA in doctoral dissertations. I use these perspectives to find some major research circle in the field of EA as well as creating the initial coding template for my analysis in the current project (see Table 2).

Table 4 EA Concept in Doctoral Dissertations

Dissertation	EA Concept	Initial Codes
Noran (2004)	"not yet fully acknowledged as a school of thought" (p.7) "EA area integrates knowledge from information systems (IS), software engineering, and project management, in the form of an overarching framework." (p.7) "EA regards the IS as one of the essential enablers towards achieving an integration of the information and material flows within the enterprise" (p.7) "…ultimate purpose of enterprise modeling is *change. Therefore, enterprise reference architectures and frameworks actually represent ontologies of change in the enterprise.*" (p.12)	GERAM Circle, Enterprise Integration, Enterprise modeling, Change process
Ekstedt (2004)	"a holistic approach to managing the enterprise systems" (abstract) "the discipline's presumption is that architectural models are the key to succeed in understanding and administrating enterprise systems" (abstract) "Enterprise Architecture should serve as decision support, primarily for the Chief Information Officer" (p.12) "For architectural models to function as decision-making support, … they must be amenable to architectural analysis" (p. 28)	KTH Research Group, enterprise systems, Decision making, Architectural Analysis, Architectural Models
Hirvonen (2005)	"as a framework for planning and managing organizations' business, information, systems and technologies" (abstract) He agrees with The Open Group's Enterprise Architecture definition.	Jyväskylä research group, Planning, Management
McDonald (2005)	"Architecting is a management discipline that only has meaning when managers value the enterprise and its total operation above the operation of a single product, business unit, or organization" (abstract) "Current approaches to EA concentrate on the design of IT systems and are therefore inadequate to design an enterprise…achieving enterprise performance involves architecting more than IT systems" (abstract)	MIT-CISR Circle, Performance, Integration, Consistency, Flexibility
Peristeras (2006)	"as a common language for all terms and relations in [an enterprise]" "provides the enabling framework in which to integrate process and data models into an enterprise wide representation." "assists decision making"	Language, Integration, Enterprise Models
Khoury (2007)	"a holistic set of models that represent an enterprise, and its environment, in order to manage change"	Models, Managing change
Pulkkinen (2008)	"EA proposes a holistic approach to the management of organizational ICT systems and infrastructure. By structuring the collaboration, it interlinks the contributuions from different communities of practice to the decision making process." (abstract)	Jyväskylä research group, IS Planning, Collaboration tool

Table 4 (Continued)

Dissertation	EA Concept	Initial Codes
Hjort-Madsen (2009)	"the analysis and documentation of an enterprise in its current and future state from an integrated strategy, business and technology perspective." (Bernard, 2005) Reviewing the literature, He summarizes the EA objectives as follows: (p.22) - Strategy and business orientation: enabling, leverage of IT, new business models. - Planning: target oriented, steering of IT programs with strong impact and securing compliance to corporate standards. - Synergies: the IT landscape developed and implemented in a systematic manner and utilizing synergies. - Adaptability: dynamic development of market, business, and technology, provide for scalability and growth. - Transparency: complexity and dependencies of architecture building blocks. - Communication between business and IT community: heterogeneous composition of people involved (from management to IT experts).	JEA Circle, Planning, Communication, Strategy and business orientation, Systematic, Synergies, Adaptability, Transparency

3. Discussion #1: The Circles in EA Research Community

As described in the introduction to the Fifth Workshop on Trends in Enterprise Architecture Research (TEAR, 2010), research on EA has been taking place in relatively isolated communities. In accordance with this truism, I defined the coding hierarchy in the template (as illustrated in Table 3 and presented in Section 1.7) to represent my interpretation of the different major perspectives on the concept of the EA. I use the term "circle" to describe a group of EA researchers who know each other and have similar views and interests regarding the concept of EA. As is the case with philosophical schools of thought (e.g., the Vienna Circle), adherents to EA research circles share certain intellectual outlooks, even worldviews of sorts. Part of a larger intellectual trend, each research circle encompasses several research groups from different universities and research institutes.

Focusing on a part of the isolated EA research communities, Schelp and Winter (2009) investigate language communities in EA research. Their research is one step forward in the treatment of differences and commonalities of isolated EA research communities. However, they focus on a narrow collection of EA research groups, mostly in technical schools. These groups have important commonalities and, as such, I consider Schelp and Winter's collection to be a circle unto itself in my categorization scheme of EA research circles. I call this circle the TEAR circle (see Table 5, the row labeled TEAR), after a major annual workshop on EA research, the Trends in Enterprise Architecture Research, the fifth of which will be held in November 2010 (TEAR, 2010). The rationale for choosing the name of this workshop for this circle is that organizers of the workshops are mainly from the EA research groups labeled TEAR in Table 5.

There are a number of significant research circles not addressed by Schelp and Winter (2009). The authors explicitly exclude a circle working on highly technical engineering aspects of enterprise architecture—I will call it the GERAM circle. Moreover,

they entirely overlook two research circles, mainly from business schools, working on management aspects of the field—I will call them the MIT-CISR circle and the JEA circle.

Schelp and Winter state that the approach of Bernus and his colleagues (Bernus and Nemes, 1996, Bernus et al., 2003, Bernus and Schmidt, 1998) constitutes a distinct EA research framework, one which they exclude because "their EA understanding is too different from the common understanding of the remaining approaches" (Schelp and Winter, 2009). The approach of Bernus and his colleagues is mainly formed in IFIP-IFAC Task Force (Bernus, 2002), which is an international standardization task force seeking to create and maintain a generalized reference architecture to organize knowledge from different enterprise integration communities. In fact, lessons learned from of their reconciling effort on enterprise integration architectures (Bernus, 2002, Bernus and Nemes, 1996, Bernus and Nemes, 1997) can be viewed as be an exemplary collaborative work in the EA research community. Thus, I have assigned another research circle to this class of research groups (see Table 5, the row labeled GERAM), calling it the Generalized Enterprise Reference Architecture and Methodology, or GERAM circle. GERAM is a product of several research groups, mostly from manufacturing automation and industrial engineering schools, contributing to the IFIP-IFAC Task Force (Bernus, 2002; see Section 3.2.2 and Table 5).

Considering the research groups that Schelp and Winter (2009) have entirely overlooked in their investigation leads me to other EA research circles, mostly from management schools, which I call the MIT-CISR circle and the JEA circle (see Table 5). The distinction between EA understanding of these new circles and technical research circles becomes clear when, for instance, Ross, Weill and Robertson (2006), of the MIT-CISR circle, explicitly state that "enterprise architecture is not an IT issue—it's a business issue" (p.viii). They call the EA understanding of technical schools "traditional IT architecture" and criticize "the historic ineffectiveness of IT architecture efforts" for their "remoteness form the reality of the business and their heavy reliance on mind-numbing detail represented in charts that look more like circuit diagrams than business descriptions and that are useful as little more than doorstops" (p.vii). Such major critiques of the EA

understanding in technical research circles, offered by management schools, as well as the fact that these critiques have been overlooked by technical circles helped me discover a new isolated EA research community in management schools. As another example in this new class of circles, consider the article by Doucet, Gøtze, Saha, and Bernard (2008), of the JEA circle, which seeks to explain the concept of EA based on the notion of coherency management in enterprises. This article also has been overlooked by literature reviews conducted in the TEAR circle (Schelp and Winter, 2009, Schonherr, 2009). In the research circles from management schools, I recognize the MIT-CISR circle and the JEA circle, as their definitions of the concept of EA are different, and their EA research focus on different domains: the private sector in MIT-CISR circle and the public sector in JEA circle. All the research circles shown in Table 5 and their key perspectives on EA will be discussed in the following sections.

Table 5 EA Research Circles and Related Research Groups

Research Circles		EA Research Groups
Technical	**TEAR**	Industrial Information and Control Systems, KTH Stockholm, Sweden EPFL Lausanne, Switzerland Telematica Institute, The Netherlands University of St. Gallen, Switzerland TU Berlin, Germany TU Munich, Germany TU of Lisbon, Portugal Radboud University Nijmegen, The Netherlands
	GERAM	IFIP–IFAC Task Force on Architectures for Enterprise Integration School of Computing and IT, Griffith University, Australia IMS-LAPS (Manufacturing Automation), University Bordeaux, France AGIP (Automation and Industrial Engineering), University of Metz, France
Management	**MIT-CISR**	MIT Sloan School of Management - Center for Information Systems Research, U.S.A IMD Business School, Switzerland
	JEA	Journal of Enterprise Architecture School of Information Studies, Syracuse University, USA Copenhagen Business School, Denmark IT University of Copenhagen, Denmark Information Technology Research Institute (ITRI), IT faculty, University of Jyväskylä, Finland

To support the analysis of the perspectives of different research circles in the following sections, I present some of the reference findings here in Table 6 and Table 7.

Table 6 illustrates exemplar dissertations and publications, related to each EA research circle. Appendix A presents in more detail the publications which I have included in the current study. Table 7 presents the research interests and keywords of different EA research circles.

Table 6 EA Research Circles and Exemplar Research on EA

Research Circle	Exemplar Research on EA
TEAR	Dissertations: Ekstedt (2004), Balabko (2005), Plazaola (2009) SEAM: Systemic Enterprise Architecture and Methodology (Wegmann, 2003) ArchiMate Project (Lankhorst, 2009) Johnson and Ekstedt (2007) Schelp and Winter (2009)
GERAM	Dissertations: Noran (2004) ISO 15704 (2000) GERAM: Generalized Enterprise Reference Architecture and Methodology (ISO/IEC, 2005) Bernus and Schmidt (1998) Bernus, Nemes, Schmidt (2003) Chen, Doumeingts, and Vernadat (2008)
MIT-CISR	Dissertations: McDonald (2005) Ross (2003) Ross, Weill, and Robertson (2006)
JEA	Dissertations: Hirvonen (2005), Pulkkinen (2008), Hjort-Madsen (2009) Bernard (2005) Doucet, Gotze, Saha, Bernard (2008)

Table 7 EA Research Circles and Research Keywords

Research Circle	Research Keywords
TEAR	EA Models, EA Tools, EA Method Engineering Architectural Analysis Business/IT Alignment Enterprise Engineering, Enterprise Ontology
GERAM	Enterprise Integration Enterprise Engineering EA Models
MIT-CISR	EA as Strategy, Strategic EA Competency Foundation for Business Execution Stages of EA Maturity Operating Models, Business Process Standardization and Integration
JEA	Government Enterprise Architecture Coherency Management EA for Alignment, Agility, and Assurance EA Consulting Service Providers

3.1. TEAR Circle

3.1.1. Overview

There are several European research groups in Sweden, Germany, the Netherlands, and Switzerland that collaborate widely with researchers with similar understandings of EA. TEAR is an annual workshop on the Trends in Enterprise Architecture Research, organized by these research groups "to bring these different communities of EA researchers together and to identify future directions for EA research" (TEAR, 2010). Schelp and Winter (2009), in their analysis of language communities in EA research, have reviewed and compared the different perspectives inside this circle. The included universities (seven research groups) in their review in addition to another university (Radboud University Nijmegen in the Netherlands), which I assign to the TEAR circle—because Erik Proper, who heads up the Theories for Enterprise Engineering group in this university (RU, 2010), is a chair of the TEAR workshop (TEAR 2010)—are presented in Table 5.

Some findings of the current study regarding the major publications and research interests of the TEAR circle are presented in Table 6 and Table 7.

The ArchiMate project on EA modeling language was an example outcome of collaboration inside the TEAR circle (Lankhorst, 2009). This is a Dutch research initiative that has developed concepts and techniques to support enterprise architects in the visualization, communication, and analysis of integrated architectures. ArchiMate is now a trademark and a technical standard of The Open Group, an industry consortium to set vendor- and technology-neutral open standards for computing infrastructure (Open Group, 2008).

3.1.2. KTH Research Group

Two of the doctoral dissertations (Ekstedt, 2004, Plazaola, 2009) analyzed in the current project belong to the Department of Industrial Information and Control Systems at the Royal Institute of Technology (KTH) in Stockholm, Sweden. Their research focuses on the analysis of architectural models of information systems in context. Much work is

directed toward the electricity sector, with a particular focus on systems that control electric power transmission and distribution. Significant research is also aimed at enterprise-wide information systems of a more general kind. In this area, Pontus Johnson, the head of the EA research at KTH, and Mathias Ekstedt have authored a book entitled *Enterprise Architecture: Models and Analyses for Information Systems Decision Making* (Johnson and Ekstedt, 2007).

Ekstedt (2004), of the KTH research group, defines in his dissertation the concept of EA by introducing the notion of "enterprise system". Then Ekstedt states that EA has evolved with the mission to take a holistic approach to managing the enterprise system. In his view, EA' presumption is that "architectural models are the key to succeed in understanding and administrating enterprise systems" (p.I). Similar to some other EA researchers (e.g. Noran, 2004), Ekstedt tends to call the EA a new discipline. Compared to many other engineering disciplines, he views EA as quite immature in many respects.

Comparing Ekstedts's views, as a representative of KTH EA research group, with some major research publications inside the TEAR circle, I found a similarity regarding the notions of architectural "models" and "analyses", but Ekstedt does not address the notion of "communication" in the EA concept while in the some other groups of TEAR circle— for example, Lankhorst (2009)—this notion is one of the key components of EA as the title of Lankhorst's book indicates: *Enterprise Architecture at Work: Modelling, Communication and Analysis* (Lankhorst, 2009).

Ekstedt (2004) argues that the concerns of a company's Chief Information Officer (CIO) should guide the rationale behind the development of EA models. However, a recent study (Turner et al., 2009), conducted by a joint team from JEA circle and GERAM circle, argues that a subordinated role of EA has led to "a failure to provide effective decision support to senior business decision makers." Specifically, it suggests that the concerns of a company's senior business management should guide the rationale behind the development and governance of EA models. In this regard, Ross et al. (2006), of MIT-CISR circle, distinguish between "EA core diagrams" (or "high-level EA") and "detailed architectures." They argue that EA core diagrams (one-page diagrams) are focused on communicating the

high-level business process and IT requirements of a company's operating model. These diagrams do not provide the necessary detail to map out technical or process design requirements. They, however, argue that, in the development of detailed architectures, non-IT people need not be involved, although they need to provide enough detail on how they will execute processes, and, what data those processes depend on. Researchers from the MIT-CISR circle, which belongs to management schools, do not use the term "EA models" or "enterprise models."

3.1.3. EPFL Research Group

In his dissertation, Balabko (2005) cites the Open Group (2008) to define the EA: "The primary reason for developing EA is to support business by providing the fundamental technology and process structure for an IT strategy" (p.3). He states that EA is a multi-disciplinary approach that enables enterprises to anticipate or react to necessary business or technical changes. From his point of view, in an EA project, the EA team develops an EA model (also called enterprise model) that represents the enterprise. The model is usually structured in hierarchical organization levels. Drawing upon the theoretical work of Wegmann (2003), he states that the highest level typically describes marketing concerns, the middle level describes business processes, and the lower level describes the IT systems. The rationale behind structuring EA models with hierarchical levels can be found in the main publication describing SEAM (Systemic Enterprise Architecture and Methodology) by Alain Wegman (2003). Balabko (2005) draws his understanding of EA and enterprise upon a living systems theory which is also formulated in SEAM (Wegmann, 2003).

3.2. GERAM Circle

3.2.1. Overview

There are at least one doctoral dissertation (Noran, 2004) as well as many research articles – mainly published in scholarly journals such as *Computers in Industry*, *Annual Reviews in Control*, and *Computer Integrated Manufacturing Systems* (all edited by Elsevier) –

which directly address the development and application of the standard ISO 15704 and its annex, GERAM (Generalised Enterprise Reference Architecture and Methodology), as their reference framework in the field of enterprise architecture (ISO15704, 2000, ISO/IEC, 2005). ISO 15704, Requirements for Enterprise-Reference Architectures and Methodologies, is a standard developed by the Technical Committee 184 at the International Organization for Standardization (ISO TC 184); this committee is entitled Industrial Automation Systems and Integration, which, according to its business plan, develops standards intended to help manufacturing industry through adding value to the investment in "industrial automation and exploitation of electronic business to gain competitive advantage."

3.2.2. About GERAM

GERAM, the result of a ten year project by the IFIP-IFAC Task Force, is about those methods, models and tools which are needed to "to build the integrated enterprise" (Bernus and Nemes, 1996), "to identify and carry out change in enterprises" (Bernus and Nemes, 1997), "to build and maintain the integrated enterprise, be it a part of an enterprise, a single enterprise or a network of enterprises (virtual enterprise or extended enterprise)" (ISO15704, 2000). GERAM is the result of generalization, based on the three "most complete enterprise reference architectures": CIMOSA (1996), the GRAI Integrated Methodology, GIM (Doumeingts et al., 1998), and the Purdue Enterprise Reference Architecture, PERA (Williams, 1994).

GERAM is described in Annex C of ISO15704:2000/Amd1:2005. ISO15704:2000 defines requirements for reference architectures and methodologies (without prescribing any specific artifacts); GERAM is provided as an example of a generalized enterprise architecture framework that satisfies these requirements. So, GERAM can be (and has been) used to assess particular architecture frameworks, or to establish a selection of architecture framework components to be used in a specific EA project (Noran and Bernus, 2009). Several mainstream frameworks of EA like Zachman Framework, DoDAF, and TOGAF have been mapped against GERAM (Bernus et al., 2003). As part of

ISO15704:2000, GERAM is regularly reviewed so as to harmonize it with other standardization efforts. This ensures that GERAM will constantly include a set of essential concepts shared and agreed upon by the EA community (Noran and Bernus, 2009).

3.2.3. Why GERAM Circle?

Though contributing to the EA body of knowledge, the articles authored by the members of this circle – including researchers from CIMOSA, GRI-GIM, PERA, GERAM, and ISO 15704 – are not cited widely by the articles of the other EA research circles; for example, one of the most important articles of the GERAM circle (Chen et al., 2008)—authored by three famous scholars of GERAM, GRI-GIM (David Chen and Guy Doumeingts), and CIMOSA (Francois Vernadat)—which addresses the past, present, and future of EA, and seeks to define and clarify basic concepts of EA, has been ignored by a literature analysis article (Schonherr, 2009), of the TEAR circle, which surveys 126 references to support a common terminology in the "discipline" of EA! As another example, consider another literature survey on EA research conducted by Langenberg and Wegmann (2004), of the TEAR circle, and does not include any articles from GERAM circle.

Schelp and Winter (2009) in their analysis of language communities in EA research, in which they mainly review the perspectives from TEAR circle, have excluded the publications by GERAM circle, "because their EA understanding is too different from the common understanding of the remaining approaches."

As such, in the present project, I choose to classify the contributions of this group of scholars under the title of GERAM circle, and I will analyze their perspectives on the concept of EA compared to other circles of research in the field of EA.

3.2.4. Selected Publications from GERAM Circle

To understand the viewpoints of the GERAM circle on the concept of EA and the related notions, I chose to critically analyze GERAM (ISO/IEC, 2005), Noran's dissertation (2004), and the recent scholarly article by Chen, Doumeingts and Vernadat (2008); moreover, I reviewed other works by prominent researchers of this circle, for example, the book titled *Handbook on Enterprise Architecture* (Bernus et al., 2003) and

articles by Peter Bernus, who is the past chair of the IFIP-IFAC Task Force for Architectures for Enterprise Integration which developed GERAM (Bernus and Nemes, 1996, Bernus and Nemes, 1997, Noran and Bernus, 2009, Turner et al., 2009).

3.2.5. Summary and Reflection

The main focus in GERAM circle is on Enterprise Engineering and Enterprise Integration. Chen et al. (2008), when explicitly discussing the problems of EA, address it explicitly to "enterprise engineering community".

In his dissertation, Noran (2004) "describes a research performed in the area of *enterprise architecture*." According to Noran, "not yet fully acknowledged as a school of thought", EA area integrates knowledge from information systems (IS), software engineering, and project management, in the form of "an overarching framework." He states that EA as a "separate discipline" is "closely related" to the information systems "discipline", because EA "deals with the enterprise as an entity which *subsumes* the IS among other systems."

Noran and Bernus (2009), in their recent publication, describe EA as "an increasingly popular approach to describe and manage changes in enterprises so as to enhance their consistency and agility" (Noran and Bernus, 2009).

Chen et al. (2008), of the GERAM circle, have a special perspective on EA which reveals further the distinctive character of this circle from other research circles. Providing a definition for enterprise, they state that "researches on enterprise architectures are mainly concerned with the manufacturing systems and their control systems of the enterprise." This idea supports the mission of IFIP-IFAP Task Force regarding their standardization concerns for manufacturing industry. Similarly, reviewing the publications by researchers of this circle, we notice that, in their EA concept, material flow is as important as information flow. For instance, Noran (2004), of the GERAM circle, emphasizes this understanding of EA in his dissertation, arguing that "EA regards the IS as one of the essential enablers towards achieving an integration of the information and material flows within the

enterprise" (p.7). This view of EA is formulated and explained in the GERAM document (ISO/IEC, 2005).

As mentioned before, Schelp and Winter argue that the GERAM circle's understanding of EA is "too different from the common understanding of the remaining approaches" (Schelp and Winter, 2009). Schelp and Winter give no explanation for their argument. However, in my opinion, it has to do with GERAM circle's special perspective on the integration of information flow with material flow, which comes from their preliminary focus on manufacturing industry. It should be noted that, although the initial point of departure of ISO 15704 and GERAM development efforts was *Architectures for Integrating Manufacturing Activities and Enterprises* (Williams et al., 1994), in the final document of this standard and its annex, it is stated that they have "the potential for application to all types of enterprise" (ISO/IEC, 2005). However, there are overtones of manufacturing and production control in the approach of GERAM research circle, which should be explicitly investigated in the future efforts to harmonize different understandings of the EA concept.

3.3. Circles in Management Schools

3.3.1. MIT-CISR Circle

The MIT Center for Information Systems Research (CISR) conducts field-based research on issues related to the management and use of information technology (IT) in complex organizations. Established at the MIT Sloan School of Management in 1974, its mission is to develop concepts and frameworks to help executives address the IT-related challenges of leading increasingly dynamic, global, and information-intensive organizations.

The key publication of this circle is the book *Enterprise Architecture as Strategy: Creating Foundation for Business Execution* (Ross et al., 2006), which summarizes the outcome of a series of research projects exploring EA in more than 200 companies (and another 256 companies where the focus was on IT governance) from 1995 to 2005.

MIT 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"(Ross et al., 2006). They view architecture as a strategic, rather than technical, exercise. In this view, a firm's architecture describes a shared vision of how a firm will operate—thus providing a shared understanding of the role of IT. They have found enterprise architecture to be a critical tool for aligning IT and business strategy and for driving business value from IT. They emphasize three key concepts in their research:

- Operating model: a simple statement of the integration and standardization requirements for the firm's core processes.
- Core diagram: a visual representation of the firm's key business processes, shared data, and integrating technology.
- Architecture maturity: a description of the journey an established firm embarks upon as it transitions into more strategic use of IT.

McDonald's dissertation (2005) is heavily influenced by the perspectives of the MIT-CISR circle. In this circle, architecture is a strategic instrument in guiding an organization through a planned course of development. As Ross et al. (2006) show with numerous case studies, successful enterprises employ an 'operating model' with clear choices on the levels of integration and standardization of business processes across the enterprise (Figure 1). This operating model should fit both their area of business and their stage of development.
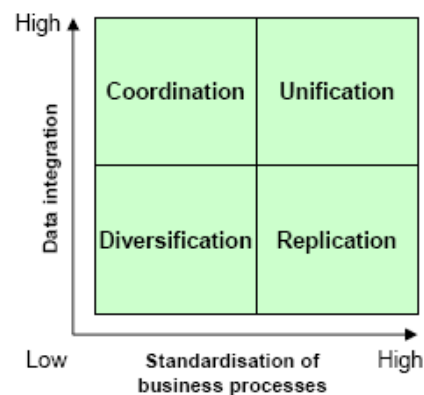

Figure 1 Operating Model (Ross et al., 2006)

Ross et al. (2006) explain the role of enterprise architecture as the organizing logic for business processes and IT infrastructure, which must reflect the integration and standardization requirements of the operating model. They also describe the 'engagement model', i.e., the governance needed to ensure that business and IT projects meet local and corporate objectives and conform to the enterprise architecture. Ross et al. (2006) have also written extensively on the role of enterprise architecture as a governance instrument; see e.g. (Ross et al., 2006).

3.3.2. JEA Circle

Journal of Enterprise Architecture (JEA) is a publication of the Association of Enterprise Architects (a|EA). The international executive committee of JEA are active scholars in the field of EA: Kristian Hjort-Madsen has completed his doctoral dissertation on Government Enterprise Architecture (Hjort-Madsen, 2009); Scott Bernard, from Syracuse University's School of Information Studies, has published the first academic textbook on EA (Bernard, 2005). John Gøtze, from the Copenhagen Business School and the Danish IT University, lectures and supervises projects in EA. He currently serves as president of the Association of Enterprise Architects (JEA, 2010).

Recently, JEA circle started a new theory about EA. They call it *Coherency Management: Architecting the Enterprise for Alignment, Agility and Assurance* (Doucet et al., 2009, Doucet et al., 2008). They define EA as "a young and still evolving management discipline" including all dimensions of an enterprise and uniquely able to serve as the meta-approach for designing and re-designing enterprises to compete in highly dynamic public and private sector environments.

This circle plays a better role in regular communication with other circles; for example, recently, Gotze from the JEA circle and Bernus from the GERAM circle have collaborated in a research project (Turner et al., 2009).

Jyväskylä Research Group

There are at least two doctoral dissertations (Hirvonen, 2005, Pulkkinen, 2008) as well as many scholarly articles published by researchers from University of Jyväskylä,

Finland. FEAR (Finnish Enterprise Architecture Research) research project at the Jyväskylä University's IT faculty, Information Technology Research Institute (ITRI) is conducting research to support the enterprise architecture (EA) work for the Finnish public administration. The doctoral dissertations were conducted as a part of the LARKKI project. LARKKI project was conducted at the Information Technology Research Institute (ITRI), in the University of Jyväskylä.

There are some similarities between the EA research group in the University of Jyväskylä and the JEA research circle. For example, the action research to adopt the government enterprise architecture, conducted by Valtonen et al. (2010), draws upon the concept of coherency management, developed by the JEA circle (Doucet et al., 2008).

3.4. Other Views

There are other EA research groups which are not connected to the major research circles described above.

3.4.1. Khoury, Kaisler and Amour

Koury (2007), in his dissertation, mainly cites Kaisler et al. (2005) as a reference for his definition of EA. He also reviews definitions by Gustas (2005) and Beznosov (1998). In fact, Khoury chooses some references from computer science community which have conducted research focusing on enterprise modeling.

Stephen Kaisler and Frank Armour, whose work (Kaisler et al., 2005) has been the main reference for defining EA in Khoury's dissertation, are co-chairs of the EA mini-track at Hawaii International Conference on System Sciences, where many EA articles, in recent years, have been presented and published.)

The Appendix A summarizes some research groups with technical or management tendencies that are not discussed in the current study.

4. Discussion #2: Related Notions

4.1. Enterprise

4.1.1. The View of the GERAM Circle

Chen, Doumeingts and Vernadat (2008), of the GERAM circle, define an enterprise, according to ISO 15704, as "one or more organizations sharing a definite mission, goals and objectives to offer an output such as a product or a service." They indicate that their definition covers the extended enterprise (long-term integration of suppliers and customers) and virtual enterprise (more oriented to interoperability of dynamic networked enterprises). In their definition, the virtual enterprise has a dynamic and less stable nature than the extended enterprise.

4.1.2. The View of the JEA Circle

Scott Bernard in his academic textbook (Bernard, 2005), which is the first textbook on EA (Doucet et al., 2008), defines the "enterprise" as: "An area of common activity and goals within an organization or between several organizations, where information and other resources are exchanged" (Bernard 2005, p.31).

4.1.3. The View of the TEAR Circle

Since ArchiMate (Lankhorst, 2009), as a contribution of the TEAR Circle, has recently become consistent with the definitions of TOGAF 9.0 (TheOpenGroup, 2008), I use the definition of enterprise provided by TOGAF: "any collection of organizations that has a common set of goals. For example, an enterprise could be a government agency, a whole corporation, a division of a corporation, a single department, or a chain of geographically distant organizations linked together by common ownership."

According to TOGAF 9.0, the term "enterprise" in the context of "enterprise architecture" can be used to denote both an entire enterprise - encompassing all of its

information and technology services, processes, and infrastructure - and a specific domain within the enterprise. In both cases, the architecture crosses multiple systems, and multiple functional groups within the enterprise.

4.1.4. Summary

Reviewing several perspectives on the notion of "enterprise" as described by different EA research circles reveals that there is no major difference. In my view, further investigation on the notion of enterprise will prove fruitful for the clarification of the EA concept. Two decades ago, starting from information systems architecture, EA at present seeks to see, understand, describe and model the whole organization through a specific lens. Question arises: What are the strengths and weaknesses of this specific lens and image? To answer this question, we need to refer to management and organizational theory and clarify what kind of image of organization (Morgan, 2006) is provided by the EA approach and which advantages and disadvantages are taken by this approach.

4.2. Enterprise Integration

Enterprise integration is one of the principle concepts guiding the GERAM circle, as the title of the development team of GERAM, the IFIP-IFAC Task Force on Architectures for Enterprise Integration, reveals. Given that the term recurs several times in my data set, both within and across the selected publications and dissertations, I have chosen to define it as a theme and to analyze the views of not only GERAM but the various EA research circles on enterprise integration.

4.2.1. The View of the GERAM Circle

The concept of enterprise integration, like enterprise engineering, is pivotal to the development and definition of GERAM. According to the annex of ISO 15704, GERAM is intended to "organise existing enterprise integration knowledge" and addresses "those

methods, models and tools which are needed to build and maintain the integrated enterprise" (ISO/IEC, 2005).

The *Handbook on Enterprise Architecture* (Bernus et al., 2003), in its description of GERAM, states, "Enterprise Integration is about breaking down organisational barriers and improving interoperability to create synergy within the enterprise to operate more efficiently and adaptively" (Bernus et al. 2003, p.22). Similarly, Chen, Doumeingts and Vernadat (2008) define enterprise integration based on EN/ISO I9439 (2003): "the process of ensuring the interaction between enterprise entities necessary to achieve domain objectives." Chen et al. (2008) mention various manners or various levels to approach enterprise integration, for example: (i) physical integration (interconnection of devices, NC machines via computer networks), (ii) application integration (integration of software applications and database systems) and (iii) business integration (co-ordination of functions that manage, control and monitor business processes). Bernus and Schmidt (1998) provide a historical account of the appearance of these three concentrations in enterprise integration:

> "The first focus of information systems research and development emerged from the need of physically enabling the information flow, a level of integration that we call today *physical integration*. As physical integration became reality through the installation of networks and adoption of standards it became possible to concentrate efforts on the *interoperability* of applications, i.e. to enable the various business applications to be combined and interconnected for new tasks, without having to re-design them. Interoperability is not yet achieved in many business areas, but practice of the 1990s brought success in some of them, such as database interoperability. The next challenge after application integration is *business integration*, which is the question how various business functions can be interconnected and efficiently combined through information systems."

Some approaches to "integration" are based on modeling or methodology (Chen et al., 2008): (1) integration through enterprise modeling (e.g. through the use of a consistent modelling framework) (Shorter, 1997) and (2) integration as a methodological approach to

achieve consistent enterprise-wide decision-making (Doumeingts et al., 1998). CIMOSA (1996), one of the ancestors of GERAM, considers enterprise integration to be a continuous process, which requires that the (possibly iterative) enterprise modeling activities should occur in parallel with the normal operation of the enterprise (Noran 2004, p.60).

Seeking to clarify the concepts of EA, information systems (IS) and "integration", Noran (2004) in the research assumption of his dissertation, which belongs to the GERAM circle, states that "EA regards the IS as one of the essential enablers towards achieving an integration of the information and material flows within the enterprise" (p.7). To further explain the role of "integration" from "the EA point of view", Noran clearly distinguishes between integration and IS where he argues that "from the EA point of view, *integration is the goal; IS are the means...* the same relation between IS and IT holds. EA perceives the business change processes as determining the IS development and (implicitly) the IT requirements" (p.9). Noran's work draws heavily upon the perspectives of Bernus and Schmidt (1998) which emphasize the importance of "integrated information flow" when they define an information system: "the main requirement that an information system must satisfy is to provide and maintain an integrated information flow throughout the enterprise, so that the right information is available whenever and wherever needed, in the quality and quantity needed" (Bernus and Schmidt, 1998).

4.2.2. The View of the KTH Research Group

A senior researcher in the KTH EA research group, Ekstedt (2004), in his dissertation, does not directly address the term "enterprise integration" but distinguishes between technical integration and organizational integration, and argues that increasing organizational integration drives technical integration, and vice versa. Comparing this classification with the integration levels proposed by Chen et al. (2008) from GERAM Circle, we can map the organizational integration to the business integration, and also we

can map the technical integration in Ekstedt's work to the physical integration and application integration in Chen et al. (2008).

In his dissertation, Ekstedt (2004) also points to the importance of the concept of business processes, and recognizes its introduction and the efforts of business process reengineering (Davenport, 1993, Hammer and Champy, 1994) as "perhaps the single most influential contributor to organizational integration" (Eks) This account of organizational integration" given by a member of the KTH EA research group is consistent with the description of enterprise integration as "... breaking down organisational barriers..." (Bernus et al. 2003, p.22), mentioned in the previous section as a perspective from the GERAM circle.

This is evidence for a mechanistic approach (Morgan, 2006) of enterprise architecture to understand the organization, which I will discuss in the section about metaphors of organization used in EA concept (This image of organization has been explained and critiqued by Gareth Morgan (2006) under the title of seeing "organization as machine.").

4.2.3. The View of the Jyväskylä Research Group

In her dissertation, Pulkkinen (2008) views the "planning for the integration of systems" as a case for EA consulting (p.15). She argues that systems development is still an area adjacent to the EA management, planning and development, so the EA plans lead to the implementation, integration, or enhancement of business information systems.

4.2.4. Summary

After more than thirty years of work on the topic, the vision of the right information for the right people at the right time and in the right format has still not been realised, and it appears that the reason is partly the lack of an underlying commonly accepted theory, and partly the lack of mature enough tools. The coherency of information flow has always been the original aim of the discipline of Enterprise Integration (EI), "The goal of enterprise integration is to provide timely and accurate exchange of consistent information between business functions to support strategic and tactical business goals in a

manner that appears to be seamless" [10], and since the 1980s [12] integration of the information flow has been a major strategic objective – whether integration by design or dynamic integration (interoperation) (Turner et al., 2009)

4.3. Information Systems Planning (ISP)

4.3.1. The View of the TEAR Circle

Within the Information Systems (IS) field, it is understood that there is a planning phase that takes place prior to the actual life cycle of an information system. This phase is devoted to a broader examination of the enterprise's system environment (Pulkkinen, 2008) and is known as information systems planning (ISP) (Olle, 1998). The ISP is mostly concerned with business considerations and is connected to strategic decisions and alignment of ICT with business goals. In her dissertation, Pulkkinen, of the Jyväskylä research group, argues that the EA concept related to the IS field takes its starting point from the ISP area (Pulkkinen 2008, p.12).

Ekstedt (2004), of the KTH research group, addresses in his dissertation the notion of ISP in EA, arguing that EA "should serve as decision support, primarily for the Chief Information Officer (CIO)" (p.12) and states that "the primary focus of the CIO is of strategic character for planning of IT systems of the enterprise system" (p.5). In his view, "the EA problems and concerns indeed have been around longer than the late 1980s, then under disciplines such as Strategic Information Systems Planning" (p.7). Thus, Ekstedt (2004) concurs with Pulkkinen (2008) in the belief that the notion of EA has developed as an offshoot of the ISP area.

In this regard, Karimi (1988) investigates the relationship between EA and strategic planning for information systems (SPIS). He stresses the importance of considering both the organizational and the technical aspects of planning in SPIS. For the organizational aspect, he emphasizes the necessity of an "integrated information systems plan" and its close link to the organization's objectives. For the technical aspect of ISP, he emphasizes the necessity of planning for information systems architecture. Karimi, whose 1988 article

predates the term enterprise architecture, in that article uses the term Information Systems Architecture (ISA), coined by Zachman (1987) and at that time the commonly used to describe the approach.

4.3.1. The View of the MIT-CISR Circle

Ross et al. (2006), of the MIT-CISR circle, do not directly address the notion of information systems planning as demonstrated in some works by the TEAR circle in the previous section. Instead, Ross et al. (2006) employ the notion of IT capability and state that their principle framework—the foundation-for-execution framework—provides an orderly view of how to "plan", implement, and leverage set of capabilities.

4.3.2. The View of the JEA Circle

Hjort-Madsen's dissertation (2009), of the JEA circle, views EA as a new approach to IT planning. In his view, EA originates from a tradition based on engineering and scientific management principles that emphasized preplanned and well-defined procedures.

4.4. Enterprise Engineering

4.4.1. The View of the GERAM Circle

Generally in the GERAM circle, instead of addressing "architects", it is common to call them "enterprise engineers" or "enterprise engineering community". For example, the preface of the main book of this circle, *Handbook on Enterprise Architecture* (Bernus et al., 2003), begins as follows: "We recommend this book as a practical guide and as a comprehensive volume for reference for *enterprise engineers.*" As another example, consider how Chen et al. (2008) address to "enterprise engineering community" when they are talking about the necessity of having common standard symbols for enterprise architecture that can be recognized and understood by all members of this community.

In the specification of GERAM presented in the Handbook on Enterprise Architecture (Bernus et al., 2003) a footnote says: "Enterprise Engineering is the collection of those tools

and methods which one can use to design and continually maintain an integrated state of the enterprise."

4.4.2. The View of the TEAR Circle

To understand the importance of the term "enterprise engineering" in the context of EA in this circle, note that the major books of this circle like "Enterprise Architecture: Creating Value by Informed Governance" (Op't Land et al., 2008) and "Enterprise Architecture at Work: Modeling, Communication and Analysis" (Lankhorst, 2009) (ArchiMate Project) are published in The Enterprise Engineering Series (by Springer), which is defined as follows: "Enterprise Engineering is an emerging discipline for coping with the challenges (agility, adaptability, etc.) and the opportunities (new markets, new technologies, etc.) faced by contemporary enterprises, including commercial, nonprofit and governmental institutions. It is based on the paradigm that such enterprises are purposefully designed systems, and thus they can be redesigned in a systematic and controlled way. Such enterprise engineering projects typically involve architecture, design, and implementation aspects."(Op't Land et al., 2008, Lankhorst, 2009)

Dietz and Hoogervorst (2008), in their manifesto for enterprise engineering, define the mission of the "discipline" of enterprise engineering" as "to combine (relevant parts from) the traditional organizational sciences and the information systems sciences, and to develop emerging theories and associated methodologies for the analysis, design, engineering, and implementation of future enterprises." They also provide a theory for the concept of enterprise engineering; they argue that the current situation in the organizational sciences is similar to the one that existed in the information systems sciences around 1970: "At that time, a revolution took place in the way people conceived information technology and its applications. Since then, people have been aware of the distinction between the *form* and the *content* of information. This revolution marks the transition from the era of Data Systems Engineering to the era of Information Systems Engineering." Accepting that the key enabling technology for shaping future enterprises is the modern ICT, they argue that true understanding the relationship between organization

and ICT is the entering into and complying with commitments between social individuals: "These commitments are raised in communication, through the so-called *intention* of communicative acts." Therefore, as the content of communication was put on top of its form in the 1970's, the intention of communication is now put on top of its content, Dietz and Hoogervorst (2008) argue. Their idea about hoe the current "revolution" in the information systems sciences shows "the transition from the era of Information Systems Engineering to the era of Enterprise Engineering, while at the same time merging with relevant parts of the Organizational Sciences" is illustrated in Figure 2.
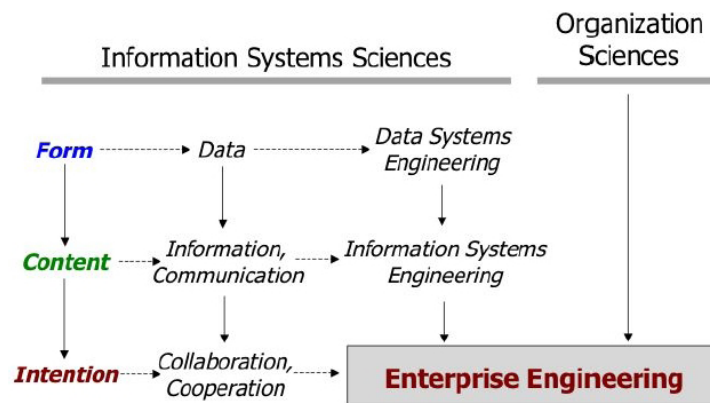

Figure 2 Enterprise Engineering (Dietz and Hoogervorst, 2008)

Dietz and Hoogervorst (2008) identify Enterprise Architecture and Enterprise Ontology as two fundamental notions that have already emerged and "seem to be indispensable for accomplishing this mission". In the context of their formulation of enterprise engineering, Dietz and Hoogervorst (2008) define the concept of EA as follows:

> "Enterprise Architecture is conceptually defined as the normative restriction of design freedom. Practically, it is a coherent and consistent set of principles that guide the design, engineering, and implementation of an enterprise. Any strategic initiative of an enterprise can only be made operational through transforming it into principles that guide the design, engineering, and implementation of the new enterprise. Only by applying this notion of Enterprise Architecture can consistency be achieved between the high-level policies (mission, strategies) and the operational business rules of an enterprise."

4.4.3. The View of the KTH Research Group

None of the academic publications authored by the members of this circle including two doctoral dissertations in the field of EA (Ekstedt, 2004, Plazaola, 2009) address the term "enterprise engineering".

5. Conclusions

In the present project, I have sought to contribute to the clarification of the EA concept. In a treatment of the research question *Who are the key academic researchers or research groups?*, One contribution of this paper is the particular attention it gives to doctoral dissertations in the field of EA, a focus that is new. I have also provided a novel categorization of the current EA research communities, encompassing the major academic research circles around the world. These circles have elsewhere been treated and analyzed separately. Even articles claiming to provide a big picture of the EA research community are ultimately focused on one narrow research circle. The current project critically reviews previous work examining these research communities in isolation. My analysis, in contrast, is more comprehensive, covering some major research circles around the world in the field of enterprise architecture.

In addressing the similarities and differences among the research circles' views, this study demonstrates that, even in academic research and doctoral dissertations, researchers do not unpack the definitions of terms central to the concept of EA. In other words, they take these terms for granted, presuming their definitions are uncontested. Furthermore, they ignore related concepts in other fields and, importantly, critiques thereof. For example, systems engineering, an interdisciplinary field, commonly takes the view of an enterprise as a system and applies theories of systems engineering to enterprise problems and issues.

To take another example, management and organizational theories, through years of inquiry both practical and research-oriented, their strengths and weaknesses have been discussed. An analysis of EA academic publications and dissertations shows that EA researchers, without attribution to organizational theory, are repeating much of that work—along with many of the weaknesses of organizational theory. For instance, EA researchers have failed to consider the well-known critiques made of mechanistic

understanding of organizations and systemic approaches to management (see for example Morgan, 2006).

To be sure, within the EA research community, there is dissent as to the mainstream concept of EA. Yet these researchers' views are overlooked by the dominant EA researchers, who fail to address their critics. For example, Ross (2003), of the MIT-CISR Circle, critiques the dominant metaphor of a building or city plan for enterprise architecture. However, we can find only one credible response to her critique (Namba, 2005), yet this response is itself ignored by the greater EA community. Likewise, the critique by Ross et al. (2006) regarding detailed EA models has not been addressed by the dominant EA groups.

In addition to these critics of the dominant notions of EA, there are critics from outside the field who challenge the entire concept of EA. For example, Peled (2007) has made credible (and searing) arguments against the EA approach, particularly regarding the application of EA to IT planning for government. Yet the EA research community totally ignores him. For example, a dissertation on government EA (Hjort-Madsen, 2009) published two years after Peled's critique does not cite his work.

As I have shown, it is the goal of most EA researchers to establish EA as no less than a discipline—a project that involves, at minimum, theorizing EA as a school of thought. They claim a great deal and have high ambitions regarding the future of EA. However, the current publications are not sufficiently critical, nor do they provide a comprehensive response to the substantial critiques of the field. A review of the backgrounds of EA researchers reveals that the majority are IT consultants. I argue that their background in the business world, where buzzwords rather than theory are the norm, has a negative influence on the rigorousness of their scholarship.

As shown above, there are differences of opinion and ambiguities in the definitions of notions related to EA. To to build robust, credible theories of EA, we need clarification of these points. My contribution is to show, in an objective way, these differences and areas of ambiguity. These efforts to clarify gray areas should continue if EA is to survive as a field, let alone be considered a discipline.

In addition, EA researchers must be attentive to critics both from within the broader EA community and from without, directly responding to those who have observed weaknesses in concepts related to EA—or in the very concept itself. Any attempt to theorize EA without noting ideas fundamental to organizational theory will not hold its own.

6. Quality, Validation and Reliability

As evidence of quality aspects of the present project, I point to the usage of methodological guidance by King (1998, 2008); specifically, I refer here to my use of template analysis as a research approach. In all steps of the project, I have followed the methodological recommendations provided by King regarding template analysis, including creating a coding template, as well as in my data interpretation. Furthermore, I have provided an account of the data collection and analysis processes of the present study (see the Research Design section, above). This detailed description, which Creswell (2007, p.178) might refer to as a "storytelling," reveals some of my research assumptions and limitations, assisting the reader to assess the quality of the research process. I have also sought to provide critical arguments throughout the review and interpretation process in a coherent and cogent manner for the reader.

There are many perspectives regarding validation and reliability in qualitative research. Reviewing these many perspectives on validation, Creswell (2007) considers validation in qualitative research to be an attempt to assess the accuracy of the findings, as best described by the researcher and participants. He also suggests that any report of research is a representation of the author. Creswell uses the term "validation" to emphasize a process, rather than "verification" (which has quantitative overtones) or historical words such as "trustworthiness" and "authenticity." He acknowledges that "there are many types of qualitative validation" (p.206) and that "authors need to choose the types and terms in which they are comfortable" (p.207). He recommends that writers reference their validation terms and strategies.

Following Creswell (2007), in this section, I reference a technique suggested by Lincoln and Guba (1985), which is "a prolonged engagement in the field" (Creswell 2007, p.202). It is my hope that my five years of practical and theoretical experience in real EA consulting projects, including reading a good many academic articles related to improving

EA methods, can be considered prolonged engagement in the field, lending the current study validation and trustworthiness.

Given my own resource limits in the current project, I have sought to give more reliability to the template analysis by first analyzing doctoral dissertations and a number of the papers solely for the purposes of developing the codes to be used for said analysis. In all instances of coding and reading, there was significant iteration as issues arose in dissertations and publications that provided clarification of earlier analysis and enabled a revision of my content codes.

One of the common ways for addressing reliability in qualitative research is the use of intercoder agreements "when multiple coders analyze and then compare their code segments to establish the reliability of the data analysis process" (Creswell 2007, p.210). Given that I conducted this study individually, using intercoder agreements was not possible. Therefore, one of my suggestions for future work is to repeat this study with at least two independent coders to enhance the reliability of the study through intercoder agreement.

7. Future Work

The opportunities for future research topics are extensive. Because of the time constraints of this project, comparative analysis of most of the themes identified herein could not be applied to the perspectives of the various EA research circles. One clear direction for future research, born out of my work, is to employ the template I have provided, analyzing closely these themes that recur throughout the selected publications.

Furthermore, different analysis approaches could be employed. For example, interviews could be conducted with researchers from the various circles with the aim of revealing their ontological and epistemological assumptions about EA and its related notions.

EA is a complex concept, and different metaphors have been employed by researchers to understand its multifaceted nature. Metaphors such as language, building or city plans, bridges, and politics—because of their pervasive use in the field—should be studied comprehensively. Metaphors, because of their great linguistic power, enhance yet also obfuscate ideas underpinning EA, and therefore a fruitful direction for future research would be to undertake a thorough study of these metaphors and their possible role in sustaining dominant interpretations of EA, as well as their power to invoke new understandings. Guiding questions for this inquiry might be: If dominant views of EA are propagated by researchers steeped in the IT business environment, what is the role of the metaphor, with its literary origins? Are the metaphors employed by critics of the prevailing views of EA intrinsically different?

In the current project, I employed a qualitative research method (non-statistical textual analysis) to understand, analyze, and compare the contributions between different research groups in the field of EA. One future study could be a kind of quantitative study. Given multiple research groups, their journal/proceeding graphs can be constructed and then the similarity/gap between them can be computed using network analysis. Such

analysis can be used for measuring similarity/gap of the topics between research groups'
scientific contributions.

Appendix A

Selected Publications and Dissertations in the Current Study

Research Circle	Research Groups and Authors

TEAR	EPFL Lausanne, Switzerland:
	     Wegmann (2003), Langenberg and Wegmann (2004), Balabko (2005)
	KTH Stockholm, Sweden:
	     Ekstedt (2004), Johnson and Ekstedt (2007), Lindstrom, Johnson,
	     Johansson, Ekstedt, and Simonsson (2006), Plazaola (2009)
	Telematica Institute, The Netherlands:
	     Lankhorst (2009)
	TU Delft and Radboud University Nijmegen, The Netherlands:
	     Wagter, van den Berg, and Luijpers (2005)
	     Dietz and Hoogervorst (2008)
	     Op't Land, Proper, Waage, Cloo, and Steghuis (2008)
	University of St. Gallen, Switzerland:
	     Fischer, Aier, and Winter (2007)
	     Schelp and Winter (2009)
	TU Berlin, Germany:
	     Schonherr (2009)
	TU Munich, Germany:
	     Buckl, Matthes, and Schweda (2009)
	TU of Lisbon, Portugal:
	     Zacarias, Caetano, Magalhaes, Pinto, and Tribolet (2007)

GERAM	IFIP-IFAC Task Force:
	     Williams et al. (1994)
	     Bernus and Nemes (1996)
	     Bernus and Nemes (1997)
	     ISO 15704 (2000)
	     Bernus, Nemes, Schmidt (2003)
	     GERAM (ISO/IEC, 2005)
	Griffith University, Australia:
	     Noran (2004)
	     Noran and Bernus (2009)
	     Bernus and Schmidt (1998)
	University Bordeaux and University of Metz, France:
	     Chen, Doumeingts, and Vernadat (2008)

MIT-CISR	Sloan School of Management, MIT, USA:
	     Ross (2003)
	     Ross, Weill, and Robertson (2006)
	     [Related] McDonald (2005)

Appendix A (continued)

Research Circle	Research Groups and Authors

JEA	Journal of Enterprise Architecture
	    Doucet, Gotze, Saha, Bernard (2008)
	School of Information Studies, Syracuse University, USA
	    Bernard (2005)
	Copenhagen Business School and IT University of Copenhagen, Denmark
	    Hjort-Madsen (2009), Hjort-Madsen and Pries-Heje (2009)
	University of Jyväskylä, Finland
	    Hirvonen (2005), Pulkkinen (2008),
	    Valtonen, Seppanen, and Leppanen (2009)
	    Valtonen, Korhonen, Rekonen,and Leppanen (2010)

Other Groups	College of Business, University of North Texas, USA
	    Kappelman (2009), Sidorova and Kappelman (2009)
	EA mini-track at Hawaii International Conference on System Sciences:
	    Kaisler, Armour, and Valivullah (2005),
	    [related] Khoury (2007)
	A Collaboration between the JEA and GERAM circles:
	    Turner, Gotze, and Bernus (2009)
	Bredemeyer Consulting—cited by some academic articles (e.g. Chen et al. (2008)):
	    Malan and Bredemeyer (2002)
	Systems Engineering and Operations Research, George Mason University, USA
	    Morganwalp and Sage (2002)
	    (Chen et al., 2008)

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