Turun yliopisto
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DISCOVERING THE CORE LOGIC AND PURPOSE OF ENTERPRISE ARCHITECTURE AS A HOLISTIC APPROACH TO BUSINESS EXECUTION

Master´s Thesis
in International Business

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15.8.2014
Turku

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1 INTRODUCTION

In order to lead the reader to the mind-set of this research the introduction attempts to evoke an interest into the research subject by providing a thorough illumination of the background, creating a sound foundation for the research, and building an argument for the research problem. Moreover, the chapter describes the researcher's motivation and legitimates the research questions as well as the purpose of the research. The introduction further explains the research by explaining the perspective of this research and presenting a theoretical framework.

1.1 Business and Architecture in a Paradigm Shift

A paradigm can be described as a cohesive set of theories, models, perceptions and assumptions – the way we understand and interpret the world. It is said to be a way of seeing, thinking, and believing – an ideology shared within a society. The word "paradigm" comes from the Greek word "paradeigma", but it was Thomas Kuhn who popularised the term in the 1960s within the field of science (e.g. Vogel 2009, 90–91; Collins 1996, 14; Mink 1992, 21). In his famous book[1] Kuhn describes a paradigm shift as a radical institutional disruption, which according to Vogel (2009, 88–89) is a revolution where ideologies within a scientific field are different before and after the change. A paradigm shift requires a turnover of an entire generation of scientists before it becomes completed. Therefore, the significance of change is rather defined by scale than pace.

Today technological advancements and constant development increasingly accelerate that pace. A paradigm is often defined in both, a stricter and a broader sense and according to Collins (1996, 14) the term is used quite loosely in literature. Durham and Durham's (1998, 52–53) definition falls in the idea of this research: "A paradigm is a set of rules that define the boundaries of a system and provide the description of the operation within the boundaries. The basic philosophy of a culture of a corporation is a paradigm for that particular time."

Technological development has greatly affected the way people act, think, communicate, store, and memorise information. It is evident that technology has affected and will continue to greatly affect our economy, society and life (e.g. Castells 2000a, 28–76; Shapiro & Varian 1999, 1–2.) During the last decades, the world has become smaller, the role of information and information technology (IT) has changed, technology has

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[1] Kuhn, Thomas S. (1970) *The Structure of Scientific Revolutions*. 2nd ed. University of Chicago Press, Chicago IL.

brought ever-faster communication to a global scale, organisational management is going through a cultural shift, and businesses are building new organisational structures and strategies. The business-environment is under constant flux. (e.g. Umar 2005, 217; Shapiro & Varian 1999, 1–9; Collins 1996, 9.) It seems as if something that began as an impact of technological development has escalated into a change of paradigm. Whether called a post-industrial society, knowledge revolution, technological revolution, information age, or a new era, it is inevitably a question of fundamental change – a paradigm shift. (Kappelman, e-mail 15.12.2012; Castells 2000a, 164).

As technological innovations change current habits and create new alternative ways for doing things, people adapt by learning and changing their behaviour and actions. If businesses are to survive longer than one era and seek life beyond a paradigm shift, they need to adapt as well. Thus, to sustain businesses need to be capable of reengineering and reinventing themselves over and over again. (e.g. Kappelman, e-mail, 15.12.2012; Senge, Kleiner, Roberts, Ross, Smith 1994, 4–7; Senge 1990). In a way, we construct the society we act in and the society in turn determines the way we act in it.

For organisations, a change of paradigm is a long-term process of adapting to great changes in the economy and society where plans, operations, and implementations turn into dynamic flows surrounded by discoveries, innovations, and excitement, but also uncertainty, instability, and risk. However, not only great changes bring challenges for enterprises; it is the pace of change that makes efficient and fast adaptation a crucial skill that determines survivors. The complex construction of organisations needs to be agile and capable of hectic execution of the business vision. Self-awareness of the organisation, its main resources and capabilities, and the ability to effect informed change, as a process of constant adaptation requires structure and architecture. If enterprises are to stay competitive, they must be able to store, combine and analyse data and big data and apply sophisticated techniques to access consistent and current information to minimise risks, lower costs, and make better, more accurate business decisions (Trevor & Kilduff 2012, 151; Addressing the business impact of data… 2010, 3; Lin 1996, 42–44).

This pace of development and change in today's business industry calls for constant discovery of competitive advantage in an increasing momentum. While organisations face the pressure of change, implementing new practices and operations with ever-tighter schedules, consequently, the pressure on research is in keeping up with that fast pace. Especially in business economics, a pragmatic discipline within social sciences, an increasing amount of new practices are implemented before the research discipline matures to produce adequate basic research and theoretical foundation to guide and support application within the industry.

Enterprise architecture is an approach that has been created in the need of getting a grip of and managing enterprises and their information systems when working towards better business execution in our rapidly changing business environment. (Enterprise

Architecture 2013; Zachman 2008.) Research on *enterprise architecture* has been ongoing only for a couple of decades and has struggled in developing the concept as a coherent whole and positioning it in its interdisciplinary field. Moreover, as a young field, the development of enterprise architecture has been practice-driven, often through empirical studies elaborating various models and enterprise-specific cases. Correspondingly, research on enterprise architecture is fragmented and stresses the pragmatic approach rather than theoretical discourse and knowledge – lacking a commonly agreed sound definition.

Enterprise architecture started to evolve from its early form of an information system architecture in the 1980s, into a concept – or a set of concepts and practices – that encompasses an enterprise's operations and organisation as a whole. (Zachman & Kappelman 2013, 87; Greefhorst & Proper 2011, 8; Shah & El Kourdi 2007, 36; Zachman 1987.) Enterprise architecture is based on holistic systems thinking, principles of shared language, and the disciplines of architecture and engineering (Zachman & Kappelman 2013, 87). It is almost an all-inclusive, in-depth collection of concepts that address the complete organisation. Not just structure, but strategy, technology, products, finance, people, web of relations, information, operations among others.

Because of the comprehensiveness, an infinite amount of enterprise architecture related organisational activities and research topics exist. In addition to engineering and architecture, enterprise architecture brings together information technologies and systems, information and communication, organisational management, and strategic management. Moreover, similarities and resembling characteristics to the idea of enterprise architecture can be found for example, from organisation theories, systems thinking, and knowledge management – the deeper examined the more encountered. The interdisciplinary nature and wide scope poses a challenge for research; research on enterprise architecture inevitably takes the researcher through a multitude of other subjects, disciplines, and fields of research that all have their own role in this holistic approach. Understanding enterprise architecture pushes for understanding all the fields it refers to and requires a capability to piece it all together in a larger picture.

In the recent years, also the strategic role of information technology (IT), and alignment between business and IT in organisations have raised significant attention among researchers and have been increasingly recognized in literature as well. As businesses are relying their operations more and more on IT, research suggests that as much as IT needs to support business conversely, business needs to support IT (e.g. Wang, Zhou & Jiang 2008; Salmans 2009). Yet it seems that organisations are lacking viable solutions for aligning these two main fields. The ideal holistic enterprise architecture takes into account the complete business, but also emphasizes the importance of well designed sophisticated IT and information systems supporting and enabling organisations' operation in today's information intensive environment. Thus, aiming towards aligned busi-

ness and IT (e.g. Wang et al. 2008, 740; Ross, Weill & Robertson 2006, 48–49; Schekkerman 2004, 13–15).

Even so, the concept's slow adoption among business professionals raises concerns (Enterprise architecture seminar 22.11.2011). Having such strong roots within the fields of information technology and information systems, enterprise architecture still seems to attract greater attention among IT professionals than business professionals when in fact, because of the holistic approach to managing the whole organisation, enterprise architecture should primarily be in the interest of business executives and higher management.

1.2 Research Gap and Problem Statement

Due to the nature of enterprise architecture research discipline, neither the background nor the goal of the research can be properly explicated or defined without referring to the initial findings of this research, which also justify the research problem. At this point it is evident that the subject and context of this thesis are both broad and complex, and locating the primary research problem requires an extensive review of research material. Research and literature on enterprise architecture point a critical research gap in basic research; existing research, literature, and other documented material reveal that despite of the wide and growing interest and research on enterprise architecture and adoption as a practice, the concept lacks a general and established theoretical foundation. (e.g. Langenberg & Wegmann 2004; Buckl, Matthes & Schweda 2009, 2.)

Moreover, several definitions of enterprise architecture can be found however, they are inconsistently interpreted and seldom brought fourth in research. Without a theoretical base and commonly agreed definition, various perceptions of enterprise architecture remain inconsistent and even contradicting (left side in figure 1). Inevitably also many implementations and academic research are based on those perceptions. With varying interpretations and meanings the representations of the concept of enterprise architecture among and between practice and research are not comparable. The left side in figure 1 illustrates this current state of perception and research on enterprise architecture.

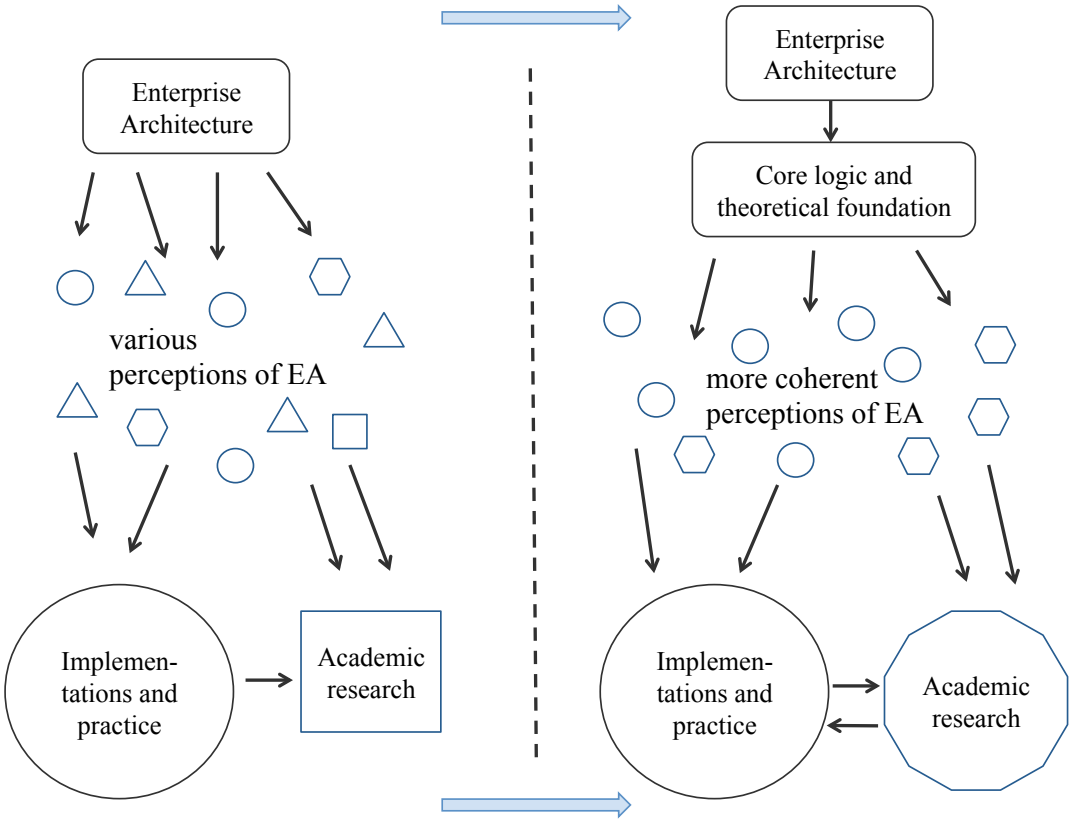

Figure 1 Importance of theoretical foundation for understanding, implementation, and research

The right side in figure 1, illustrates how theorising and building general consistent understanding of enterprise architecture creates more coherence in the ways the concept is perceived and is the target state of the discipline to which this research aims to contribute. Increased knowledge produced by theoretical research and more consistent perceptions of enterprise architecture support better implementation in practice. Furthermore, enhanced implementation provides a better ground for empirical research and thus also supports academic research. Here, the researcher's role is to bring the theoretical and empirical worlds as close to each other as possible (Dubin 1969, 9–10).

In this research, basic research is considered as theorising research into the concept itself to enhance the understanding of enterprise architecture, its core elements and their interrelation, and its fundamental purpose as well as potential for praxis. Low level or lack of theoretical and basic research can have severe consequences within the entire research discipline and thus, also the concept's application in practice (Kallio 2004, 37–38). Enterprise architecture still needs further research to become a well-established concept and practice supporting the quality of wide implementation across industries.

The proposed research gap enjoys support from the findings of four previous research, of which three are literature reviews conducted on enterprise architecture research: Based on a study on current aspects of enterprise architecture research, Langen-

berg and Wegmann (2004) suggest that despite a wide range of topics covered, the field of enterprise architecture is still lacking sufficient basic research. Furthermore, six years later Buckl's et al. (2009) findings support this conclusion by stating that a multitude of different approaches to enterprise architecture are proposed in literature and the plurality of various methods and models are indicators of the research discipline's low maturity. In enterprise architecture implementation is always case-specific to the individual organisation, which adds to the complexity and plurality of empirical research and certainly necessitates theoretical foundation to guide and support implementation. In addition, Aier, Johnson, and Schelp (2009, 314) suggest that research on various means for reducing complexity of enterprise architecture programmes, caused by different models and methods, is to be a future trend. All previous research are important contribution to the research discipline. However, considering the discipline's low maturity and relatively short history of enterprise architecture it is clear that more basic research is necessary to be conducted – especially critical synthesising research from a business- and management perspective.

Consequently, existing research and literature unveils a wide range of different perceptions and interpretations as well as implementations of enterprise architecture. Most confusion seems to be closely related to the role of IT, or more specifically, the scope of IT within the concept of enterprise architecture. Enterprise architecture is often seen as planning, organising, and managing the IT and information systems of an enterprise. It is often approached as a project or separate projects in different departments within the organisation or as some separate function in the enterprise, which is not in line with the holistic nature of enterprise architecture or the terminology used within the discipline. It seems that the current state of enterprise architecture research discipline stresses a more technical approach rather than studying the so-called softer issues in organisational management such as in this research.

Understanding enterprise architecture based on existing research and literature is a challenging task, as much research define the concept vaguely while descriptions and implementations vary or are intentionally partial or stripped. It is true, that implementing a holistic practice into a complex enterprise must be done in steps. However, the mission should not be taking the first couple of steps imagining that one walked the whole stairs. In these cases it is obvious that many enterprise architecture projects fail in returning the value proposed for the holistic practice.

The various contradicting perceptions may be an indication of a wider misunderstanding or unawareness of the core logic and purpose of enterprise architecture across the industry and academia. Accordingly, Zachman (2011; Enterprise architecture seminar 22.11.2011) has pointed out that the holistic nature of enterprise architecture is often misunderstood or misinterpreted and therefore implemented with wrong means or for a wrong purpose. In the worst case implementation can even be carried out without a

carefully thought purpose and objective. Moreover, this results in a prodigious amount of inconsistency in expectations, goal setting, and measurement in many enterprise architecture programs. Despite of differing interpretations and implementations many seem to expect to achieve more or less the same objectives, benefits, and strategic advancements associated with practicing holistic enterprise architecture or reported from practicing successful enterprise architecture. At the same time many enterprise architecture programs are terminated due to failure in delivering adequate business value (Jung 2009, 294; Boster, Liu & Thomas 2000, 43–44).

All in all, there is a vast amount of important topics and aspects in enterprise architecture that still need to be researched. At this time however, conducting conceptual basic research was seen as most current, interesting and most important in order to contribute to creating the theoretical foundation needed for further research, but also for the development of successful application and praxis. Thus, in this research the researcher is interested in understanding enterprise architecture and its discipline and in contributing to the body of knowledge by acquiring important knowledge for the benefit of academia and economy.

1.3 Motivation and Purpose of the Research

Scientific research is conducted to generate new knowledge and insight. Especially in applied research, the objective is usually to achieve a practical goal – to better understand the nature of problems to be solved and to find applicable solutions for developing practice. As opposed to applied research, basic research does not primarily target practical solutions, but is theoretical or experimental work with the purpose of acquiring new knowledge of phenomena. "Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view." (OECD Factbook 2011-2012: Economic, Environmental and Social Statistics).

However, in addition to the primary goal of understanding phenomena it may be argued that ultimately the goal of also basic research is to improve application of knowledge into praxis – particularly in the business research discipline. In conformance with the words of Habermas (1972, 301), a well-known sociologist and philosopher: "The only knowledge that can truly orient action is knowledge that frees itself from mere human interests and is based on Ideas – in other words, knowledge that has taken a theoretical attitude." Theoretical research and basic research are vital for acquiring knowledge and developing applications in practice (Wacker 1998, 361). As in many cases, the motivation for this research derives from the author's personal interest in the subject.

Initially enterprise architecture became the subject of this Master's thesis in the end of November in 2011. It was in an enterprise architecture seminar in Helsinki, attended by IT-personnel, IT-managers, and CIOs in the audience, listening to the seminar's keynote speaker John A. Zachman. His presentation on enterprise architecture was perspicuous and intelligible. It was encouraging and inspiring, yet extremely logical. Most importantly however, the presentation reflected the researcher's previous understanding and personal perception of enterprise architecture. The motivation was ultimately sparked by the idea of a great potential in the holistic mind-set of this practice and a wonder of the difficulty surrounding this logical concept. This previous understanding, as described in hermeneutics, is adopted as the guiding principle that directs the research process towards meaningful theory. Admittedly, in the beginning of a research the research problem is not always clearly defined, but often finds its final shape during the research process. The iterative process in compliance with the hermeneutic circle fines down the research problem as knowledge of the subject and research discipline increases.

This research initially started with the idea of planning for a way to innovatively combine the essence of enterprise architecture with the researcher's previous interests on internal communication and strategy execution. However, researching the effects of enterprise architecture in another context or its correlation with strategy execution for example, turned out to be by no means reasonable when taking into account the initial findings of the state of enterprise architecture research and the broad variety of perceptions of the concept. Next the focus was on the researcher's need to demystify enterprise architecture and its purpose in the digital business economy. And during that process the initial research goal had transformed into discovering the essence of enterprise architecture, a deep understanding of the concept within its interdisciplinary field, and based on these, the underlying causes for the various interpretations and thus also possible wider misperception.

As the research gap and problem statement suggest, the field and concept of enterprise architecture lacks sufficient basic research and theoretical foundation. Research and literature on enterprise architecture mostly take a pragmatic approach, the research field possesses a great amount of inconsistent interpretations, and there is a bewildering plurality of existing models and frameworks that are rather misleading. In the present state, the research discipline lacks the ability to provide a comprehensive and clear picture of the fundamental purpose of enterprise architecture and the ability to elaborate the core logic in and meaning of adopting the practice of enterprise architecture in an enterprise in today's digital business economy.

Although still developing and maturing, enterprise architecture is an extremely interesting and promising concept for businesses in the information age and therefore requires much further divergent thinking within academic research. The researcher's mo-

tivation stems from the need to better understand this phenomenon, which might seem very straightforward and logical and yet appears as overwhelmingly complex and confusing. Enterprise architecture is a fascinating concept because it is relatively new and it addresses the current challenges business enterprises are facing along the increasing digitalisation among other things characteristic of the digital information age. Another strong motivation behind this research is also created by the desire to discover new ways of resolving the challenge of successful strategy execution. The importance of successful enterprise architecture is the ultimate goal of managing an organisation successfully. Then again, the newness of the discipline makes it a very challenging subject for research.

This research can be explained in four parts, which comprise the structure of interest and intent. Firstly, the external pressure and demands that the changing business environment poses for businesses have evoked the need for greater adaptation and flexibility in organisations' operation. Secondly, the increasing complexity of enterprises, their systems, and operations has created an internal pressure for better organisation and agility within the enterprise. Thirdly, the confusion created by the coalition of 1) the strong role of IT in organisations' operation, 2) the strong roots in inception and development of enterprise architecture in the field of IT, 3) the role of business- and strategic management within enterprise architecture and 4) the strong interdisciplinary nature of enterprise architecture combining two traditionally very different disciplines; aligning business and IT. And finally, enterprise architecture addresses these organisational and managerial needs by suggesting a more structured design and integration for the structure of the business enterprise, including efficient utilization of sophisticated IT systems. Table 1 elucidates the operationalization of the research as derived from the motivational drivers behind the knowledge creation interest.

Table 1 From motivation to operationalization of the research

<table>
<tr><th>Motivational drivers</th><th>Sub questions</th><th>Main research question</th></tr>
<tr><td rowspan="2">Growth and development of IT and changes in business environment, creating challenges and resulting in increasingly complex and intricate business enterprises.</td><td>What is the context of enterprise architecture?</td><td rowspan="5">What are the core logic and mind-set of enterprise architecture and its purpose for businesses in today's increasingly digital and information intensive business environment?</td></tr>
<tr><td>Why is enterprise architecture needed?</td></tr>
<tr><td>The ambiguous concept and mind-set of enterprise architecture.</td><td rowspan="2">How enterprise architecture is perceived and understood and how the concept is defined?</td></tr>
<tr><td>Indicators of wider misperception.</td></tr>
<tr><td>Interest in holistic management and successful strategy execution</td><td>What is enterprise architecture's role in organisations and for management?</td></tr>
</table>

This research aims to build a coherent, logical, and justified construction of a truly holistic enterprise architecture. It seeks to obtain knowledge of the perceptions and understandings of enterprise architecture, the events that filter those understandings, and their underlying causes. And based on the discovered understandings and created ideal construction of enterprise architecture, build a conceptual model of the suggested approach to enterprise architecture and the planning of its implementation. These motivational drivers explained have resulted in the following main research question: *What are the core logic and mind-set of enterprise architecture and its purpose for businesses in today's increasingly digital and information intensive business environment?* To guide and support the pursue of understanding enterprise architecture by answering to the main research question, the research seeks to answer the following sub questions:

- *What is the context of enterprise architecture?*
- *Why is enterprise architecture needed?*
- *How enterprise architecture is perceived and understood and how the concept is defined?*
- *What is enterprise architecture's role in organisations and for management?*

The aim of this research requires a wider representation of the larger context that is, the digital business environment in the information age. The purpose of a comprehensive discussion of the organisation embedded in its information and knowledge intensive global environment is to guide the reader through the increasing complexity in today's systems, which create the need for enterprise architecture while the current speci-

fied theoretical knowledge builds the grounds for understanding the mind-set of holistic enterprise architecture approach.

Figure 2 depicts the conceptual framework of this research. The research begins from the information age as the organisations' environment filled with data and creating turbulence and increasing complexity while challenging the organisation's performance and operation.

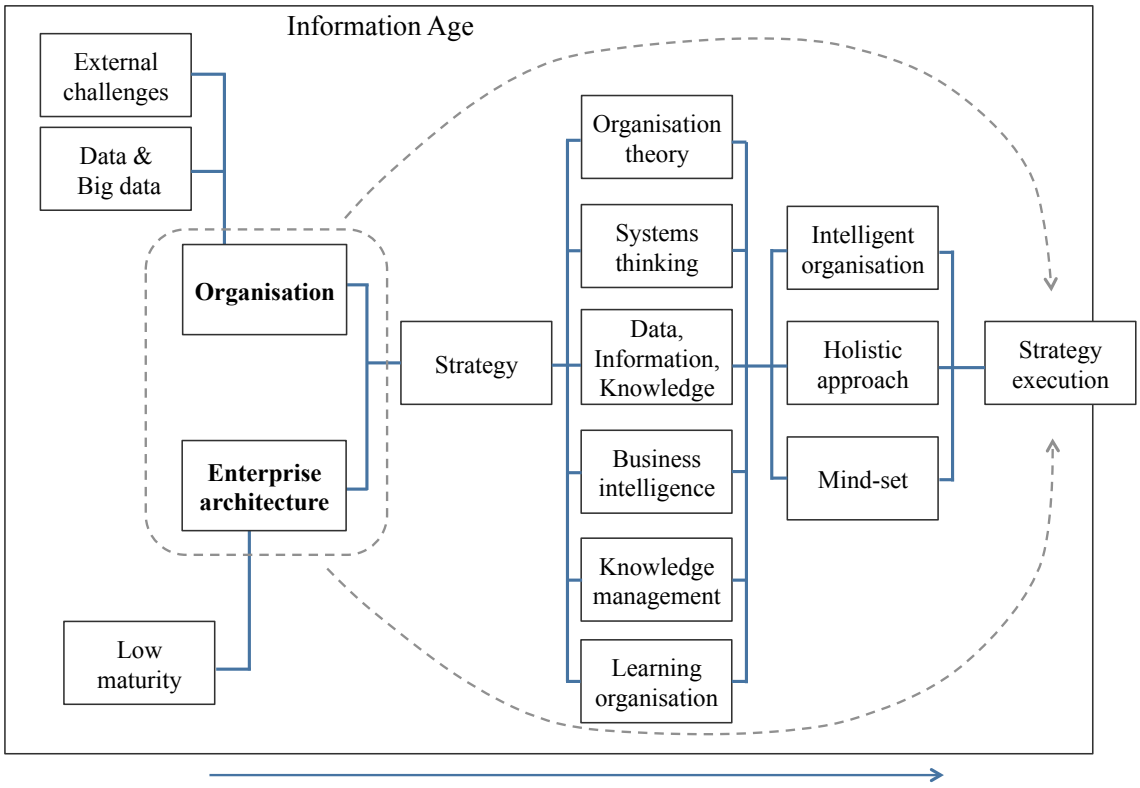

Figure 2 Conceptual framework

Enterprise architecture is seen as a management approach that addresses organisational challenges by the logic of architecture. The business strategy is in focus as the central vision that is the priority in both, organisation and enterprise architecture. Organisation theory, systems thinking, nature of data, information, and knowledge, business intelligence, knowledge management, and organisational learning altogether build a theoretical foundation for the organisation, enterprise architecture, and their symbiosis. Enterprise architecture seeks to bring a holistic organising logic and mind-set to the knowledge-driven intelligent organisation. Their coherent symbiosis pursues efficient and sustainable strategy execution, all in the context of the information age.

Because enterprise architecture is an organising logic for enterprises, the approach to implementation and structure differs between the public and private sectors. This research, as illustrated in figure 3, focuses on enterprise architecture in the aspect of busi-

nesses within the private sector. The terms organisation, business, and enterprise are used interchangeably to describe a business entity.

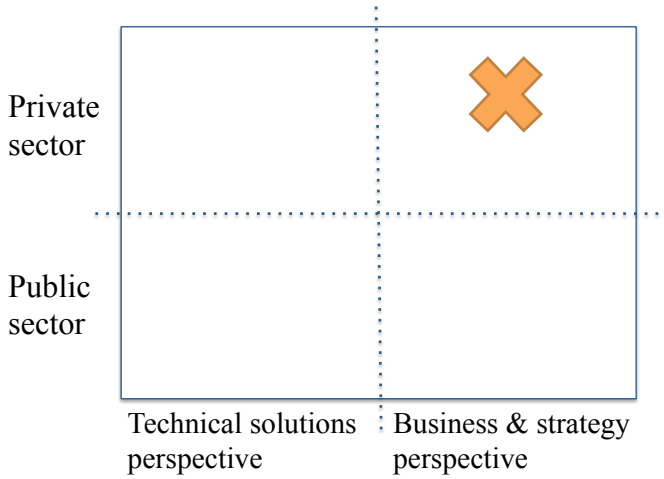

Figure 3 Perspective and focus of this research

However, due to the general logic and nature as well as level of abstraction of the enterprise architecture approach, mind-set, and core logic addressed in this research, they may be seen as widely applicable to enterprises of any form or interest.

Regardless of profession, discipline, or major subject studied this research report is targeted for anyone who enters the world of enterprise architecture seeking to understand the essential mind-set, idea, and purpose behind the concept before diving deeper into the details of planning and execution – or anyone else interested in the subject.

2 RESEARCH METHODOLOGY AND LITERATURE

This chapter aims to provide a thorough look into the overall research strategy and design by bringing transparency to the research process and providing a more detailed view of the nature of the research. The underlying philosophical assumptions are explicated to illustrate the researcher's perception of the research and knowledge creation, how the philosophy guides the research process and reflects the methodological aspect. The theoretical research approach and purpose of analysis and synthesis in this research are explained. An overview of research and literature on enterprise architecture aims to provide understanding of the state of the research discipline and builds grounds for the development of the concept of enterprise architecture.

2.1 Philosophical Considerations

Philosophical assumptions determine the researcher's view of the world, formation of truth and knowledge as well as understanding of the nature of knowledge and reality. They also provide boundaries for the orientation of the research and methodological choices. Therefore, identifying the underlying philosophical assumptions is important and will assist the reader in understanding the nature of the research, how knowledge is created and how the aims and purpose of the research are pursued. (Hirsjärvi, Remes, Sajavaara 2009, 129–131.)

Although, some researchers find it unnecessary to explicitly state their philosophical assumptions (Eriksson & Kovalainen 2008, 11), explicating the philosophical premise creates transparency to the research process and justifies and increases understanding of the methodological choices taken. (Wilson 2010, 9; Hirsjärvi, Remes, Sajavaara 2001, 117–118.) Especially in theoretical research, methodology is more closely related to the philosophical assumptions. Philosophy of science is not a field of black and white choices, but has over centuries developed into an interconnected scheme where approaches, views, and assumptions blend on some parts and might contradict on other parts. Accordingly, a research approach is not always related to one specific tradition and thus, allows the use of methods within different traditions of the philosophy of science. (Puusa & Juuti 2011, 11; Eriksson & Kovalainen 2008, 12, 15). Figure 4 explains some commonly adopted philosophical approaches in business research by positioning them on a two-dimensional diagram:

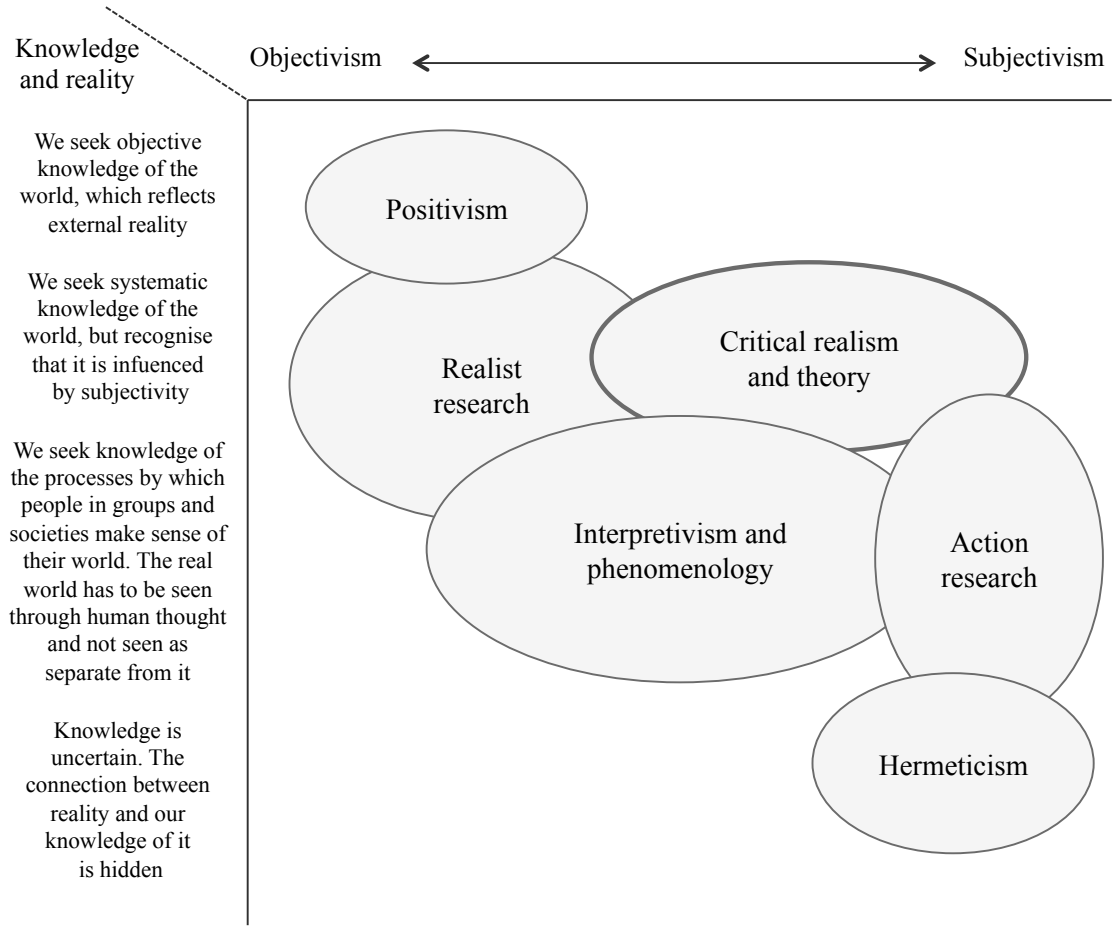

Figure 4 Common forms of business research positioned (adapted from Fisher 2004, 13)

The horizontal axis measures the ontological conception of reality between two opposites: objectivism and subjectivism. The vertical axis describes the epistemological view of knowledge and reality. In this research, the researcher is aware of and acknowledges mechanisms and structures that affect our society, but sees that various understandings of these exist. Accordingly, the ontological assumption is that an objective reality exists external to the researcher, but it is understood as being influenced by the subjective interpretation of a social actor. A socially constructed reality is interpreted differently based on the interpreter's perceptions and experiences and can therefore change according to context as well as over time. Solely this would be an idealist subjectivist assumption.

As a conception of reality, the view in this research is closer to subjectivism than objectivism, but also contains a thought from empiricism, a positivist epistemology, where reality is seen as material. As figure 4 demonstrates, the philosophical approach in this research mainly reflects critical realism. As a sort of combination of objectivism and subjectivism Eriksson and Kovalainen (2008, 15) name this view substantialism, which is commonly associated with critical realism. In general in social science reality is

thought to be affected by human intentions, of which hermeneutics claims that the foundation for all knowledge lies in understanding those intentions (Eriksson & Kovalainen 2008, 20–21). The critical realist approach recognises three depths of reality that are, as illustrated in figure 5 below, analogous to Popper's ontology of three worlds. (Anttila 2005, 43–44; Niiniluoto 2003, 21–25; Fisher 2004, 220–221; Popper 1979, 106.)

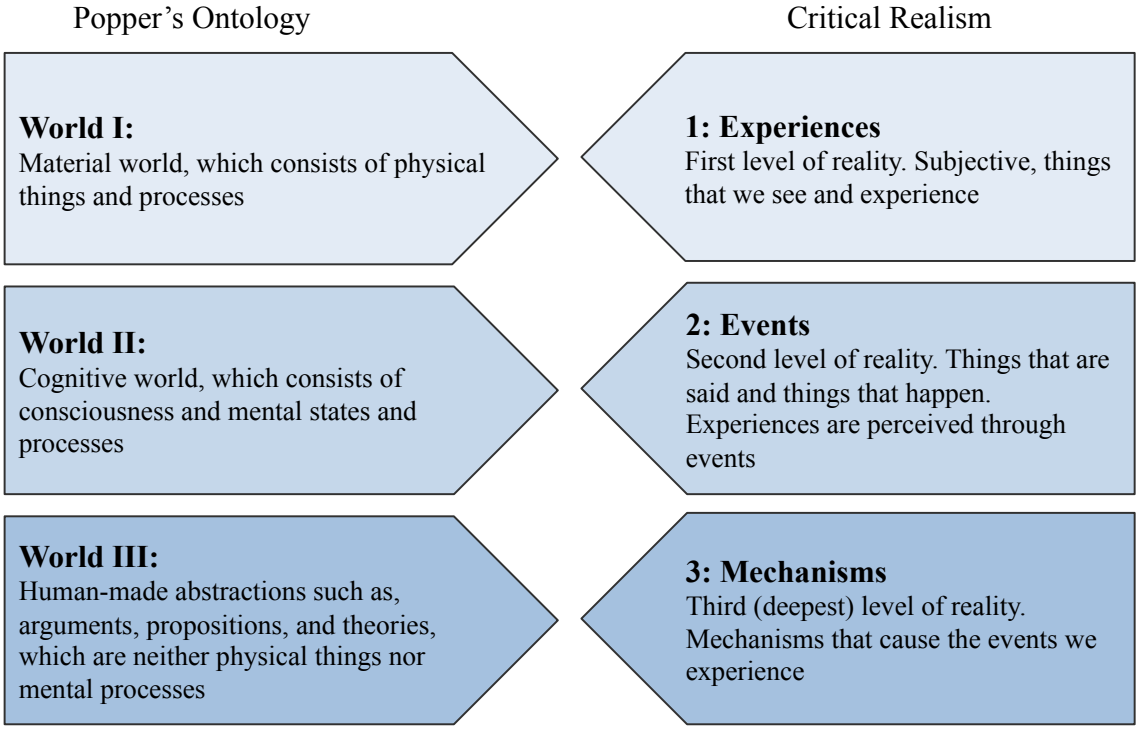

Figure 5 Popper's ontology versus critical realist reality

Popper's ontology is a way to see reality as being constructed of three worlds that interact with each other. Their relationship is paralleled with the concept of evolution; each world is dependent on the previous one, so that world III would not exist without world II, which again would not exist without world I (Kallio 2004, 60; Niiniuoto 2003, 24; Popper 1979, 67–70). Popper's ontology elucidates the epistemological view that critical realism takes claiming that knowledge appears on and can be obtained from all of the three levels (Niiniluoto 2003, 79). And the deepest level of underlying mechanisms, causing things to appear as they do on the second level that occurs in our world, is the reality that researchers should discover (Fisher 2004, 220). In hermeneutic thought, the deepest level of interpretation attempts to reveal structures of phenomena and connections to other factors and it is the level where one comes across many of the critical theory methods (Anttila 2005, 281).

Knowledge is one of the most debated issues in philosophy of science; where a common sense view of knowledge is simply knowing how things are and how the world

behaves, epistemologies of knowledge are still not straightforward. In a deeper discussion of the construction of knowledge Tuomi (1999, 98) suggests that "knowledge does not correspond to reality, instead it "agrees" with it and guides our thinking and acting". Anantatmula (2007, 122) defines that "knowledge is derived from thinking and is a combination of information, experience, and insight. Deriving knowledge from information requires human judgement and is based on context and experience." Hence, knowledge is sensemaking of objects that exist in our environment – physical and abstract. Whereas explicit knowledge is articulated and can be found in physical or documented forms, tacit knowledge is personal within a social context and appears through people's communications, actions, and interconnections (Jennex 2007, 3; Anantatmula 2007, 122).

Knowledge is closely intertwined with human cognition and therefore cannot be independent of perceptions, but rather is formed through conscious construction. (Tuomi, 1999, 94–98.) The fact that knowledge is affected by perception exposes a possibility for error in current beliefs and knowledge. Changing or reshaping knowledge requires justified and logical argumentation towards the current knowledge that is, the current perception of reality. Knowledge, as understood in this research, is logical and justified argumentation about reality, which in social sciences is rather accepted as truth than proved universally true or false, as is more characteristic of exact sciences (Kallio 2004, 39). Accordingly, in pursue of demystifying enterprise architecture the aforementioned three levels expose a seemingly endless amount of knowledge to be derived from the subject matter. On this account, the way the philosophical approach provides an enlightening view to the theoretical research process has been rewarding to discover.

2.2 Research Approach and Theoretical Research as a Method

The business research discipline is commonly thought to be more nomological and pragmatic than theoretical, emphasising and even favouring empirical research (see e.g. Kallio 2006a, 511; Habermas 1972, 310). Particularly in the Master's level, theoretical research is close to non-existent in practice and in methodology literature as well. Nevertheless, the role of theoretical research should not be underestimated as many fundamental and groundbreaking findings have been achieved through theoretical research. Development of empirical research and its practical applicability is in fact dependent on theory (Wacker 1998, 361).

The aim of this research addresses questions that require an inductive theoretical research and conceptual and theoretical reasoning with a fuller awareness of the interdisciplinary enterprise architecture domain. Therefore, the research approach is admittedly theoretical by nature. Theoretical research has been long seen to be mainly conceptual

research and there is a logical explanation why: theories in general are composed of concepts. However, while conceptual analysis is commonly an important part of research not all theoretical research can be counted as just conceptual research (Kallio 2004, 41–42).

The nature of enterprise architecture, its close relation to technology, and its relationship to the surrounding business environment and society makes it – as a concept – very broad, interdisciplinary, multifaceted, and complex. Enterprise architecture acts as an umbrella-concept for a number of other concepts it is constructed of. An analysis of concepts involved is needed for the construction of a theoretical model and an ideal holistic structure for enterprise architecture. An accurate conception through a generalizable theory is evident for the diffusion of this valuable understanding across disciplines. From the hermeneutic aspect, the research may be positioned on the deepest level of interpretation, which aims to reconstruct phenomena and create new theories for deeper understanding (Anttila 2005, 281).

Concepts are logical *abstractions* or generalisations that have been created to describe and explain phenomena in our reality (e.g. Berg 2004, 16–17; Uusitalo 2001, 38–39). In other words, when groups of things are found to have some important relation or interaction they are named with abstractions. Following the steps of medieval philosophers Fisher (2004, 217) calls these abstractions *universals*. In fact, when we consider business, organisational, and managerial research it is mostly research into abstractions and ideas – universals, which claim something of reality such as, strategic management, lean production, and supply chain management for example. The critical realist approach takes the stand that an underlying mechanism exists, different events shape the way we see and understand universals, and individual experience forms our perception of the subject matter described by the universal. (Hirsjärvi et al. 2009, 129–131, 161; Eriksson & Kovalainen 2008, 15, 19; Fisher 2004, 13–17, 219–221; Kallio 2004, 39.)

Concepts vary in scope as they describe phenomena of different extent. Some describe physical things and may have a clearer meaning however, the broader the concept is, the more abstract it becomes (Hirsjärvi et al. 2001, 136). Concepts enable abstract thinking and thus, are the foundation of meaningful communication (Kallio 2004, 36; Ghauri & Grønhaug 2002, 31–32). Consequently, theoretical descriptions and models are vital, not only for understanding, but also for the diffusion, development and application of complex ideas and concepts within a discipline. Accordingly, unclear or confusing concepts may even hinder the development of a research discipline, which argues for the importance of conceptual research (Kallio 2004, 37–38). Moreover, *terminology* is an important part of concepts; concepts are used to describe phenomena, concepts are named using abstractions, and abstractions are named with terms. Hence, the term used to describe the content and meaning of the concept affects the way the concept is understood.

Despite the multitude of topics within existing research, the uncertainty and confusion surrounding enterprise architecture in this case admittedly stems from the lack of basic research when understood as theorising research into the concept itself for its further establishment and understanding and ultimately better applicability in practice (Miller & Salkind 2002, 4–5). When researching a relatively new concept like enterprise architecture, the idea of basic research and including conceptual analysis in the research are well justified.

Theories and concepts cannot be experienced in the material world, but are thought to exist in the abstract level of reality (Popper's world III)[2] (Niiniluoto 2003, 23). Dubin (1969, 9–10) suggests that in behavioural sciences *theory* is a construction of the empirical system in our mind, which the scientist strives to bring as close to the empirical system as possible. Theory is usually defined as a set of concepts that describe or explain or even predict a phenomenon or its operation (e.g. Eriksson & Kovalainen 2008, 309; Berg 2004, 15–16; Fisher 2004, 109, 115; Uusitalo 2001, 19). Ghauri and Grønhaug's (2002, 33) interpretation of theory as "a system for ordering concepts in a way that produces understanding or insights" is pleasantly descriptive.

There is some variety in the wording used to define a theory regarding its purpose and context. For example, in a general sense theory can be thought to describe different aspects of some phenomenon whereas, in applied research, theory can describe the interrelation of for instance processes, patterns or events (Berg 2004, 15–16). Hence, reality is explained and simplified using universals and concepts, which when logically grouped together, explain the reality in the form of a model or theory. Accordingly, to increase clarity of the report the terms theory, model, and theoretical model are used as synonymous throughout this research. All theories produced by scientific research are published to face critique and questioning by the scientific research community. The knowledge or theory is considered to be truthful once it survives that questioning and critique and until otherwise proven. And in social sciences falsification generally means accepting contradicting knowledge or another contradicting theory as truth, which then substitutes the former knowledge (Kallio 2004, 39; Uusitalo 2001, 17).

Critical realism follows specific philosophical thinking, but does not assign to specific methods and allows the use of multi-methodological approaches in seek of richer research and enhanced analyses (Eriksson & Kovalainen 2008, 19). Even though normative and methodological guidelines for theoretical research are unbelievably scarce, scientific research ethics should not be compromised by underestimating their importance in discussion (Eriksson & Kovalainen 2008, 62–63; Kallio 2006a, 511; Ghauri & Grønhaug 2002, 18; Hirsjärvi et al. 2001, 28; Uusitalo 2001, 19). On the contrary, the

[2] See Popper's Ontology of three worlds in section 2.1 (p. 23).

researcher must consider his or her solutions much more closely when engaging in theoretical research or research that is in intense relation to theory (Eskola & Suoranta 1998, 30). In this context, expressing reflexivity and maintaining methodological transparency requires closer discussion of the knowledge creation process.

Traditionally scientific research has been based on the method of analysis, which is considered as the success factor for all scientific research (e.g. Uusitalo 2001, 23). A fundamental idea in understanding larger complex things is analysing or deconstructing them, that is, dividing them into smaller constituents. When examining those constituents separately they become more understandable. In addition to scientific research, also in everyday-life analysis is used as a basic weapon against complexity as generally any larger whole is easier to understand and manage when broken down into smaller parts. However, if analysis is only used to disintegrate phenomena an underlying risk of weakening the overall picture is elicited. Losing the overall picture can lead to fundamental misunderstandings and in some cases it may have serious consequences.

Today, the amount of scientific research has exploded and researchers in social sciences are concentrating on evermore-specific research subjects. Consequently, a risk of losing the overall picture within a complete research discipline exists. (Kallio 2004, 52; 2006b, 19; Uusitalo 2001, 23.) In addition to the lack of basic research, academic research on enterprise architecture suffers from fragmentation created by a micro-perspective in analysis common to the discipline. Moreover, as an immature concept embracing immense complexity and a number of various methods and tools for implementation, the concept of enterprise architecture is burdened by a similar phenomenon of fragmentation.

Synthesis in turn, is understood as an opposing process to analysis where an overall picture is reconstructed from many separated parts. The broadest and most typical form of research synthesis is a literature review, which often is an integral part of many other types of research. Another form of synthesis in social sciences is a qualitative research synthesis also called a research review or a systematic review[3]. (Cooper 2010, 6; Kallio 2004, 52; 2006b, 19, 22; Fink 2005.) Nevertheless, this research requires a less of a mainstream solution; a traditional type of literature review is not included as theoretical reasoning and inference are in principle based on a broad range of research and literature. However, a quantitative overview of collected material on enterprise architecture is presented. Therefore, doing a literature review is not in the objective of this research, but a review of enterprise architecture in research and literature is. The purpose of the

[3] The term meta-analysis is sometimes used as a synonym for the aforementioned however, in literature meta-analysis is defined as a quantitative synthesis for statistically combining numerical research results (Cooper 2010, 243–251; Kallio 2006b, 25–26).

synthesis is to question and derive understanding of the subject matter by evaluating characteristics, descriptions, interpretations, and purposes of enterprise architecture within the research material. In addition to knowing what research and literature holds of the subject the interest is rather to question current knowledge and understanding in the spirit of divergent inference. A synthesising approach is essential in understanding broad and complex phenomena as it seeks to create a holistic understanding of the overall picture by recombining and integrating the more specific understanding provided by analysis.

Exploring insights through conceptual analysis and interpreting enterprise architecture from the research material brings an interpretive and hermeneutic dimension to the research In addition, given the circumstances in which the research problem has begun as very unstructured and the way the open minded research process proceeded in an ongoing dialogue with the research material that is, followed the hermeneutic circle, striving for understanding and seeking to demystify enterprise architecture, one might even see close resemblance to *exploratory research*. (Laine 2010, 36; Anttila 2005, 280–282, 306; Ghauri & Grønhaug 2002, 48, 87.)

Analysis and synthesis are both processes where the researcher seeks to contribute to the body of knowledge by creating new knowledge with critical and logical, yet justified argumentation and by following principles of good research practice as agreed within the scientific community. Ultimately the research can be seen as inquiring into and evaluating interpretations and meanings as well as creating them through analysis and synthesis. In an iterative research process inductive and deductive reasoning take turns one after the other and it is not always clear where one stops and the other starts (Eriksson & Kovalainen 2008, 23). When the course of reasoning alternates between the more specific in relation to the whole and the whole regarding the more specific, the knowledge creation logic is abductive.

The *exploratory approach* of this research aims to take the inference of analysis and synthesis even further with theoretical abductive reasoning from purposes and causalities within the concept of holistic enterprise architecture and between the concept and its context to establish a meaningful ground towards theory. Abduction involves studying facts and reality and creating theory that explains them regardless of the direction and way of reasoning. According to Peirce[4], who greatly contributed to the development of the concept, abductive reasoning can be described as the logic of exploratory data analysis and a process that creates an explanatory hypothesis. The process hypothesis is based on the idea that formulating a theory requires the researcher to make observations

[4] Charles Sanders Peirce (1839-1914), a world-known American philosopher and pioneer in pragmatism (see Aaltola 2010, 16).

based on a guiding principle. The guiding principle can be an idea, a preliminary understanding or a vague intuition and it is thought to literally guide the theory formation by directing the research towards issues that are seen potential in creating new perceptions and ideas – new theory. Thus, the process is not blindly based on observations from previously collected data as according to the inductive logic. The exploratory nature of reasoning allows the guiding principle to be changed along the research process if necessary – Peirce argues that only this way can a meaningful theory be created. (Eriksson & Kovalainen 2008, 23, 302; Anttila 2005, 118–120, 465.) Abductive reasoning divides analysis into two by adding to the regular conscious and rational level the study of deeper mechanisms on an unconscious level (Anttila 2005, 385).

Another fundamental character of this research in addition to being theoretical and synthesising is *criticism*. Although, all research can be considered somewhat critical by the historical nature of science, there are features that distinguish a clearly critical interest in knowledge from other types **(**Eriksson & Kovalainen 2008, 262). Critical and reflexive approaches support the abductive research and knowledge creation process (Laine 2010, 34). Actually, criticism and reflexivity are intertwined and reinforce each other: On one hand, research literature describes criticism as twofold, paying attention to the research process and methodology as well as data and the research subject (e.g. Eriksson & Kovalainen 2008, 260–275; Anttila 2005, 385–394). On the other hand, reflexivity reveals the researcher's awareness of the methodological choices taken, factors that affect the knowledge creation process, and the way knowledge is created among other things, making it an important part of quality in a research. Self-reflection is directed by the researcher's emancipatory cognitive interest (Habermas 1972, 310). In fact, critical thinking facilitates reflexivity in a research by focusing attention on the research process in addition to the subject matter and opening both for discussion.

The critical approach is important in revealing possible gaps in previous research, exposing need for new knowledge, and for acquiring understanding of the subject matter, evaluating the various viewpoints it embraces, and solving possible problems (Eriksson & Kovalainen 2008, 260–263; Anttila 2005, 385). Critical questioning also facilitates creative and innovative ideas in the abductive research. Accordingly, innovative thinking should precede the processes of creating reasoning and forming solutions in a scientific manner. As there are no established ways for creating innovativeness in a research, adopting and applying divergent thinking is important in abundant knowledge creation (Uusitalo 2001, 22). In the case of enterprise architecture attention must be paid on questioning possible habitual thinking and interpretations within the enterprise architecture discipline and possibly other closely related disciplines, which participate in or affect the development of the concept and discipline of enterprise architecture. Critical questioning helps unveil potential controversies in common attitudes, understanding, and beliefs about the developing concept of enterprise architecture. Investigating possi-

ble controversies and misunderstandings of enterprise architecture represents the emancipatory interest of inquiry introduced by Habermas (1972, 310–311). Keeping in mind the general difficulty in understanding the holistic nature and main purpose of enterprise architecture and the various conceptions of the concept, conducting a theoretical research on literature, existing research, and industry practices is justified for elaborating the essence and current stage of development of enterprise architecture.

2.3 Overview of Enterprise Architecture Research and Literature

Due to the low maturity of enterprise architecture, and the discipline's practice-driven nature, collecting material from both, industry and academia was regarded as essential for achieving a comprehensive view of the state and nature of the concept. Accordingly, concentrating on either one would not have served the purpose of obtaining an adequate view and understanding of enterprise architecture. In this research the purpose was to collect, in addition to the material on all other relevant subjects surrounding the concept, a rich set of material on enterprise architecture in order to gain a comprehensive understanding of the young discipline. The data collection began by identifying various available materials that explicitly named enterprise architecture in the title or within content. The data on enterprise architecture was divided into four main types as categorised in figure 6.

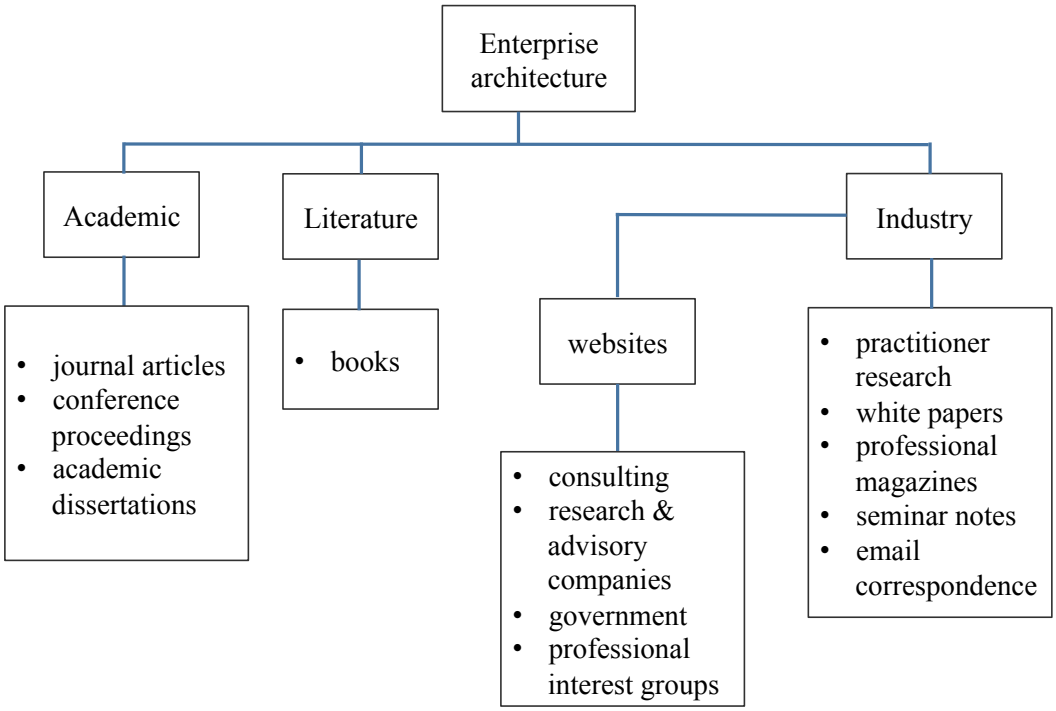

Figure 6 Data classification

The categorisation in figure 6 is approximate as a deeper review of the material reveals some overlapping. For example, industry practitioners naturally collaborate with academic research and many have written books as well. The collected research on enterprise architecture are either publicly available or in electronic databases that are available for students at the University of Turku and students at the Aalto university in Helsinki. These include for example, ABI/INFORM Global (ProQuest), ACM - Association for Computing Machinery, Business Source Complete (EBSCO), Emerald Journals (Emerald), IEEE/IEE Electronic Library, JSTOR, SAGE Publications, ScienceDirect, Springer LINK, and Wiley Online library. All material was collected between November 2011 and April 2014.

Altogether 217 articles and 10 books with exact or very close relevance to enterprise architecture were collected in order to get an understanding of the current state of research and the general perception of enterprise architecture within the discipline. All books were published between 2005 and 2012 of which seven explicitly address enterprise architecture instead of any one of its domains. Noteworthy is that almost one fourth of the articles and conference proceedings were published by The Institute of Electrical and Electronics Engineers (IEEE), also the developer of the ISO/IEC 42010:2007(E) IEEE Std 1471-2000 International standard for architectural description of software-intensive systems.

According to Robins (2004, 251–253), data used in research, in the field of strategic management is often less than ten years old. However, data used in the fields of organisation studies and economics is often from prior decades or even centuries. Figure 7 shows the amount of collected articles by publishing year, which clearly reflects the young discipline's development.

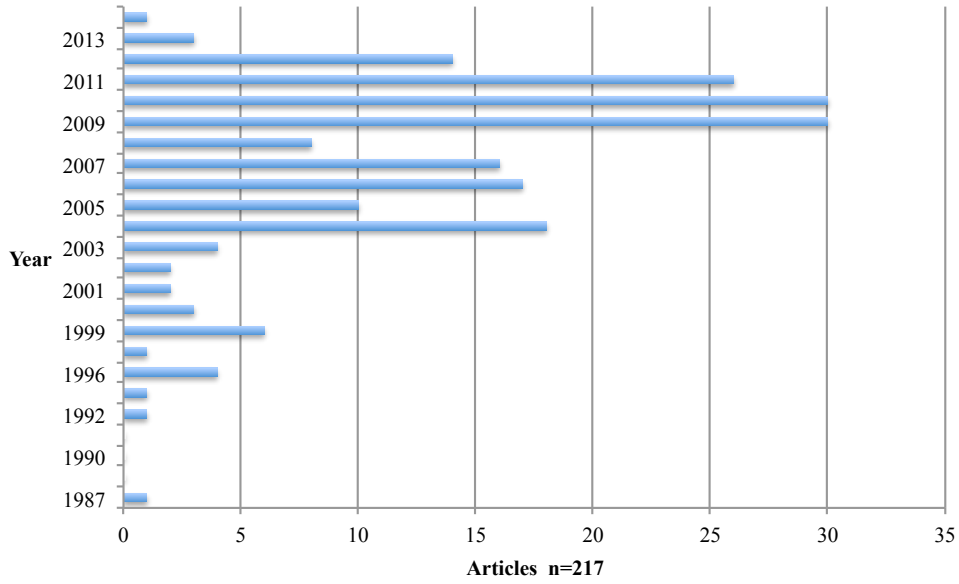

Figure 7 EA research articles by year of publication

Within the collected academic and professional articles on the subject of enterprise architecture, the first published article is *A framework for information systems architecture,* written by Zachman, published in 1987. As discussed, this article is commonly considered as the inception of the concept and discipline of enterprise architecture. Later in 1992, the article *Extending and formalizing the framework for information systems architecture* by Sowa and Zachman (1992) was published. In this article the Information Systems Architecture (ISA) framework or taxonomy was extended to include more views of the architected system. Notable is that only 15 (including the two aforementioned articles) of the collected 217 articles regarding enterprise architecture were published before the turn of the millennium and were all published in professional IT publications such as, IBM Systems Journal and IT Professional Magazine by IEEE.

Research in this young discipline is mainly conducted after the 1990s and a majority of the research on enterprise architecture have been published after 2004 when academic research, conference proceedings, and practitioner research on the respective subject boomed. Practitioner research included active industry actors and global consulting and advisory companies such as, Infosys and Gartner. A majority of the collected articles were published between 2009 and 2012. Regarding conceptual and practical development, enterprise architecture is clearly a practice-driven discipline however, research on enterprise architecture is dominated by academic research and conference proceedings as shown in figure 8 below.

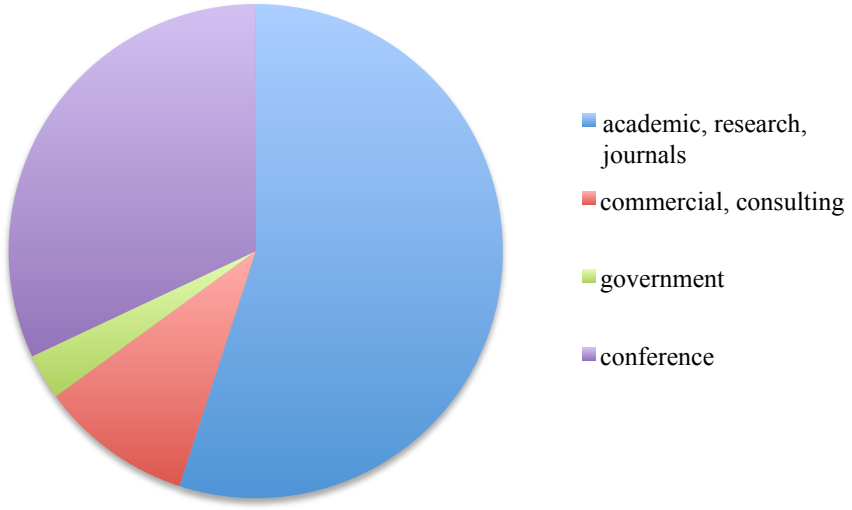

Figure 8 EA articles by type

The inference of the discipline being practice-driven goes beyond research publication; academic research seems to be dominated by implementation-oriented research and further development of phenomena originally arising from practice. This is the main reason why despite of the large amount of research, the concept's main constitution,

definition, and focus is not commonly agreed upon. The fact that enterprise architecture discipline suffers from a lack of theoretical basic research strongly suggests that the role of academic research in researching the theory and basic elements of the concept itself is minor.

This is where the importance of synthesising research comes to front. Naturally implementation in practice varies and is case-specific. A variety of tools, frameworks, and methods from different aspects have been created to fit in different enterprises and different situations related to enterprise architecture. The richness of implementation aspects, together with the relatively low maturity-level of the concept, results in current literature providing a very fragmented picture of enterprise architecture. If academic research continuously conducts analysis, following phenomena within the industry and without conducting basic research, the result may very well be a fragmented discipline of science that fails in providing a coherent commonly agreed definition and composition for the concept of enterprise architecture. Thus, all forms of synthesising research are needed to guide further and future research by providing an overall picture of the field.

The collected research material were also categorised by country representation (figure 9). This means that whenever one or more countries were explicitly named for the respective authors they were listed thus, the total amount of country representation is greater than the amount of articles.

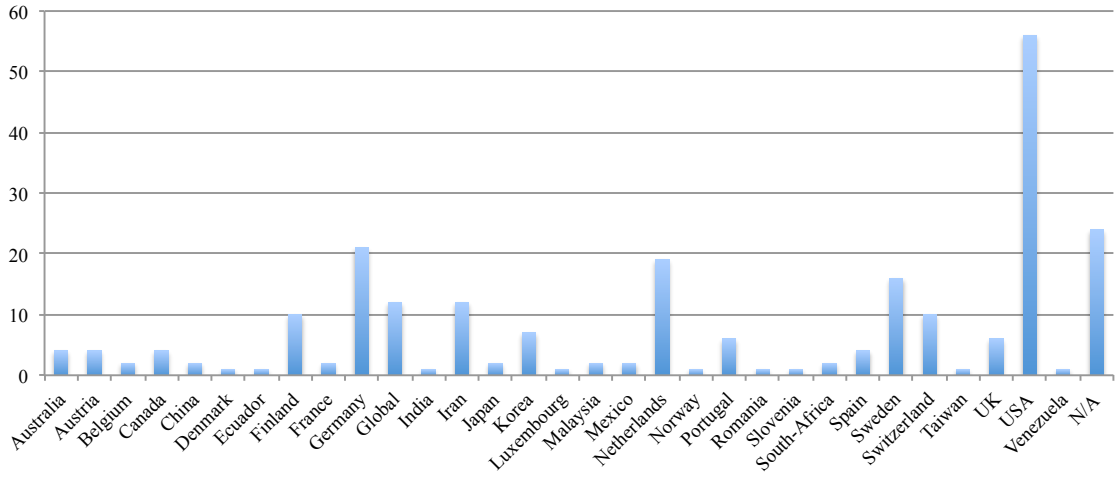

Figure 9 Country representation in enterprise architecture publications

24 articles did not name any country for the author or associated university. The *global* category represents 12 research articles conducted and published by global consulting, research, and advisory companies. Until 2002 research was mainly published in the United States and in 2003 onwards began to decentralize geographically. A great

deal of the articles represents the United States, Germany, India, Sweden, and the Netherlands.

Basically, the logic of architecture can be applied to any single entity. Accordingly, it is as applicable to a function or to a single project, as it is to a whole organization. This being the case, it is important to emphasise that there is a difference between enterprise architecture and any other architecture. Research on enterprise architecture has been conducted from numerous perspectives (figure 10).

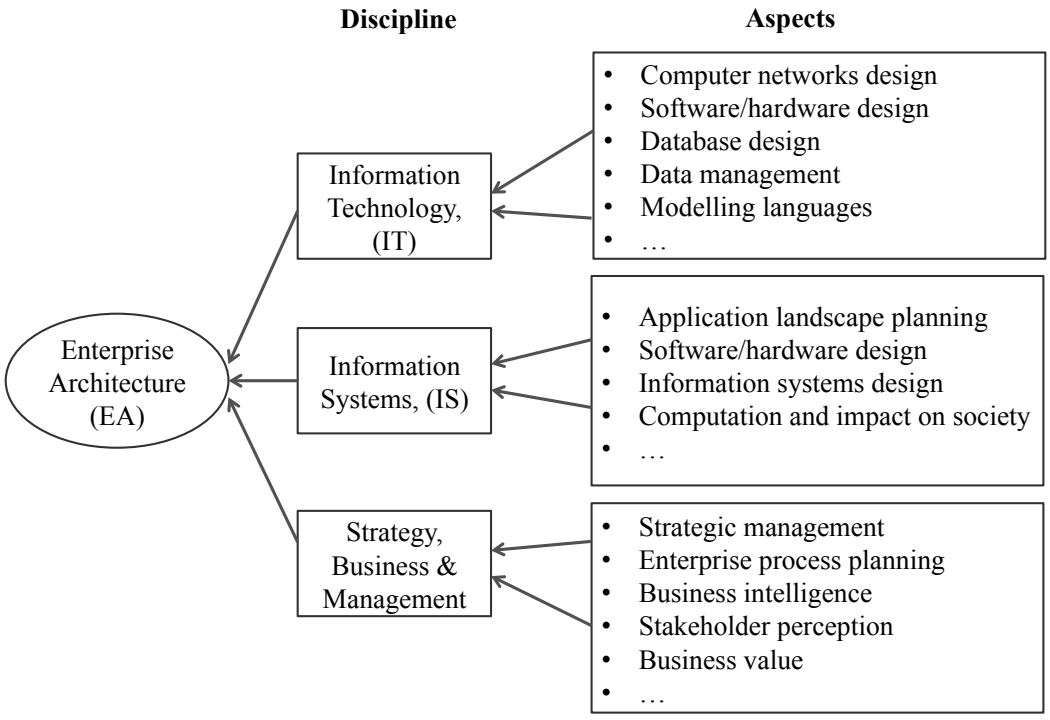

Figure 10 Common research aspects on enterprise architecture

As figure 10 illustrates, research on enterprise architecture can be roughly divided into the viewpoints of three disciplines: information technology (IT), information systems (IS), and business and strategic management. Commonly, researchers conduct research from various aspects within their respective discipline. IT and IS disciplines clearly dominate the research landscape however, following the trend in recent enterprise architecture development, research regarding the business perspective of enterprise architecture is increasing. The vitality of IT and IS in today's business landscape inevitably shapes the structures and management approaches of businesses regardless of industry or field. Therefore, it is important that strategically managing IT intensive organisations gain both, interest and a growing foothold in research. Developing an appropriate and sustainable management approach requires understanding the fundamental nature of this change and on that account, the organisation within its environment in the information age.

2.4 Quality and Trustworthiness of the Research

Unlike for quantitative and qualitative research, methodology literature does not explicitly present criteria for evaluating quality or trustworthiness of theoretical research. Some theoretical research merely state this fact and hold from further discussion. As a matter of fact, also trustworthiness is a concept mostly used in evaluating qualitative research (e.g. Eriksson & Kovalainen 2008, 290). Nevertheless, theoretical research can and should be evaluated. The concept of trustworthiness cannot be directly applied to theoretical research as such. However, the trustworthiness of a theoretical research process can be evaluated in general, by evaluating how the research material is collected, analysed, and reported. In this research source criticism is considered important and thus, all material is collected only from sources that could be evaluated as reliable and of high quality such as, academic research journals, conference proceedings, and global companies' and other well-known industry actors' research and publications. The broad material was collected objectively by following the subjects and topics addressed in the research.

While studying the evolution of enterprise architecture also data from Google was used. Google can arguably present current and global trends as Google's search engine is a long-time market leader with a global desktop search engine market share of 74 per cent and a global mobile and tablet search engine market share of 88.95 per cent during the last year that is, from April 2013 to April 2014 (Desktop Search Engine Market Share 2014; Mobile/Tablet Search Engine Market Share 2014). Another positive credibility factor for Google Trends results is that they are user-generated data and thus, genuinely represent a public interest, which is one of the most important types of data in the information age.

To maximise the quality and trustworthiness of this research, great attention is directed into creating transparency to the research- and knowledge creation processes, but also to the justification of reasoning and argumentation throughout the research report. The research material is critically questioned and analysed and inference justified by openly and carefully grounding arguments that altogether build a response to the research questions. In addition to criticism, reflexivity is a feature that not only creates quality, but also communicates it. Reflexivity is sought by constantly being aware of and profoundly discussing the research methodology as well as the researcher's role and consistency of the research process.

The research questions have been formed based on the discovered research gap and extremely current problem statement to guide the research process and pursue of broad and ambitious research objectives. The research subject is extremely timely and regarding the research gap and problem statement, the research itself is highly significant. For the importance of perception and interpretation, the overall quality and transparency are

emphasised with deep and well-grounded reasoning. Hence, thorough discussion of topics surrounding and supporting the core message is considered important and reasonable. To avoid misinterpretation, concepts are carefully explained before placed into context.

As methods for theoretical research are in general vague, the methodology discussion in this research opens the research process by discussing the philosophical considerations in more detail. Because the knowledge creation is mainly based on theoretical reasoning and inference, opening the philosophical assumptions for further discussion reveals many guidelines that support the overall knowledge creation- and research process. That said, both objective and non-objective factors alternately affect the research process; it is acknowledged that the researcher's role, prior knowledge, personality, experience and relationship to the research subject cannot be ignored, but rather are a part of observations, new idea generation, and ultimately knowledge creation. (e.g. Hirsjärvi et al. 2009, 129–131, 161; Eriksson & Kovalainen 2008, 15, 19; Fisher 2004, 13–17, 219–221; Kallio 2004, 39.) Thus, in order to create proper scientific theoretical research, the researcher must rely on creating transparency to the research process by explicating the philosophical assumptions and the methodological process, while making logical and justified arguments. In order to stay logical and well grounded, interpretations and inference must be carefully made, yet the researcher should keep an open mind and not restrain creative ideas.

The structure of the research report is considered consistent; In order to create grounds for the need and purpose of enterprise architecture and thus, also for the timeliness and need of this research, the research begins by describing and analysing the information age and society as the organisation's business environment, on which the organisation's existence is based. Then the development and current state of enterprise architecture is introduced and analysed. An analysis of the concept's terminology is included. As a synthesis of these analyses the main composition and core logic are inferred based on the discovered need, purpose, context, and nature of the concept.

Although, inductive research always represents the researcher's view and cannot be technically proven as valid, the researcher's role in knowledge creation and inference is highly important for new discoveries. The overall reliability of inference and dependence to the research material can be expressed by proper and open reporting – a central feature pursued in this research.

3 ORGANISATIONS IN THE INFORMATION AGE

Chapter three discusses the information age as the business environment in constant flux, the increasing dependence on new technologies, current challenges that modern organisations face, and organisational features for responding to the growing turbulence. Right exploitation of the idea and practice of enterprise architecture targets to respond to the external challenges in the information age and brings a potential for the organisation to transform itself closer towards an intelligent learning organisation. The view of the organisation embedded in its information intensive environment, as discussed in this chapter, altogether build a theoretical foundation for conceptualising the core logic, purpose, and mind-set of holistic enterprise architecture and are therefore important to bring to the front in this research, before analysing enterprise architecture itself.

3.1 The Information Society

Information and communication exist in every society, but since the new technological paradigm began to form around fifty years ago, their dynamics have changed, which led to a new information economy (Castells 2000a, 39–50, 53–54). Technological development has enabled data capturing, data processing, information management, and knowledge diffusion on a completely new level. The effects have blended into our society; information has become a product and a critical asset for organisations in the information age, when economic wealth and competitive advantage are generated from creating, exploiting, and distributing information and knowledge (e.g. Roberts 2009, 285).

Kelly (1998, 1–3) wrote in the late 1990s that we are ongoing a change from the industrialized economy towards a new economy based more on intangible attributes – information, innovation, knowledge, communication, networks, and relationships. This change is still ongoing. Documentation is vastly digitized and communication conveyed to email, instant messaging, chats, blogs, forums, and social media – bits and bytes on the World Wide Web. Both organizations and individuals have to adapt to the evolving environment. While operations have only become wider, businesses can be characterized by their drive to overcome limits of time and space.

Digitalization is one of the key factors in driving enterprises' evolution as illustrated in figure 11. The blue upward line represents the volume, speed, and continuous increase in enterprises' data, information, and communication on the way from paper-based processes to modern IT-based solutions in a network society. The rough time

scale emphasizes the fairly short time during which the adaptation and development of enterprises have taken place. (Enterprise Information Management 2011.)

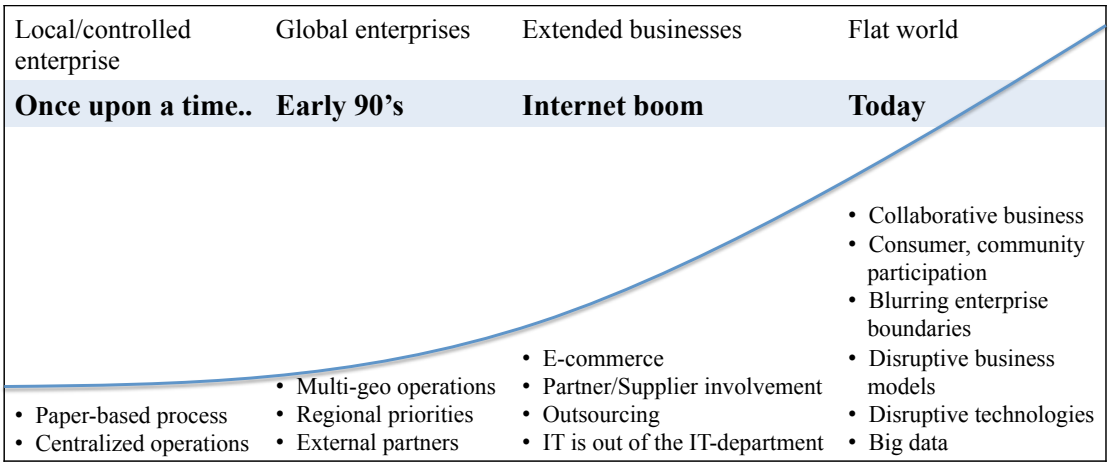

Figure 11 Enterprise evolution (adapted from Enterprise Information Management 2011)

The mass of intangibility has made today's information globally available, dispersed, and often uncontrolled. In terms of information dynamics, today's world is flat – information moves instantly without boundaries and is mobile. (e.g. Enterprise Information Management 2011; Hatch 1997, 24.) Castells (2000a, 101) argues that the world economy became truly global only after information and communication technologies (ICT) and governments' and international institutions' deregulation enabled the global environment. Castells has made a noteworthy distinction between the world economy and the global economy: "A world economy – that is, an economy in which capital accumulation proceeds throughout the world – has existed in the West at least since the sixteenth century. A global economy is something different: it is an economy with the capacity to work as a unit in real time, or chosen time, on a planetary scale."

The essence of the new information economy is threefold: It is global, it favours intangible things, and its interrelations are intense (Kelly 1998, 2). Kelly's notion contains similarities with Castells' (2000a, 77–78) distinction of the new economy as informational, global, and networked and the idea of an interrelated network society as the social structure of the global economy in the information age. With the social structure of a society he refers to the organisational arrangements of humans, their interaction, and the interplay between their relationships and experiences of production, consumption, and power. Castells' further view is that, as old forms of organisation, networks are now able to cope with focused decision-making and flexible decentralisation as they are empowered by new ICT of the current technological paradigm. (Castells 2000a; 2000b.) However, as sophisticated as the current technological solutions may be, adopting them into everyday practice is a true challenge and there is still much to be developed in this

world. Additionally, webs, as clusters of companies collaborating around a certain technology, have been proposed to be the new strategy of the information age (Webs - a new strategy for the information age? 1997, 121–122).

The information economy, being the organisations' operating environment, brings a vast amount of new possibilities, but also sets ground for new challenges. Businesses build strategies based on intangible assets, which affects the overall form of operation, strategy, execution, and management (Earl 1999). Organisational values have shifted from efficiency, standardisation, and control to customer service, quality, diversity, and innovation (Hatch 1997, 25). In each era, organisations' performance and thus, economic growth, are tied to certain economic drivers characteristic to the society that constitutes the environment the organisations operate in. Changes in the dynamics of the operating environment often result in changes in these drivers. (e.g. Murray & Sekella 2007, 91; Alberts & Papp 1997, iii–iv; Barayre, Calovski, Fondeur Gil, González Sanz, Guigue, Indjikian, Korka, Pérez Cusó & Teltscher 2007, xxiii.)

Recognising the right drivers and being able to harness them into the organisation's operation can be surprisingly challenging. Some enterprises adapt well to changes by quickly adopting new ways of thinking and operating and by being able to connect their business with the right drivers. Then again, some organisations might not even realise the change before it is too late. Glazer (1991, 1-2) examined several business cases and pointed out the important connection between IT, information management, business strategy, and competitive advantage over 20 years ago: "In all cases, the organization first put in place an information technology infrastructure and then went beyond the technology to view the management of "information" itself as an asset to gain competitive advantage."

The new era is described in literature with a variety of terms such as, the information society, informationalism, information age, information economy, information revolution, knowledge revolution, knowledge economy, information technology revolution, digital age, and post-industrial society (e.g. Castells 2000a; Edmunds & Morris 2000; Glazer 1991; Kelly 1998; Tuemmler 2004.) The European Union interprets information society as synonymous to the meaning of new information and communication technologies (ICT) and has placed it in the core of its 21st century strategy (Information Society 2012). Gane's (2006, 21) interpretation of the new era aptly describes today's life: "The information age is, above all, about instant living. It is about the intervention of ever-faster technologies into all spheres of 'human' life… …It is also perhaps about the speed-up of social and cultural transformation in general."

Literature presents discussion over the accuracy of the terms used to describe the phenomenon of our present time as it differs from the previous paradigm – the industrial age. Many definitions of the new era identify separate sociological perceptions. Terms used in literature are chosen according to that perception, other relevant disciplines,

scope, and the author's viewpoint. Nevertheless, they all recognise the notion of fostering information, developing technology, innovation, and knowledge diffusion.

Also different perceptions of the way the new era has evolved exist in literature. Arguments state for example that both, technological and informational revolutions have already occurred with industrialisation and with the invention of telegraph, telephone, and radio (e.g. Castells 2000a, 28–76; Shapiro & Varian 1999, 1–9). Pemberton (1995, 54) suggests that we entered the information economy in the 1920s, ever since the rise of modern management. According to Drucker (1993, 19–20) three revolutions have taken place with regard to the role of knowledge. At first, knowledge was applied to making and moving things, which resulted in the industrial revolution. Along with Taylor's[5] scientific management, knowledge was applied to the work process, which in turn created a productivity revolution. Then, knowledge continued to become increasingly central in operation and soon the main factor of production; knowledge was applied to knowledge itself i.e. knowledge used for making knowledge more productive. Drucker describes this as the management revolution.

If in the 1990s these changes had created a knowledge economy that Drucker did not yet dare to call a knowledge society, at the time of this research, in 2014, one might arguably consider that a knowledge society is present. According to Castells (2000a, 39–50, 53–54) the information technology revolution that formed the core of the twentieth century resulted from the invention of the transistor and the first programmable computer. Whereas, the diffusion of information technologies that converged into a new paradigm was enabled by the invention of the microprocessor later in 1971. Moreover, Bawden and Weller (2005, 778–779) suggest that the origins of the information society reach as far as the nineteenth century industrial revolution, referring to a crisis of communication triggered by the invention of telegraph, telephone, and the transformation of transportation and delivery of postal mail through the development of railways. Transportation is indeed an important element of societal development, as it has allowed for the greater dispersion of goods, individuals, and habitat. However, in the discussion of development, inventions, innovations, and revolutions there is a difference between discovering new ways of utilising existing means and technologies and discovering completely new things that are based on new technology. Both schemes of development are essential and noteworthy. Yet, within long-term development, discovering new technologies that enable things previously unachievable is crucial.

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[5] Frederick Winslow Taylor was an American mechanical engineer and the originator of the scientific management movement. He is best known by his works *The Principles of Scientific Management* and *Shop Management* published in 1911 (www.nytimes.com/learning/general/onthisday/bday/0320.html).

The history and development of technology, IT, and ICT are often divided into stages, phases, or waves (Brock & Schwarz 1998, 65–69.) Bell, widely considered as the most influential sociologist of the twentieth century and the originator of the concept of the information society, makes a logical distinction between changes in the character of technology. He emphasizes three historical distinctions of technology from industrial to post-industrial society:

- mechanical technology (machines)
- electrical technology (wired and wireless communication)
- intellectual technology (programming, linguistics, and algorithms)

According to Bell technology provides potentialities and instrumentalities, but does not determine social change. Hence, he believes that technology and technique are the underlying drivers of the development of our society, as they have enabled the increased productivity that services depend on. He argues that the emergence of a service economy brought us to the information society, because information has become an essential part of service work. Information is what matters, not raw power or energy. Therefore, the post-industrial society is also an information society. (Bell 1973, xxxvii–xxxviii; Webster 2005, 441–443; Waters 1996.) In accord with Bell, Shapiro and Varian (1999, 1–2, 8–9) state that the information economy and its breathless pace of change are driven by advancements in IT and technological infrastructure. Today's economy is indeed different from that of a century ago because technology has changed the way information can be created, accessed, produced, shared, and utilised. Although many things that were previously challenging can now be done with ease and completely new things have been invented, the fundamental economic laws remain unchanged.

Information technology has a significant role in organisational development as well; while IT is increasing its importance in business execution, IT managers are gradually drawn to the strategic field. As internet used to be a communication media that has evolved into a business platform, similarly, IT used to be a means for enterprises to reduce costs and improve efficiency. But thereafter, IT has become a key driver in the information economy, that is, a valuable strategic asset for organisations with the potential to create added value and competitive advantage (Ruest & Ruest 2006; Hugoson, Magoulas & Pessi 2011, 53; Wieringa, Blanken, Fokkinga & Grefen 2003). The leverage of IT in business and organisational value creation lies in effective utilisation and diffusion of information and knowledge. Consequently, to reach that advantage, it is important for organisations to focus on aligning their strategic business processes with well designed IT systems. Various strategies and processes from different aspects have been developed however, many still seem to address only a certain section or part of an organisation or its processes instead of the complete enterprise as a whole to activate the entirety with its resources, vision, and means to achieve its main objectives – the organisation as a system within its environment.

3.2 The Organisation within its Environment

Organisation theorists take multiple perspectives in their view of the organisation. Ultimately, any chosen perspective is in a way inadequate as focusing attention on some aspects always ignores others and thus, prevents one from gaining a total holistic understanding. As Hatch (1997, 7) admits, this phenomenon of multiple perspectives results from the complexity of the organisation that is, the challenge of sensing or addressing the magnitude of things within the abstract concept. For this reason, theorising concepts without embracing a certain perspective and excluding excess attributes would be incomprehensible, which is the very reason for the use of simplification in models, concepts, and theories. Hence, at this point a conceptual model of the organisation is to the purpose.

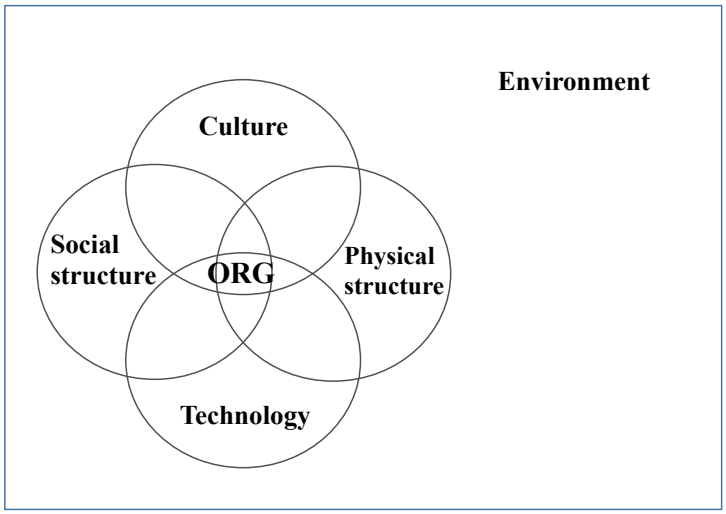

Figure 12 A conceptual model of an organisation (adapted from Hatch 1997, 15)

Figure 12 above, illuminates how organisation theories attempt to explain the organisation through multiple perspectives such as, a part of an environment, a technology, a social structure, a physical structure, a culture, and as strategic human actions. The perspectives are not substitutable with one another, but describe the organisation from a particular aspect and all of the perspectives interrelate in various ways and cover overlapping interests. Studying organisations as a part of their environment focuses on characteristics like global competition, fragmentation of markets, consumer choice and demand, and international decentralisation of capital and production. The technological aspect addresses for example, manufacturing, production, automation, information-, and IT systems. Seeing the organisation as a social structure emphasises organisational forms (e.g. strategic alliances, networks, and virtual organisations), vertical and horizontal hierarchies, social influences, and norms. Organisational values and traditions are examples of the cultural aspect whereas; logistics, transportation, product life cycles,

and physical concentration of people are examples of the physical structure viewpoint, which focuses on aspects of space and time. (Harisalo 2008, 7–12; Hatch 1997, 24–26.)

A textbook-like explanation of organisation theories is not in the purpose of this thesis however, it is a fair belief that in order to understand the current and the coming, it is necessary to know the past and because organisation theories attempt to explain the organisation, an outline of the theories provides a starting point for further understanding, discussion, and divergent thinking. For a clarified view of their development, organisation theories can be categorised according to their central idea and sphere within each phase of time. Although many of the theories have evolved simultaneously, these categories may be placed in the following chronological order (Harisalo 2008, 37–40):

- *Scientific management* – focus on material motivational factors and is considered as the first attempt to theorise an organisation.
- *Classical theory* – focus on performance and efficiency.
- *Human relations* – a more humanistic view, which opposed scientific management and focused on social relationships and norms as sources of motivation.
- *Structuralism* – or theory of bureaucracy focused on organisations as rational systems with power and authority.
- *Systems theory* – a revolutionary aspect of systems with their various interrelations brought a completely new level of understanding.
- *Theory of power* – focus on possession and use of power and authority in organisations.
- *Contingency theory* – relationship with and influence of the organisation's environment.
- *Strategic management* – strategic versus operative thinking, introduced strategic planning and predicting.
- *Organisational culture* – visible structures, norms, and processes are external effects and reflections of the underlying culture and deeper unconscious level.
- *Theory of innovation* – focus on organisational change and development and the organisation's desire (or lack of) to renew itself.

Organisation theories have been developed over time, in parallel with changing paradigms, and by respective influencers. Today, a number of organisation theories exist however, unlike in the enterprise architecture discipline, the multitude of theories is not a weakness for the discipline. The various viewpoints complement each other and all contribute to the whole creating a richness and strength for the discipline. The theoretical viewpoints are still very relevant and in the viewpoint of this research especially that of the systems theory.

The general systems theory (GST), introduced by von Bertalanffy[6] in 1950, has a history of benefiting scientific research and the field of science in general (Pouvreau 2006, 6). As mentioned, systems theory has provided an enlightening view to the structural and functional commonalities between and within phenomena. Systems thinking is a powerful tool for making knowledge wider and more intelligible (Sutherland 1974, 592). Applying systems thinking into different fields of science once widened general understanding and opened the mind to interdisciplinary discourse and the generic dimension of knowledge. Accordingly, instead of a theory, the general systems theory has been referred to as a new epistemology. The roots of systems thinking are in the general systems theory, juxtaposing reductionist analysis and atomization of science – a stand that may be recognised in certain parts of this research as well. (Sutherland 1974, 592; Ludwig von Bertalanffy (1901–1972).)

The purpose of this research requires the previously mentioned enlightened view to understand enterprise architecture's composition, purpose, and criticality from an organisational and business point of view. Explaining and justifying enterprise architecture as a critical business issue is vitally important and requires discussing the interrelations within and between the elements of enterprise architecture and other concepts that are used to give grounds for the holistic enterprise architecture. Thus, also this research benefits greatly from systems thinking.

A common definition of a *system* describes it as a unit or collection of components that share a cause together for accomplishing a specific goal, function or set of functions, and that have some interrelationships or interdependencies that differentiate them from other components external to the system (e.g. International standard ISO/IEC 42010:2007, 3; Hatch 1997, 34–35; Senge et al. 1994, 90). A logical view of the world is that of a large system containing several components that make the system's internal structure. Traditionally, research on organisations has concentrated much on the organisation itself – the internal structure, which was thought to embrace the key factors for the organisation's success – these key factors just needed to be found. And only in the latter half of the twentieth century, after Bertalanffy's general systems theory, arose the question of how the environment affects the organisation. (Harisalo 2008, 215.)

Systems thinking is important for business and management research, because business enterprises and organisations are systems in the global economy, which – as their environment – can be seen as a complex system of systems. In general, a system of systems is the organisation of a set of separate complex systems, related to themselves as

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[6] Ludwig von Bertalanffy (1901–1972) was an Austrian biologist who introduced the General Systems Theory (GST) and is considered as an important contributor in the intellectual history of the 20th century (http://www.isss.org/lumLVB.htm).

well as the environment they are embedded in (Karcanias & Hessami 2011, 28–29; Hatch 1997, 39). The modernist approach describes organisations as open systems embedded in and experiencing close dependence with their environment (Dervitsiotis 2012, 998; Hatch 1997, 34–38). Figure 13 depicts the concept of an organisation as an open system.

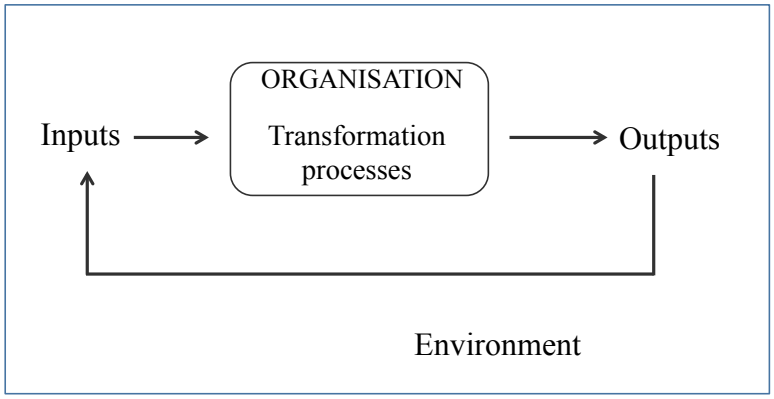

Figure 13 Open system view of an organisation (adapted from Hatch 1997, 38)

The concept of open systems was originally ideated and introduced by Bertalanffy in his work in biology where he defined open systems as "…systems that maintain their dynamic existence by continuously exchanging matter and energy with their environment (The nature of systems 2014). Thus, on one hand, organisations rely on their environment for resources as inputs and justification for their continued existence and on the other hand, they contribute to the construction of their environment by transforming those inputs to outputs that is, producing products or services (Choo 2002, 8; Hatch 1997, 34–38).

This illustration of a systems-view of an organisation might seem ridiculously simple at first, but it is the very idea that created the understanding of dynamic interactions between parts within a system from both, human and technological aspects i.e. systemic knowledge (Sheffield, Sankaran & Haslett 2012, 128). From the information age perspective (figure 14) today's organisations are open systems that maintain their dynamic existence by continuously exchanging data and information with their environment.

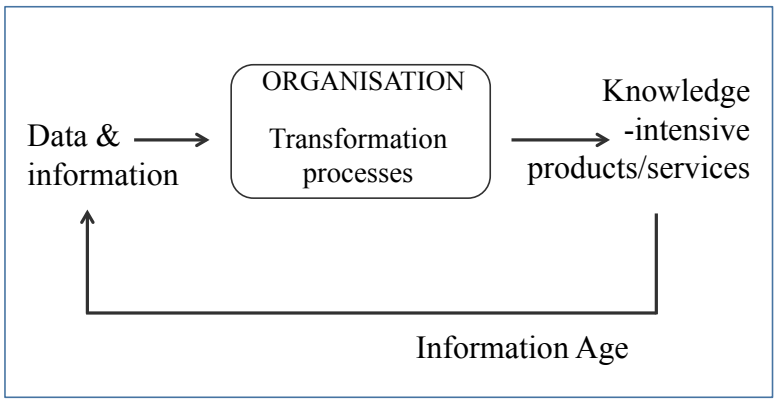

Figure 14 Open organisation in the information age

Organisations acquire and consume data from their environment, transform these data into knowledge and create products and services based on or constructed of information and knowledge. Naturally in a broader sense organisations exchange also energy, products, services, and other resources. As discussed, being able to collect and utilise accurate and timely data is vital.

The importance of the environment's effect on organisations became fully established by the time of the development of contingency theory in the 1970s. Today, we only need to worry about not forgetting what was discovered in the previous century. To increase competitiveness and to be successful, organisations should organise their structure and align their internal capabilities with the demands and constraints of the environment. That is, the central idea in the generic field of organisational development (Harisalo 2008, 215–217; Kock 1999, 3). However, adjusting organisational structure according to the environment is not simple.

Early studies of organisational adaptation found that organisations that operated in more static environments had a more hierarchical and mechanic structure that emphasised rules and control. Conversely, organisations that operated in more volatile environments were more flexible because they embraced organic structures with decentralised decision-making. (Choo 2002, 3.) The horizontal structure helped coping with the changing environment, but brought along internal differentiation, which resulted in greater complexity. Today, internal organisational challenges arise from among others, ever-greater complexity, the growing colossal size of organisations, and disintegration of units resulting in business silos. Organisational challenges created by external factors, arise from uncertainty that stems from increasing complexity and accelerating rate of change – identical to those that burdened the minds of the early modernist thinkers. (Alberts & Papp 1997, iii; Hatch 1997, 88–91.)

3.3 Challenges for Organisations

The information age presents a variety of external demands to which organisations have to respond. This section discusses four main challenges that are considered to be the most central within the current business environment namely, accelerating rate and pace of change that creates a turbulent environment, extensive and increasing complexity, and information intensity created by an increasing need of and dependence on knowledge. Altogether, these constantly challenge successful strategy execution.

3.3.1 Accelerating Pace of Change

Literature and research repeat that change is the only constant in today's business environment and technological development has been the main driver in this change (e.g. Castells 2000a, 28–76; Shapiro & Varian 1999, 8). The rapid pace of technological development has indeed widely affected and continues to affect the society and economy. The information age, as described in section 2.1, not only transforms organisations' business environment, but affects their operating models and thus, also changes the organisations.

From the business organisations' point of view the accelerating pace of change creates a great challenge. Organisations' adaptation to changes in the economic and technological environments is already challenging. The post-industrial society's empowerment of consumer demand has increased organisations' need for greater responsiveness and submitting to external pressure, as opposed to authority (e.g. Hatch 1997, 25). When change is rapid and constant, in order to stay viable, organisations need to be capable of reinventing themselves over and over again following a similar pace. Managers cannot base decision-making and organisational development on intuition and business instinct, because it is not efficient enough and most importantly the schedule of the information age and knowledge economy simply does not have time for a trial-and-error way of working. Although intuition is often a good thing, a need for new concepts and methods for processing and utilising all the available information has emerged. Organisations need a viable approach, such as enterprise architecture, for getting a grip of the constant change.

The surrounding volatility creates a growing need for agility and flexibility, which have gained increasing priority in research on retaining competitive advantage in the dynamic environment (e.g. Ross et al. 2006, 12; Hatch 1997, 23). For any organisation to be agile and flexible, being well aware of one's own structure and internal capabilities is critical. Additionally, constant awareness of the environment and ability to intelligently navigate among variable external demands and constraints has become the price

of survival. (Choo 2002, 2–12; Sterman 2000, 3–4; Castells 2000a, 164–165, 176; Hatch 1997, 53–54, 63.)

Thirty years ago, when organisations were facing the transition from industrial society to post-industrial society, Huber (1984, 929) reminded that based on contingency theory and systems theory and respective research, it could be inferred that in general an organisation's goal is to survive and in order for an organisation to survive, it must be aligned with its environment. When an organisation is well aligned with its environment it has a greater possibility of surviving when compared to the ones being misaligned. Furthermore, when the environment changes and misalignment occurs, the organisation has four options for action (Huber 1984, 933):

1. adapt to the changed external demands
2. move to a different environment
3. change the environment to a more compatible state
4. rely on slack (i.e. not react)

Regarding the characteristics of the information age the inference is that choices number two and three are inapplicable and number four will most likely lead to undesirable consequences according to the general goal of an organisation's existence. Hence, organisations need to change with respect to their environment and managers are responsible for leading their organisations through challenges while successfully positioning them within change. Based on the advancements brought by the creation of systems theory and the development of contingency theory in the twentieth century this inference should not be surprising in 2014. Still, these previous advancements do not make practice in today's reality any easier. They only contribute to the body of knowledge and the benefit of gaining knowledge (i.e. learning from previous experiences) is that it eliminates the need of reinventing the wheel over and over again – it enables development and improvement. This brings to mind the words of Shapiro and Varian (1999, 2) noting in their Business Week bestseller "Technology changes. Economic laws do not." Considering the nature of the demanding changes of the twentieth century, reported by Huber (1984) among others, it can be noted that those changes in our history are qualitatively much less different than they are quantitatively when compared to our current transition phase to the described knowledge intensive information age. Organisations in the post-industrial era were fighting against knowledge explosion, increasing complexity, and increasing turbulence (Huber 1984, 931–933).

3.3.2 Increasing Complexity

Complexity in a system is often thought to arise merely from a rigorous amount of components within the system (see Dervitsiotis 2012). *Complex systems* in turn, are

defined as systems with many elements and actors, that contain subsystems, are not dividable into smaller units, and which interact in intense connected networks (Espinosa & Porter 2011, 56). When the amount of components in a system increases it creates *combinatorial complexity* or *detail complexity*, resulting from the increased possibility of different combinations, dependencies, and detail. However, a simple system (with low detail complexity) can also be complex. A simple system can create high *dynamic complexity* when its interrelations are considered over time.

In the modern world, complexity is often so tremendous that it is incomprehensible for the human mind. Thus, applying advanced technologies is an effective means for dealing with complexity. Natural and human systems often have high dynamic complexity however, dealing with variables in a state of change is not straightforward in systems where cause and effect are non-linear. (Combe & Botschen 2004, 501–502; Sterman 2000, 21.) This means that when the system includes subjective actors (people) that are affected by perception, personality, and beliefs obvious interventions may have obscure consequences. Cybernetics is a field that originally studied the human brain and neural networks, but its theoretical fundamentals have been applied to the organisational context where it investigates how organisations as complex systems organise themselves by regulation, evolving, and learning. Cybernetics has then been referred to as the theory of complexity and as the science of effective organisation. (Espinosa & Porter 2011, 56.)

The intensely interlinked environment gradually reshapes organizations' operating models, while increasing their complexity beyond understanding (Armour, Kaisler & Liu 1999, 35). In other words, as enterprises grow, operations become international, organisations become global, markets expand, alliances are formed, collaboration increases, the amount of information increases, competition intensifies, and constantly improving efficiency becomes vital for survival – enterprises become increasingly complex (e.g. Riempp & Gieffers-Ankel 2007; Shah & El Kourdi 2007; Veasey 2001; Henderson & Venkatraman 1999). Choo (2002, 10) defines an organisation's complexity as "…a function of how many information sources it needs, how many business elements it must coordinate, and the number and type of relationships binding these elements."

In the business and organisation context various types of complexity, in addition to detail- and dynamic complexity, have been described in literature and research. When discussing complexity in organisations' environment, Hatch (1997, 89, 168) describes complexity as the number and diversity of elements in the environment that is, detail complexity. Hatch also describes structural complexity, arising as a response to perceived external (environmental) complexity or from horizontal (number of units) and vertical (levels of hierarchy) differentiation (internal). Dervitsiotis (2012) introduces a number of different types of complexity such as, environmental complexity, operational complexity or individual complexity, strategic complexity also called institutional com-

plexity or systemic complexity, operating complexity, built-in or inherent complexity, design complexity, dysfunctional complexity, and imposed complexity. All these complexities arise from various sources, however, Dervitsiotis seems to refer to the aforementioned detail complexity in explaining each of the types. Moreover, this kind of approach could unnecessarily lead to an endless list of obscure complexities, while the actual cause or type of complexity remains unchanged.

Nevertheless, at this point it may be concluded that two major categories for organisational complexity are 1) internal complexity and 2) external complexity and two main types of complexity are 1) detail complexity and 2) dynamic complexity. However, a combination of the latter two (detail & dynamic) is not mentioned, but can be considered as an even more complex type of complexity. According to the Oxford Dictionary of English (2013), the adjective *dense* means "closely compacted in substance" or "having the constituent parts crowded closely together" and might indicate difficulty in understanding due to complexity. Hence, the combination of detail complexity and dynamic complexity may be called *dense complexity.*

In their quite recent article Sheffield et al. (2012, 127) discuss complexity in project management and take an interesting view on the phenomenon. They suggest that four types of systems or projects can be identified according to their number of components and number of interactions that is, level of complexity. Each type of system has a matching project management method that changes similarly according to the number of components and interactions. Regardless of the focus being on project management, their view, illustrated in figure 15 below, is interesting also from the point of view of the whole organisation and thus, deserves attention in discussion.

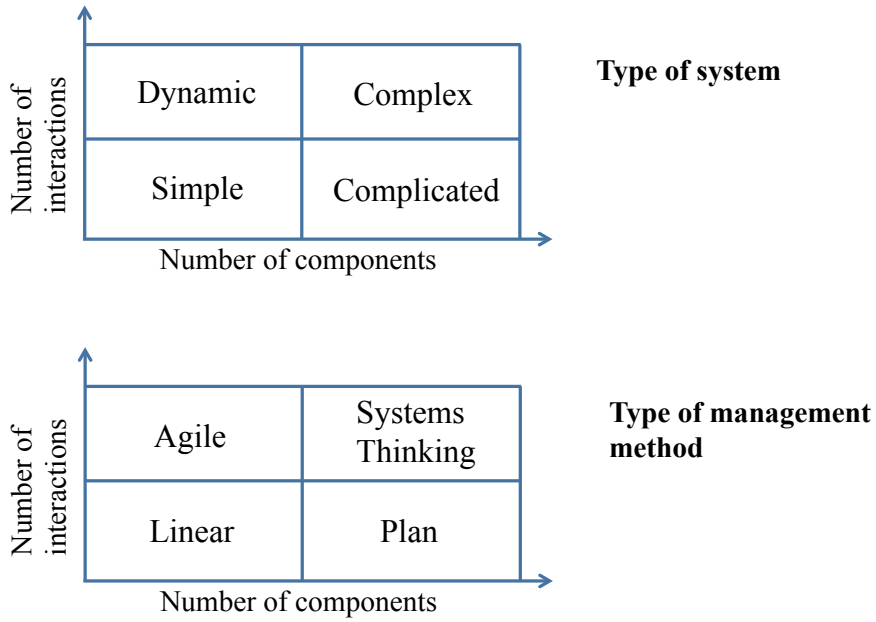

Figure 15 Management method according to system complexity (see, Sheffield et al. 2012, 127)

Sheffield et al. (2012, 127) suggest that once the amount of components in a system increases, but their interactions do not, the system becomes complicated and when the components' interactions increase as well, the system becomes truly complex, which corresponds to dense complexity described above. Accordingly, a large amount of components would require the management to create an extensive implementation plan whereas a great number of interactions require an agile management method. With a linear management method they refer to the traditional waterfall-model whereas, a highly complex system requires systems thinking for sufficient management.

Actually, in spite of Sheffield et al. referring to project management, the underlying meaning of their view gives grounds for and summarises several arguments in this research; it justifies the discussion of the information society and its characteristics for understanding the need for agility in today's business environment that is, in dynamic situations or systems (as concluded in the previous section 3.2.1), which have also spurred the development of enterprise architecture. It illustrates the magnitude of high-level complexity by showing that even a highly complicated system increases in complexity when more interactions are added. In the case that both (components and interactions) increase, complexity increases as well. This justifies the discussion of complexity in the current research as a true challenge for organisations in the global economy as well as the importance and benefit of systems thinking when dealing with complex systems and situations. Sheffield's et al. (2012, 127) view also gives an important idea for managing an organisation in the current era, which due to its complexity requires an

ever-wider view and more skills from managers who are responsible for the organisation's success (or failure).

Technological development has significantly affected organisations' operations as the roles of information technology and information systems have changed and gained increasing importance in modern enterprises. Commonly, IT infrastructures and information systems evolve in tandem with the development of enterprises. Shifting trends in technology often cause loss of stability in systems all over organizations, even in the most basic operations. Multiple diverse technological implementations accumulating to an organization's system over time results in complexity and various compliance constraints. (Enterprise Information Management 2011.) Consequently, the challenge of large application landscapes is, that they have not been developed at once and aligned with current business information and communication requirements. On the contrary, application landscapes have in many cases evolved over a long period of time, resulting in a combination of overlapping and out-dated applications and systems, which only add to the internal complexity of the organisation. (Tolido, Aksu, Muller & Anderson-Smith 2011, 4–11; Raadt, van der, Schouten & Vliet van 2008, 19–20.)

Today, enterprises may operate hundreds or thousands of applications in their information systems, extending to encompass the entire enterprise. (Riempp & Gieffers-Ankel 2007, 359–360; Zachman 1987, 276.) Thus, most companies are cluttered with systems, which do not fulfil the businesses' needs anymore and might become restraints for innovation, agility and competitiveness. (Tolido et al. 2011, 4–11; Raadt, van der et al. 2008, 19–20.) Therefore, due to the strong influence of technology on organisations' operation I suggest technological complexity to be added as a type of internal complexity in an organisation. Although, the gradual development of technologies is one external cause, the level of technological complexity in an enterprise is ultimately dependent on internal decisions, actions, and structure. Complexity itself is not automatically a positive or negative feature. However, regarding businesses and enterprises it has become a challenge for performance.

3.3.3 Information Need, Quality, and Overload

One definite character of the information age is the enormous and growing amount of data and thus, also information and knowledge. The terms data, information, and knowledge are often used interchangeably in literature (e.g. Too much information: How to cope with data overload 2011; Edmunds & Morris 2000, 19; Tuomi 2000, 103–104). A conventional view is that information is created by combining data into meaningful structures that can be communicated (Tuomi 2000, 103, 105). Although, data, information, and knowledge are seemingly obvious concepts, in order to avoid any con-

fusion commonly associated with these concepts, their relationship is explicated using Tuomi's (2000, 103–106) knowledge hierarchy. Accordingly, data, information, and knowledge can be placed in a hierarchy as figure 16 below elucidates.

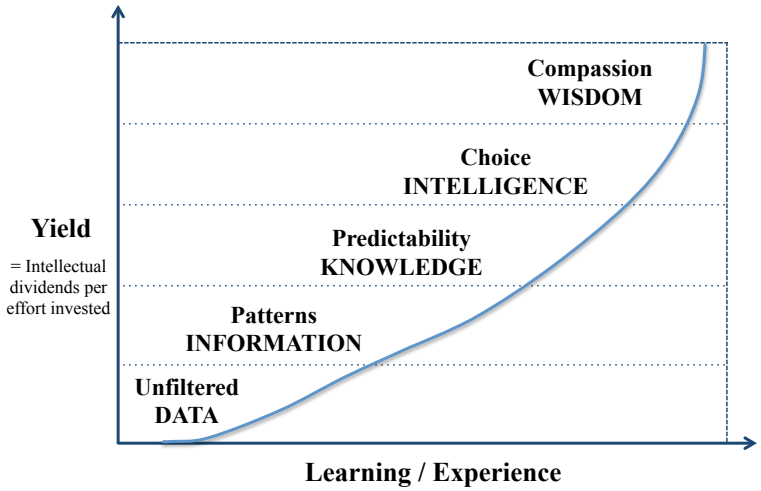

Figure 16 Knowledge hierarchy (adapted from Tuomi 2000, 106)

Data in the bottom tier are simple facts that do not have any meaning as such, because they are seen to appear in isolation. Once data are mined that is, arranged in a structure and put into context they create information. In short, data mining can be defined as "Extracting useful information from large data sets" (Hand, Mannila & Smyth 2001)[7] or as "…the process of exploration and analysis, by automatic or semi-automatic means, of large quantities of data in order to discover meaningful patterns and rules" (Berry & Linoff 1997, 5)[8]

Thus, information is data with pattern and one cannot have information without data. Information in turn, becomes knowledge once it is interpreted that is, given some meaning. Interpretation brings information to the interpreter's consciousness and mental models, where it becomes knowledge and enables prediction and inference in the cognitive sense. Tuomi (2000, 105–106) suggests that knowledge has two further stages: intelligence and wisdom. When the mind uses knowledge to carry out various decisions, behaviour becomes intelligent. Furthermore, when intelligent behaviour is guided by commitment and values, it is based on wisdom. Hence, intelligent and wise behaviour is, in addition to the subject actor, dependent on the quality of data.

[7] (see, Shmueli, Patel & Bruce 2010, 3)

[8] (see, Shmueli et al. 2010, 3)

In the current era the dominant factor in the economy is information, which is increasingly extracted from digital data. The reason for this is that a majority of actions and thoughts are carried through or transmitted by technology that produces data. And because the twenty-first century economy runs on information and knowledge, digital data have become the essential raw material in creating valuable information and IT has become an important asset, a driver for performance and economic growth by enabling the creation, capturing, and processing of data to extract information and execute efficient business processes based on enhanced knowledge. Thus, the amounts of data and information have exploded. The technological advancements our society has achieved have resulted in the production of an overwhelming amount of information much greater than we are able to process. Consequently, the focus of technological development, in addition to creating more data, is on capturing, storing, processing, and interpreting these data. The experience is information overload. (e.g. Anderson & de Palma 2012; Eppler & Mengis 2004; Edmunds & Morris 2000.)

The concept of information overload is not straightforward as it is formed through perception and experience. The experience of information overload has been explained to result from various situations such as, receiving more relevant information than can be processed or the burden of too much irrelevant information that causes difficulty in finding the relevant or specific information that is searched (Edmunds & Morris 2000, 18–19). The massive increase of information has brought forth the concept of *attention economics*, articulated by the well-known economist Herbert Simon in 1970 (see Shapiro & Varian 1999, 6; Anderson & de Palma 2012, 1) when he reasoned an important phenomenon, very current for the present time: "a wealth of information creates a poverty of attention".

Simon saw the limit in human comprehension for processing information, that is, the point of information overload. Hence, to enable further development, technology continued from where human capacity ended. In general information overload is defined as exposure to too much information. Information overload has gained increasing attention across disciplines and in 1995, Butcher (1995, 1–2) had already identified three dimensions of management research into information overload:

- problem of personal information overload
- problem of organisational information overload
- problem of customer information overload.

The experience of information overload has been discussed for decades; what began as an excess amount of papers piling up on office desks have evolved into one person encountering thousands of messages through multiple channels on a daily basis. (Anderson & de Palma 2012, 2; Butcher 1995). Information overload and its effects have been described with various terms such as, data smog, information fatigue syndrome, analysis paralysis, and cognitive overload (e.g. Eppler & Mengis 2004, 326; Edmunds

& Morris 2000, 18; Too much information: How to cope with data overload 2011). As a phenomenon regarding experience it is again one that has significantly changed over time in a more quantitative than qualitative manner.

In addition to the amount of data and information, perhaps the most significant attributes of information overload are availability and exposure. The latter being often associated with an individual consumer perspective (Anderson & de Palma 2012, 2). As discussed in section 3.1, in terms of information the world has become flat; information is shared globally in almost real-time. Thus, the problem of information overload is most importantly a result of being exposed to excessive amounts of information. This is justly the case regarding individuals – consumers, and the people that organisations consist of. Nevertheless, on a general level, the organisation does not experience this kind of overload. On the contrary, data hide enormous value and insight that organisations crave for, or should if they seek to compete in the global digital market. Thus, the data explosion is not an overload due to reversed interests; uncaptured data or *data exhaust*[9] are seen as untapped insights and opportunity, not as disturbing noise. However, when we move to a more specific level, which is also a technical level where the data collection purpose is specified, all data that are not included in that specification turns to unwanted noise for the respective purpose. The ability to discard noise directly affects the quality of data.

A constant need for information is also a way to respond to uncertainty. However, assuming that uncertainty, as a condition of the environment, is similar for organisations is not scientifically just. Previously, uncertainty has been thought to be a direct result of increasing complexity and increasing rate of change. However, because of the fact that organisations do not experience uncertainty, but people do, it becomes a vague condition. Based on perception one condition might be uncertain to some managers, but not to others, which should be taken into account. Thus, it has been suggested that uncertainty is linked with the need for new information and that in a rapidly changing environment the need for new information is constant.

Since 1995, research have addressed also the nature and characteristics of information itself, of which quality, more precisely data quality, has become a critical factor for organisations. (Hall 2010; Eppler & Mengis 2004, 330–331). With recent technological advancements sophisticated information systems open an ever-rigorous amount of data from the environment to the consumption of the organisation. Thus, the quality and security of data have become key issues in modern information management (Umar,

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[9] *data exhaust* is a term used by particular IBM personnel to describe data that is generated in great amounts on a daily basis, but typically untapped for business insight (Zikopoulos, deRoos, Parasuraman, Deutsch, Corrigan & Giles 2013, 5).

Karabatis, Ness, Horowitz & Elmagardmid 1999). However, in many organisations IT and business departments or managers have inconsistent views of data and information.

According to a Forbes Insights survey (Hall 2010, 7–8) of more than 200 business- and IT executives at leading global enterprises, disagreement appears on issues such as, data ownership, data quality, understanding the effects of data quality issues, and the causes of those issues. Some examples of data quality issues are gathering duplicate data, data migrated from old systems to new ones are incomplete or inaccurate, lack of access to critical information, using incomplete information, inconsistent data, inaccurate data due to data entry errors, using old data, and missing sales due to bad data. Furthermore, the study suggests that reaching agreement on how to resolve these issues might be difficult as individuals and departments push for solutions that best suit their needs instead of the organisation's as a whole. (Hall 2010, 8.)

This seems to be too often the case, which is why emphasising transparent holistic thinking intertwined with strategy is extremely important and should be amalgamated within the organisational culture with great efforts. In a broader sense, as technology and information systems are an ever-larger part of business, even the culture of putting IT and business in different camps, figuratively speaking, arguably does not help to resolve communication issues, interest priorities, and cooperation difficulties between the departments, in which ultimately all people work everyday for the same goal.

3.3.4 Strategy Execution

Upon the aforementioned challenges, research shows that there is a notable gap between organisations' strategy formulation and strategy implementation for successful execution. Many businesses fail to bridge this gap because they fail in connecting their operations with the strategic goals that have been set. (Kamensky 2000, 144–145; Skurnik, Laamanen & Ylisirniö 2010.) Many organisations are struggling with combining the somewhat abstract essence of strategy with practice. According to the research conducted by The Strategic Management Society of Finland (SSJS Strategiabarometri 2007–2010), one of the main problems that cause strategy implementation to fail is too little correlation between strategy and reality. In many cases a strategy has been formulated without a clear or correct understanding of the operational level and daily actions in the organisation. Strategy should not be a separate management function or a separate set of tasks on top of the usual daily work. It is a process where the organisation’s vision and mission are transferred into daily duties within the organisation. Therefore, strategy should not be thought as something that an organisation has, but as something that people do. (Kaplan & Norton 2004, 54; Johnson, Langley, Melin & Whittington 2007, 3)

Whether the execution of a strategy is successful or not depends on the metrics used to measure and evaluate it.

Aligning business and IT is often discussed as an important factor in strategy execution. That is, elaborating the structure, processes, goals, and information needs so that the IT infrastructure can be designed to better fulfil business needs. However, the alignment can easily disrupt, leading both sides to develop in different directions. Both, business and IT need to be agile enough, changeable when needed, and organized to be manageable. Therefore, organizational structures and processes must be transparent – then the combination of business and IT can be developed as a coherent whole. Success is created from a stable foundation for executing business (Ross et al. 2006). If the organisation fails in connecting processes with its strategies it is evident that they cannot but fail. Nevertheless, the continuously discussed high rate of unsuccessful strategy executions is remarkable.

3.4 The Intelligent Organization

An intelligent organisation has high quality knowledge to guide decision-making and support the organisation's adaptation to the demanding environment. Knowledge is obtained from timely and accurate information, which is derived from timely and accurate data. Hence, fostering competitiveness means that enterprise information value chain, information management, business intelligence, and knowledge management are crucial attributes of the information age organisations and thus, are discussed in this section. Ever-better cooperation and alignment between IT and business is needed. Information diffusion and transparency are vital for organisational learning and evolving towards an intelligent organisation.

3.4.1 Data and the Emergence of Big Data

In addition to the long-established continuum of technological development and shifting trends, the information age has brought a new era into the IT discipline as well – the big data era. (e.g. Carter 2011; Deutsch, Eaton, Lapis, deRoos and Zikopoulos 2012; Data, data everywhere: A special report on managing information 2010; Hilbert & López 2011.) Data is everywhere. It has been estimated that in 2012, every day 2.5 quintillion[10] bytes of data were created and 90 per cent of all data in the world have been cre-

[10] Quintillion bytes = Exabyte (EB) = 1000 000 000 000 000 000 or 10^{18} bytes

ated during the last two years. In 2009, all the data of the world were counted to approximately 0.8 zettabytes[11] (ZB). In 2010 the amount increased by 25 per cent to 1 zettabyte. Moreover, the amount was estimated to grow by 80 per cent by the end of 2011. (Zikopoulos et al. 2013, 9; What is big data?).

The proliferation of data is escalating; in addition to millions of sensors embedded in the physical world constantly recording data from devices such as cars, airplanes, traffic systems, trains, weather sensors, mail, and mobile phones, companies are collecting vast amounts of data from their operations, suppliers, and customers. This cycle of sensing and recording is called *instrumentation* (Meeting the challenge of big data 2012, 11; Deutsch et al. 2012, 3–7). Big data consists of both human- and machine-generated data feeds. Sensory data is often referred to as machine-to-machine (M2M) data, as sensors record data that are then transmitted to other devices or machines for further actions (Carter 2011, 5; Deutsch et al. 2012, 4). Sensory data, smart devices, social tools, web pages and other online activity are all interconnected, which again creates more data. Facebook generates 10 terabytes[12] (TB) and Twitter generates 7 terabytes of data every day. Some enterprises produce similar amounts of data each hour. (Deutsch et al. 2012, xxiv–7.)

Big data is often described simply as an amount of data, so large that it cannot be processed with conventional tools and methods. However, the notion seems somewhat incomplete when taking into account that data have different formats that require different tools and the amount of data is growing exponentially as the technologies used to store, process, and analyse it develop. Accordingly, some say that the definition of big data should be more subjective, leaving room for evolving state, the constant development and not limiting merely to large size. (e.g. Brown, Bughin, Chui, Dobbs, Hung Byers, Manyika & Roxburgh 2011, 1; Carter 2011, 1; Troester 2012, 2).

Hence, big data can also be defined through its main characteristics: *volume, variety,* and *velocity. Volume* is the most obvious feature referring to the exploding growth in the amount of data, which has increased from terabytes to exabytes and further on to zettabytes in a relatively short time. *Variety* implies different types of data structure. Although all data have some structure, as figure 17 below illustrates, most data are either semi-structured or unstructured (e.g. Edmunds & Morris 2000; Deutsch et al. 2012; Lin 1996; Carter 2011).

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[11] 1 Zettabyte (ZB) = 1000 000 000 000 000 000 000 or 10^{21} bytes (Carter 2011, 2; Zikopoulos et al. 2013, 9).

[12] 1 Terabyte (TB) = 1000 000 000 000 or 10^{12} bytes. 1 TB = 1000 Gigabytes (GB) (Lyman & Varian 2003).

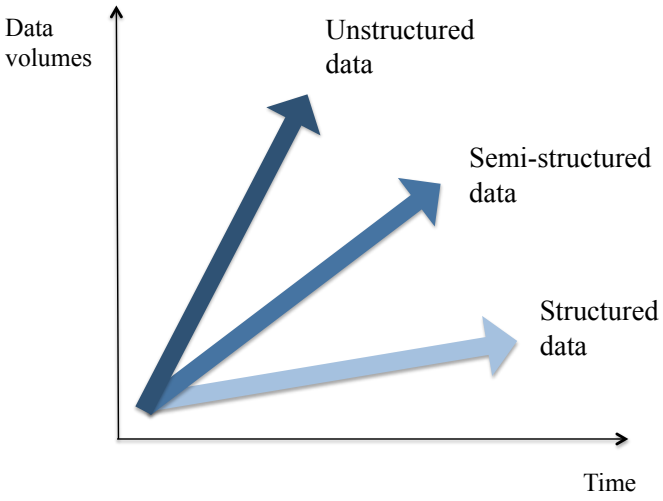

Figure 17 Big data structure (adapted from Carter 2011, 5)

For example, video and rich media are unstructured data, whereas weblogs, blog-posts, social media feeds or other written open comments are semi-structured. A face-book post for example, is marked in a JavaScript Object Notation (JSON) format, which is structured data, but contains an unstructured component, namely the open text that was written in the post. Open text is unstructured because it contains meanings and in-terpretation, which cannot be analysed in traditional ways. The semi- and unstructured data is where the previously unreached extremely valuable insight lies. The idea of the so called big data tools is the possibility to collect and analyse for instance, customer insights from reviews, experiences, and discussion shared in social media. *Velocity* in turn, does not refer only to the rate at which data arrives at the enterprise, but also to the reaction time taken to process and make use of these data[13]. The time taken in each phase of the process creates latency as illustrated in figure 18.

[13] The process of turning data into knowledge as illustrated in the knowledge hierarchy in figure 16, p. 53

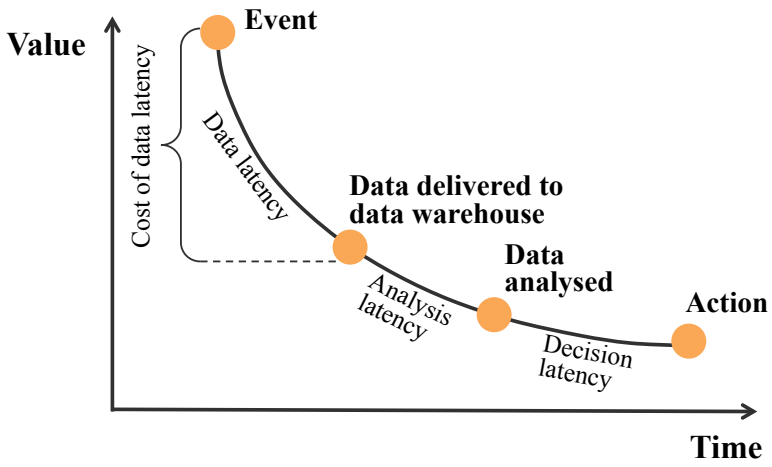

Figure 18 Correlation between latency and value of information (adapted from Data integration architectures for operational data warehousing 2012, 2)

For example, it is very common to analyse data at rest. In that case, data are gathered, stored and then analysed as in the process depicted in figure 18 above. This means that when the data to be analysed are in motion, samples from the data flow are first stored and then analysed. Thus, processing velocity can be surprisingly low, regardless of the velocity of data. Latency affects data quality directly; as business is moving closer and closer to real time, the data guiding and supporting business decision-making must be timely. As discussed earlier in section 3.2.3, one of the data quality issues faced was using old data. One of the advancements of new tools is minimum latency, which means a total velocity so high, that it brings the possibility to analyse very large amounts of data in motion. This means that instead of taking samples from a larger set of data it is possible to analyse almost the whole data flow as it flows. That is high velocity and minimum latency. (Zikopoulos et al. 2013, 9–14; Deutsch et al. 2012, 5–9; Meeting the challenge of big data 2012, 4,10; Carter 2011, 5.)

In addition to volume, variety, and velocity, practitioners have named also other characteristics derived from their wide experience of numerous customer projects. For example *veracity* has been recently added to refer to the quality and trustworthiness of data. When businesses rely their operation and decision-making on data, it is very important that they use high-quality data that on one hand can be separated from low-quality data by disregarding noise and spam and on the other hand can be turned into trustworthy insights (Zikopoulos et al. 2013, 14-15). Also value can be distinguished as a big data characteristic. Big data is typically very low density and therefore, it is not very valuable in single observations, but valuable information can be revealed from large amounts of data with aggregation and analysis (Meeting the challenge of big data 2012, 4).

Information has become a vital ingredient in the new economy. However, while the amount of available data is rapidly increasing, the amount of data that enterprises are able to process develops much slower. Enterprises are facing the challenge of big data. (e.g. Romero-Morales, Schroeck, Shockley, Smart & Tufano 2012; Overcoming obstacles with BI and big data 2012; Meeting the challenge of big data 2012; Lin 1996.) Competition and accelerating pace of change create a need to figure out how to extract value and insight from all the data we possess.

Emphasizing the significance of this change is important, as big data has been predicted to create extremely high additional value to business operations. Still, a survey conducted by the IBM Institute for Business Value (Romero-Morales et al. 2012, 6) suggests that most organisations (over 70 per cent) are only beginning to develop their big data efforts and 24 per cent have not started any big data activities. This indicates, that over half of the responding organisations do not yet access and utilize the insights of their own organisations. Moreover, it has been estimated for example, that the potential annual value of big data to the administration of Europe's public sector is up to € 250 billion and big data could create a 60 per cent potential increase in retailers' operating margins (Brown et al. 2011, 1–13). Gartner Inc. has estimated big data to create globally around 4.4 million IT jobs between 2012 and 2015 (Thibodeau, 2012, 6). Economic surplus derived from big data utilisation is available to enterprises, governments as well as consumers.

3.4.2 Knowledge Management and Organizational Learning

As an establishing discipline, knowledge management (KM) has been increasingly related with the expectation of improving organisational effectiveness as well as competitiveness within its environment (Jennex 2007, 51–170; Kock 1999, 45; Bahrami 1992). Knowledge management can be defined as "…the practice of selectively applying knowledge from previous experiences of decision making to current and future decision-making activities with the express purpose of improving the organization's effectiveness." (Jennex 2007, 6).

As a means to improve the organisation's capability of acquiring, processing, distributing, and utilising information to produce knowledge, knowledge management aims towards flexibility and agility to empower the organisation's effectiveness. In contrast, many research suggest that the majority of competitive advantage results from the effective use of IT (e.g. Weill & Ross 2009; Ross et al. 2006, 1–2; Data integration architectures for operational data warehousing 2012, 2). Nevertheless, both are arguable causalities and do not appear in contradiction. It should be noted that here IT is a means for practicing and supporting the process of knowledge management that is, a means to

achieve the higher-level objectives of the idea and practice of knowledge management. With respect to the aforementioned definition, because experience and decision-making are mainly human activities, it may be inferred that the direct goal of IT is not that of knowledge management, but is rather a part of its process and that the two complement and empower each other. Regarding the characteristics of the information age, it could be even argued that using sophisticated information systems and technologies in enterprises, to acquire relevant business information, is useless without knowledge management.

Knowledge management is a discipline that combines the human cognitive components i.e. mental models with more technical components. In other words, knowledge exists as tacit and explicit (Seleim, Ashour & Khalil 2007, 304; Jennex 2007, 3). Traditionally IT has been an effective tool for storing and transferring explicit knowledge, because it is easier to formalise and document. IT provides data, information, and knowledge repositories as well as means for capturing, retrieving, and communicating them. Conversely, IT has been less effective in handling unstructured tacit knowledge. However, as was discussed in the previous section (3.3.1), ICT and IS innovations are increasingly filling this gap. Within the transition to a knowledge intensive era the role of information and communication technologies has dramatically changed in a relatively short time. IT no longer carries solely a back-office role, but has received a more central role as a means to achieve business value and not only support business strategies, but create new strategies for better innovation, competitiveness and cooperation. (Hugoson et al. 2011, 53; Henderson & Venkatraman 1999, 472.)

Advanced enterprise information systems, that have previously been available only to organisations and enterprises that possess greater resources, no longer require large investments. Technological innovations and advancements have brought sophisticated information technologies and information systems to the reach of smaller businesses as well. A new generation of knowledge workers combined with the low hierarchies in today's organisations have resulted in the integration of data analysis into daily work tasks and expanded decision-making vertically (Morris 2010, 1). Many organisations today operate data warehouses, where they capture data gathered from different activities throughout the extended organisation. Then, various analytics applications are run on the data warehouse to aggregate and analyse the data to derive valuable information that can be leveraged into better business decisions that is, business intelligence. The purpose of business intelligence is to monitor and identify important events in the environment and gather relevant data to enforce informed decision-making. All in all, business intelligence can be seen as an important management tool. (Choo 2002, 86–87, 90–91.) However, as previously suggested solely IT systems are not sufficient in creating knowledge. Valuable knowledge requires experience and interpretation as human additions.

To create value, knowledge management seeks to bring forth data, information, and knowledge both, internal and external to the explicit and efficient use of the organisation. The main objective of knowledge management is to maximise business performance by capitalising on knowledge assets. Knowledge facilitates learning and creates capabilities that are used to respond to the opportunities, pressures, and other events in the environment (Massey, Ramesh & Montoya-Weiss 2007, 79–82.) In addition to the external events, knowledge management aims to enhance organisational performance also internally.

Business Process Reengineering (BPR) is a means to enhance an organisation's internal structure and workflows to facilitate the organisation's capability of adapting (Lin 1996, 45) and thus, has been connected with knowledge management. However, as such, BPR often concentrates solely on rethinking and redesigning business processes as a somewhat isolated endeavour i.e. disregarding other attributes within the system. When booming in the early 1990s, BPR resulted in massive restructurings and staff reductions and therefore gained a rather unattractive reputation (e.g. Kock 1999, 9). According to Jennex (2007, 7) many organisations discovered afterwards that they had lost important key knowledge in the process. Thus, Massey et al. (2007, 80) argue that BPR is unlikely successful if the human element in knowledge-intensive processes is ignored. The lesson learned from early BPR processes led organisations to identify and manage their internal knowledge as well.

When compared to the history of BPR, organisational learning introduced by Senge (1990) was a much softer approach to organisational development. Ultimately, an organisation is the result of thinking and interacting of individuals therein. (Kock 1999, 9; Senge et al. 1994.) In his discussion of the new network society, Castells (2007, 1) takes a similar, but broader view when suggesting that "the way people think determines the fate of norms and values on which societies are constructed". In other words, organisational learning is experienced collective individual learning accumulated over time and taken into account within the organisation. When individuals learn the gained knowledge is stored in the organisation's repositories also called organisational memory. In order to utilise this knowledge, communicating and sharing becomes important. However, there are two qualities in learning namely, single-loop and double-loop learning, illustrated in figure 19.

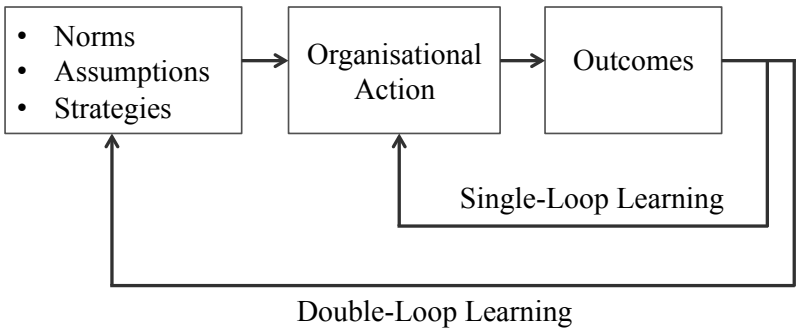

Figure 19 Organisational Learning Loops (adapted from Choo 2002, 13–14)

When an organisational action is executed it creates a certain outcome. In single-loop learning the outcome of the organisational action is detected as a single feedback loop. Adjustments are then made according to the feedback, but within the set strategies and norms. Single-loop learning does not change or correct behaviour and thus, errors might result in a situation where one (figuratively) runs around putting out fires. In double-loop learning, corrective action is sparked by feedback that affects organisational action, but makes another loop to change needed norms and strategies. (Choo 2002, 14; Hatch 1997, 371–372.) Not needed to say that organisational development requires double-loop learning.

On a more abstract level, an organisation can be thought to learn if its potential behaviours are changed through its information processing. An intelligent organisation takes a holistic approach to its information and knowledge management. It masters scanning of its environment, highly utilises business intelligence, is not paralysed by complexity, and succeeds in sharing and integrating all different types of knowledge within all levels of the organisation (Choo 2002, 10–12).

Enabling an organisation to learn efficiently requires information and knowledge being transparent and available when needed regardless of the people within the organisation changing. To enable this, the organisation needs special knowledge repositories where information and knowledge can be stored within the organisation. A learning organisation also requires a visible history. In order for an organisation to be able to learn from its actions and the consequences of previously performed actions, information on these must be available for review. Enterprise architecture is often associated with modelling information systems, but also modelling business processes, and with the principles of business process management and business process reengineering. Updating the modelled organisation records the history of its operations and structural changes. The role of sophisticated information systems in enterprise architecture brings a potential for efficient information storage, analysis, and management and thus, a potential for a learning organisation.

4 ENTERPRISE ARCHITECTURE

Chapter four aims to provide a comprehensive analysis of the current state of enterprise architecture; the concept's history, evolution, and the ambiguity that burdens the definition and interpretation. In addition, the enterprise architecture terminology is analysed. Combining the knowledge obtained from each reveals even deeper understanding of enterprise architecture and provides a solid base for further analysis and perception of the core logic and purpose.

4.1 History and Evolution

Neither the term nor the concept of "architecture" is new. For centuries, classical architecture has steered and supported the physical world of construction, enabling ambitious plans and ever-greater buildings to be created. For the concept's structural logic, the term has been adopted by the IT discipline to support planning and structuring of information systems and in the recent years architecture has become an increasingly popular term within the business discipline as well. (e.g. Veasey 2001, 420.) The use of the term "architecture" in reference to computers and programming has been traced back to the 1960s when computer and software systems started to become larger and more complex. Increasing attention had to be focused on the structure and function of the growing systems and their integration. (Op 't Land, Proper, Waage, Cloo & Steghuis 2009, 25–26; Greefhorst & Proper 1998, 7.)

At that time IBM (International Business Machines Corporation) started developing a structure and blueprint for enterprise information systems. Together with Walker, Zachman contributed strongly to the development of architectural structures behind *Business Systems Planning (BSP)*, which later became an important management tool for organisations (Coetzee 2009). As discussed in the context of information society (section 3.1), the benefits gained from the development of coherent IT infrastructures and information management appeared in research already in the 1990s. Studying several business cases Glazer (1991, 1-2) identified competitive advantage in organisations that had well planned IT infrastructures and that understood the value of managing information. Hence, the development of information systems architectures commenced the evolution of the concept of enterprise architecture. Figure 20 below, outlines important milestones in the history and evolution of enterprise architecture.

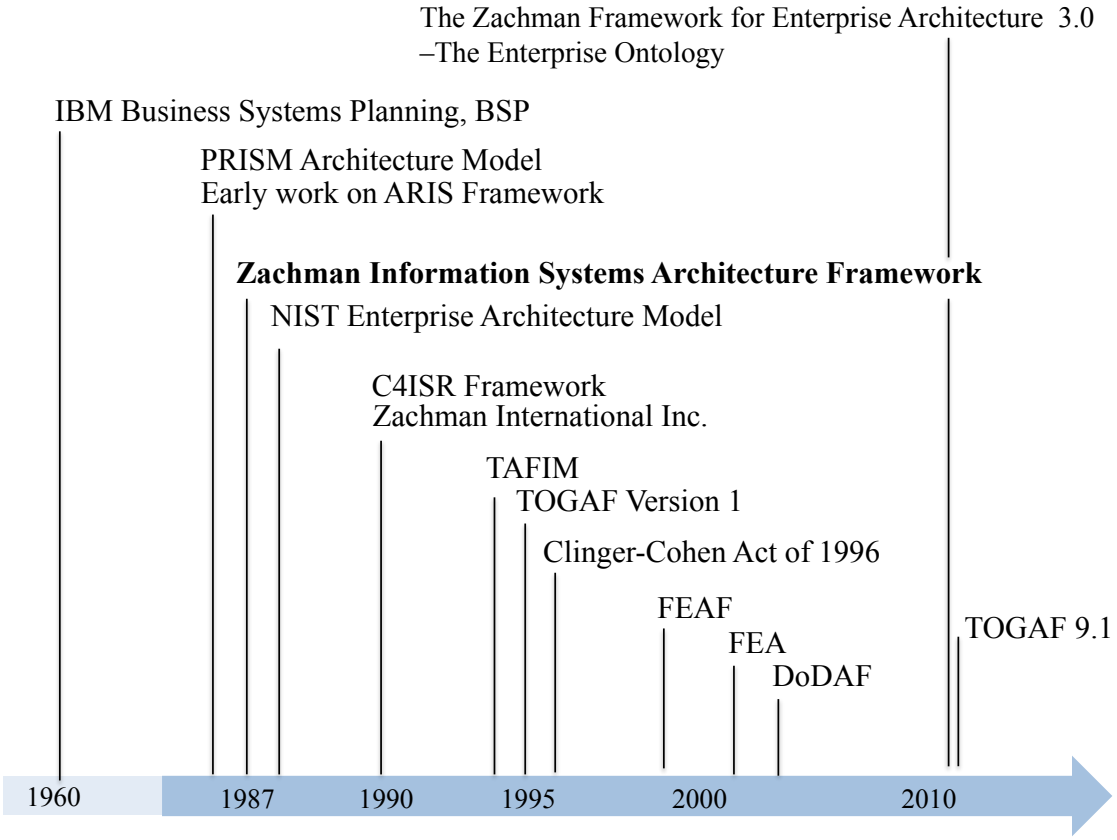

Figure 20 Enterprise architecture evolution timeline (see, Sessions 2007)

The idea of enterprise architecture is widely agreed to have born from Zachman's framework that was published in his article *A framework for information systems architecture*, in 1987. (Franke, Höök, König, Lagerström, Närman, Ullberg, Gustafsson & Ekstedt 2009, 327; Shah & El Kourdi 2007, 36; Zachman 1987.) However, Greefhorst and Proper (1998, 7–8) point out that simultaneously the concept of architecture was used in information systems work in a North American project called the Partnership for Research in Information Systems Management (PRISM), which published the *PRISM Architecture Model* in 1986 and in the early work of Scheer (1998) on Computer Integrated Manufacturing (CIM), which later developed into the *ARIS Framework.* The ARIS (Architecture of Integrated Information Systems) is a concept and framework for describing and modelling computer-aided information systems as they reflect business processes. (Scheer 1998, 1–6.) Moreover, Greefhorst and Proper (1998, 8) seem to criticise Zachman's recognition as the founder of enterprise architecture by adding that his article from 1987 actually focuses on computerised information systems and the title of his article "..clearly suggests a focus on information systems architecture rather than enterprise architecture in general" (Greefhorst & Proper 1998, 8). However, based on literature the term enterprise architecture was only coined several years later, in the 1990s.

Despite Zachman's article originally conceiving a framework for an architectural description for complex implementations of enterprise-wide information systems, he discusses business priorities and strategy, and argues for the necessity of a structure or architecture in keeping the business from disintegrating. Furthermore, in his initial framework he developed three models with their respective perspectives: Model of the business (owner's perspective), model of an information system (designer's perspective), and technology model (builder's perspective) (Zachman 1987). Zachman had a vision of realising increased business value and agility with a holistic multi-perspective approach that aligns business processes and information technology within an organisation. Thus, the Zachman framework for information systems architecture may justly be seen as the early form of enterprise architecture.

Since then, Zachman has continued his work by developing and expanding the framework in order to emphasize the holistic enterprise-wide view. At some point it was clear that promoting a holistic view required changing the framework name from Information Systems Architecture (ISA) into something more enterprise-wide. In 1993 the framework was officially renamed as "Enterprise Architecture - A Framework" (Zachman 2009). Despite of all the work, still in 2013 the Zachman Framework for Enterprise Architecture is said to be almost universally misinterpreted (Zachman & Kappelman 2013, 88). Zachman's role in affecting enterprise architecture and the way it is perceived has continued from the seminal work. His influence is both, implicit and explicit; implicit in the way that his seminal work still affects other following work within the discipline and explicit through his continuing active role in numerous enterprise architecture endeavours throughout the industry. Because Zachman's work has so strongly and widely influenced the field it is thus, widely discussed in this research as well. For a more thorough statement of the development of enterprise architecture, see appendix 1.

Although enterprise architecture has been adopted and developed internationally, the United States has played a pioneering role in the history of enterprise architecture. Zachman's work and the strong influence of the federal government's adoption of enterprise architecture as a practice have had a central role in the concept's development. The US Federal Government has developed several federal enterprise architecture frameworks such as, the concept of Command, Control, Communications, Computers, Intelligence, Surveillance, Reconnaissance (C4ISR), the Technical Architecture Framework for Information Management (TAFIM), Federal Enterprise Architecture Framework (FEAF), Federal Architecture Framework (FEA), and Department od Defence Architecture Framework (DoDAF), which have contributed to the field in general. (McDaniel 2012, 2; Coetzee 2009; DoD Chief Information Officer: Laws, Regulations, and Policies 2009; Sessions 2007; Federal Enterprise Architecture Framework 1999.) The Open Group (a global consortium that leads the development of open, vendor-neutral IT standards and certifications) developed its framework (The Open Group Architecture

Framework, TOGAF) based on the TAFIM (Sessions 2007). Whereas Zachman's framework is the definitive framework for enterprise architecture, the others are implementation frameworks or methodologies for implementing enterprise architecture (Enterprise architecture and strategic planning in large companies 2014).

When studying and mapping the development of enterprise architecture, it is interesting to see how general interest on enterprise architecture have developed during time. In several academic research, authors have evaluated the popularity of relevant search terms by typing them on Google Search and reporting the number of search results. However, the millions or billions broad match search results found all over the web do not tell much. Instead, a better indicator of the popularity of a specific subject is the number of searches people have done on Google's search engine. The number of searches is user-generated data, which represent the public opinion and therefore, are one of the most important types of data in the information age. Hence, to get a view of the *development of interest*[14] in enterprise architecture, a Google Trends search was done for the following four enterprise architecture related terms:

1. "enterprise architecture" (blue line/column)
2. "Zachman" (red line/column)
3. "Zachman framework" (yellow line/column)
4. "TOGAF" (green line/column)

[14] "The numbers on the graph reflect how many searches have been done for a particular term, relative to the total number of searches done on Google over time. They don't represent absolute search volume numbers, because the data is normalized and presented on a scale from 0-100. Each point on the graph is divided by the highest point, or 100. When we don't have enough data, 0 is shown. When comparing two or more items, bars appear next to the chart. The bar height represents the average of all points on the graph for that search term. A downward trending line means that a search term's popularity is decreasing. It doesn't mean that the absolute, or total, number of searches for that term is decreasing." (About Trends Graphs 11.5.2014.)

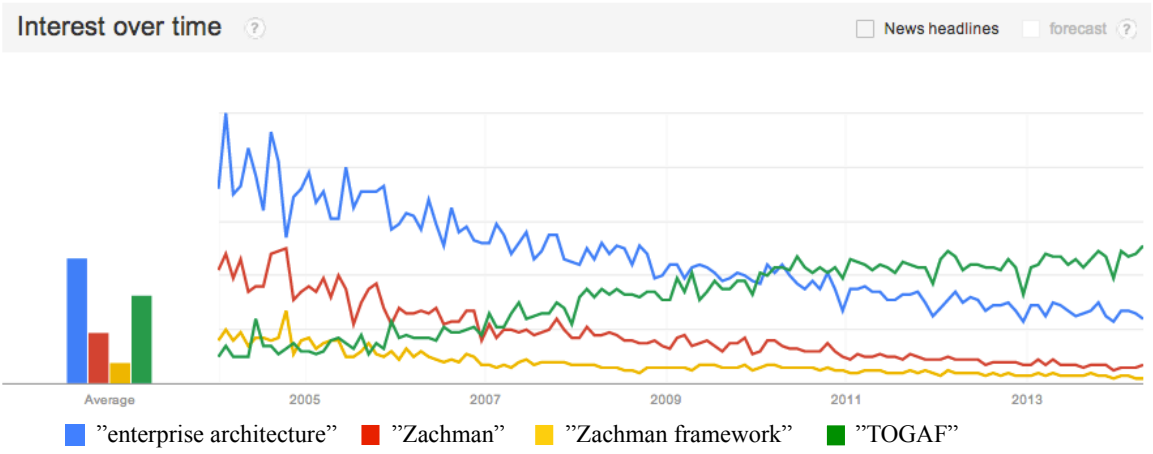

Figure 21 Enterprise Architecture Search Trends (Google Trends 11.5.2014)

Figure 21 represents the worldwide search trend within a timeframe from January 2004 until April 2014. During this time, the trends for "enterprise architecture", "Zachman", and "Zachman framework" follow a rather similar declining trend, whereas searches for "TOGAF" have developed in a quite opposite manner. When put into context, these data may provide some more information.

Based on the overview of research and literature on enterprise architecture in section 2.3, the volume of academic research somewhat boomed in 2004 as enterprise architecture gained more attention among industry and academia. Earlier, the federal government had gained increasing experience and had released several frameworks by 2003. In 2004 the interest for "enterprise architecture" was at its all-time high during this specific timeframe. It might be that the trend in searches with more generic terms declines as the subject becomes more familiar. Accordingly, at the same time the trends in searches with more specific terms increases. "Zachman" and "Zachman framework" are more specific terms however, due to the influence of Zachman's seminal work and presence in the history and development of enterprise architecture these terms may reasonably behave as more generic terms for the subject.

During the first couple of years "enterprise architecture" and "Zachman" were the most popular searches of all four terms. At that time the popularity of searches for both frameworks was much lower. However, after the first couple of years interest in "TOGAF" started to increase while the others' continued declining. This might be explained by the fact that TOGAF is an applicable open source method for enterprise architecture providing a platform for an online community of developers and subscribers and thus, can be estimated to create much more traffic online relative to sites that provide more static content and information. Moreover, as the subject becomes more familiar practice starts to gain more attention and static information on websites do not create many returning users. Actually, "TOGAF" is the only search term that starts from close to zero in Google's index in 2004.

Since then the TOGAF standard has become more popular and continues to do so. Along with the increase in implementation of enterprise architecture programs the number of individual professionals' certification has increased. For example, certification for the TOGAF 9 standard, which was released in March 2009 reached a 25 000 milestone in completed certifications in September 2013 (Gardner 2011; 2013). This previous discussion can be inferred also from the history and context of enterprise architecture and interestingly the volatility of searches on Google may be seen to support these events. However, this can only be speculated, as the graph itself does not imply any causes for these trends. Nevertheless, enterprise architecture is a very current subject that is gaining increasing attention among organisations and academia as the discipline matures.

4.2 Interest Groups and Industry Associations

Whilst businesses are facing one of the most turbulent times in history, the challenges caused by increasing change and complexity are globally shared. Enterprise architecture has provided a new way of responding to these universal challenges. Therefore, the idea started to diffuse rapidly. On one hand, practitioners such as, consulting companies have been quick to adopt, develop, and test new enterprise architectural practices. Whether global advisories or local SMBs, they have seen a great opportunity in promulgating the new approach. During the last two decades a number of enterprise architecture methodologies have been formed. However, this practice-driven diffusion within the industry has not developed in a unified way resulting in the development of a fragmented array of tools, practices, and interpretations.

On the other hand, simultaneously several industry associations, institutes, advocacy groups, and research and educating organisations have been established to serve the field, industry, and profession of enterprise architecture. Many of these entities work on standardising and unifying the concept, seeking to establish enterprise architecture as a practice and profession with more consistency in quality and thus, better success in implementation. Still however, they suffer from a somewhat similar challenge of not operating with a unified voice.

A further examination of the industry associations and other active organisations in the field of enterprise architecture reveals quite strong interconnections between the entities (see appendix 2). Each entity has its own role in the industry and community. These entities, their collaboration and interconnections will constantly change over time, but they all share a similar goal of developing and enhancing the concept and profession of enterprise architecture. Although, appendix 2 reveals only a fraction of the strong interconnections within the field of enterprise architecture, these connections have not been explicitly investigated in earlier enterprise architecture research. There-

fore, the analysis of different interest groups and industry associations reveals another level of understanding the field of enterprise architecture. An essential finding based on the analysis, is that in the end there is a relatively small group of experts and professionals that influence the development, public appearance, professional community, practice, university collaborations, and current issues of enterprise architecture within the industry. The only noteworthy exception is the Open Group's open contribution and development within their community. Although, this larger community directly affects only the TOGAF methodology and practice, due to its popularity and wide adoption it also indirectly strongly affects the whole discipline.

Maturing a profession and discipline requires a lot of time and work. Steve Nunn, CEO at the Association of Enterprise Architects and COO at The Open Group, estimates that the maturity of enterprise architecture as a profession on a scale of one to ten is at the moment about two, because there is still a lot to be done in creating a mature profession for enterprise architects (Gardner 2011). In addition to the aforementioned organisations and interest groups that have been established specifically for enterprise architecture, there are some large IT service and consulting companies such as, IBM, Gartner, Capgemini, and Infosys that have adopted enterprise architecture into their scope. An interesting observation is that most of them are from the IT field. Also the Institute of Electrical and Electronics Engineers (IEEE) is quite actively present in issues relating to enterprise architecture for example, by organising conferences and publishing conference proceedings and workshop papers. Expanding or moving focus to cover enterprise architecture clearly from within the business discipline (e.g. strategy, strategic management or business and administration in general) is far less common if not non-existent.

4.3 Ambiguity in Enterprise Architecture

First and foremost it is clear that enterprise architecture is not yet a well-established concept nor a practice or profession, but still finding its form and role within the society (cf. Davoudi & Aliee 2009, 131). In spite of the concept and practice being developed for over two decades yet, acquiring adequate information about enterprise architecture at the time of this research has been a challenging task. The amount of publications in the field has significantly increased, especially in the recent years. Nevertheless, literature and research still present an extremely fragmented view of enterprise architecture. This finding is also supported by the research of Buckl, Matthes, Roth, Schultz, Schweda (2010, 44), Schöenherr (2009), and van der Raadt and van Vliet (2008, 103). The fact that research and literature explain enterprise architecture using several and

various viewpoints with different purposes, structures, scopes, roles, principles, and foci makes grasping the core logic and idea challenging.

The variety of Enterprise Architecture Frameworks creates confusion as well. Many frameworks have come and gone since their development began in the 1980s; general frameworks, meta-frameworks, improved frameworks, and extended frameworks have been developed in sought of better applicability and implementation in practice. Even a framework for evaluating and choosing enterprise architecture frameworks has been developed. (Franke et al. 2009; Kim, Kim, Kwon, Hong, Song & Baik 2005). The ambiguity created by so many various frameworks has resulted in Schekkerman (2004), an active developer of enterprise architecture, writing a book for this purpose. His book became an international bestseller and has an excellent title that speaks for itself: *How to Survive in the Jungle of enterprise Architecture Frameworks: Creating or choosing and Enterprise Architecture Framework*.

Enterprise architecture frameworks, although all called frameworks, have developed for different purposes and are therefore interpreted inconsistently (e.g. Franke et al. 2009, 327). Frameworks are variously presented as tools, methods, plans, and descriptions for enterprise architecture or its information systems. Nevertheless, all enterprise architecture frameworks are not methods as often interpreted. The most visible example of this confusion is the often-made comparison of the Zachman Framework for Enterprise Architecture (the Enterprise Ontology) with various other frameworks. The main issue in this case is that the Zachman Framework is an *ontology*, a fundamental structure for enterprise architecture. Its 6 x 6 matrix shows the elements and viewpoints needed for an architectural representation of an enterprise, but does not contain any processes or methods for implementation. Most often the other frameworks it is compared to are methods and therefore, the Zachman Framework is often presented as incomplete, inappropriate or inconvenient in evaluations and comparisons against other frameworks.

The multitude in perceptions of frameworks speaks for the low maturity of the concept. Ohren (2005, 131–141) proposes an architecture framework ontology suggesting that while several enterprise architecture frameworks exist they tend to have overlapping application domains and place different meanings on same terms while more or less using their own proprietary vocabulary. Moreover, Ohren (2005, 136) has also pointed out the poor distinction between the enterprise and its information systems, stating that many frameworks claim to be enterprise architecture frameworks, but then focus merely on the architecture of the information systems within the enterprise. This type of interpretation of enterprise architecture was clearly visible in the research material and analysis conducted for the current research. Enterprise architecture is a broad topic from any aspect and each implementation is as unique as the adopting enterprise itself. Therefore, also translating best practices from praxis to theory might be challeng-

ing. Nevertheless, this does not mean that good or excellent implementations do not exist.

Collecting the history timeline and mapping the interest groups and industry associations affirm that all frameworks are more or less based on Zachman's original idea. Arguably, from today's point of view, adopting Zachman's ontology as the base of a theoretical foundation for enterprise architecture would have supported the congruent development of following methods and the development of the entire discipline. It may be speculated that if numerous frameworks for different and various purposes were developed, but clearly built as methods based on Zachman's ontology (instead of building varying frameworks in parallel with a misinterpreted thought-to-be-method) there is a possibility that the purpose and core logic of enterprise architecture would not have become so ambiguous and unclear.

Several definitions of enterprise architecture have been formed, yet no explicit common agreement exists. The definitions help in getting a sense of the logic and idea of the concept, but still the composition of enterprise architecture and its core elements are left vague. In addition, general inconsistency in the use of terms burdens discussions of enterprise architecture, its varying constituent elements, and its use, which only increases confusion, and even more when the essence of the concept is not clear. This may be an indication of misperception regarding the fundamental nature of enterprise architecture (Zachman & Kappelman 2013, 88).

According to Drobik (2002) the situation cannot be said to be any better from the practitioner's point of view. Despite of a growing number of enterprise architects practicing worldwide, a commonly accepted baseline of knowledge or standards or guidelines to ensure consistent service delivery do not exist. In addition, there is no common agreement on what enterprise architecture encompasses. (Walrad, Lane, Wallk & Hirst 2014, 42.) Thus, the industry and academia share these concerns. Basic research, as understood in the current research, addresses these problems being the key to progress within the field. However, the research discipline of enterprise architecture seems to have jumped over this phase. This has much to do with the fact that enterprise architecture is a practice-driven discipline. Academic research seems to have started investigating and exploring the process and adoption, before thoroughly understanding the concept (Langenberg & Wegmann 2004, 7; Buckl et al. 2009; Schöenherr 2009).

Enterprise architecture brought the concept and term of architecture into the context of organisations (Lankhorst et al. 2005, 2) and with the organisation-wide view the ambiguity arose. Adopting architecture into business thinking from the IT field requires a lot of effort and interdisciplinary understanding. This need derives from the fact that development has intertwined these two disciplines. Roughly, the situation is as follows: Architecture is successfully used in designing and building information systems. The fundamental idea is also used in business process management using business process

modelling and for instance in business process engineering. However, when architecture is (figuratively) put on an organisation, which consists of business processes that are supported by IT systems or that are IT systems themselves, keeping clear where one ends and the other begins on an abstract level is at least ambiguous.

The confusion derives from the difference in viewpoints and therefore, the key is in a new level of interdisciplinary thinking. When information systems and technology are an integral part of businesses they cannot be dealt with separately as in silos when adopting holistic thinking. Neither can their architectures. Thus, in enterprise architecture the viewpoint is neither that of the IT nor that of the business – it is interdisciplinarily holistic.

4.3.1 Definitions and Descriptions

As suggested by the research gap and problem statement, one major obstacle troubling the discipline of enterprise architecture is the lack of agreement on the definition of enterprise architecture (e.g. Schöenherr 2009; Pereira & Sousa 2004, 1367). "Enterprise architecture is a term that is often used but rarely studied." (Drobik 2002). Relative to the timeline of publications within the field, Drobik (2002) points out the need for more basic research quite early and regardless of him stating this point almost 12 years ago, unfortunately it still holds true.

A definition should be simple and understandable and contain explicit clear concepts to express important distinctions in the field. The scope of a good definition should cover important areas of interest and not exclude even obvious phenomena. Thus, a valuable definition explains the subject well and expresses the organisation, relationships, and important information of concepts within the subject being defined. Hence, by exposing the overall space of the concept and its interrelations a well-formed definition provides important questions for research and points possible research gaps or directions to be discovered.

Explicitly stated definitions of enterprise architecture can be found in literature (table 4). However, considering the amount of publications, definitions are seldom presented. Also in research, definitions are rarely used and the concept of enterprise architecture is most often explained using an analogy. For example, the meaning of architecture in the enterprise context is often explained using examples of building architecture and reflecting those on the organisation (e.g. Bernard 2012, 32; Lankhorst et al. 2005, 1; Zachman 1987). Building a house is a good analogy for explaining enterprise architecture still, interpretations of enterprise architecture do not seem to correlate with it. Table 4 shows how definitions of enterprise architecture embrace various views and different types and scopes.

Table 2 Definitions of enterprise architecture

Definition	Origin	View/Type	Reference
"A coherent whole of principles, methods, and models that are used in the design and realisation of an enterprise's organisational structure, business processes, information systems, and infrastructure."	Proprietary	internal to the organisation /method	Lankhorst et al. (2005, 3)
"Enterprise architecture (EA) identifies the main components of the organization, its information systems, the ways in which these components work together in order to achieve defined business objectives, and the way in which the information systems support the business processes of the organization. The components include staff, business processes, technology, information, financial, and other resources, etc."	Proprietary	internal, structural /descriptive	Kaisler, Armour & Valivullah (2005, 1)
"Enterprise Architecture–a strategic information asset base, which defines the mission, the information necessary to perform the mission, and the technologies necessary to perform the mission, and the transitional processes for implementing new technologies in response to the changing mission needs. An enterprise architecture includes a baseline architecture, target architecture, and a sequencing plan."	Federal CIO Council	internal or external strategic, evolutionary /descriptive, process	CIO Council (2001, 5)
"An enterprise architecture is a plan of record, a blueprint of the permitted structure, arrangement, configuration, functional groupings/partitioning, interfaces, data, protocols, logical functionality, integration, technology, of IT resources needed to support a corporate or organizational business function or mission."	Proprietary	internal, static technical view /descriptive	Minoli (2008, 35)
[Enterprise Architecture] "The Analysis and documentation of an enterprise in its current and future states from an integrated strategy, business, and technology perspective."	Proprietary	internal strategic, evolutionary /descriptive	Bernard (2012, 31)
"In TOGAF, "architecture" has two meanings depending upon the context: 1) A formal description of a system, or a detailed plan of the system at component level to guide its implementation	The Open Group	internal, structural evolutionary, /descriptive	(TOGAF 9.1 Core concepts)

2) The structure of components, their inter-relationships, and the principles and guidelines governing their design and evolution over time"		limited to plain "architecture"	
"Enterprise architecture is the process of translating business vision and strategy into effective enterprise change by creating, communicating and improving the key requirements, principles and models that describe the enterprise's future state and enable its evolution. The scope of the enterprise architecture includes the people, processes, information and technology of the enterprise, and their relationships to one another and to the external environment. Enterprise architects compose holistic solutions that address the business challenges of the enterprise and support the governance needed to implement them."	Gartner Inc.	internal and external strategic, change, evolutionary, /descriptive, process	Lapkin, Allega, Burke, Burton, Bittler, Handler, James, Robertson, Newman, Weiss, Buchanan & Gall (2008, 2)

Based on these definitions, it is not clear whether enterprise architecture is a method for doing some set of processes or a static architectural representation that does not include any implementation or both. The definitions vary in scope and viewpoint; Lankhorst et al. (2005, 3) clearly define enterprise architecture as a method and take an internal view by not including any context outside the organisation. Kaisler et al. (2005, 1) also take an internal viewpoint, but regard enterprise architecture more as a representation of the organisation's structure, resources, and their interrelations than a process. The Federal CIO Council's (2001, 5) definition includes both, a descriptive part and a process view. With "changing mission needs" it implicitly implies that the enterprise is a responsive system within its operational space, although not explicitly stating whether these needs are external or internal to the enterprise. It also takes a strategic stand including an evolutionary dimension from the "as-is" architecture to the "to-be" architecture.

Minoli's (2008, 35) definition represents an IT point of view and thus, rather describes a static IT architecture than enterprise architecture. This kind of (mis)interpretation is similar to that of enterprise architecture frameworks claimed by Ohren (2005, 136) and appears also in academic research reports where holistic and enterprise-wide might be interpreted to mean a holistic approach to enterprise-wide information systems, disregarding all other aspects of the organisation (Khayami 2010, 1277; Ekstedt, Franke, Johnson, Lagerström, Sommerstad, Ullberg & Buschle 2009, 327). However, misperception is difficult to determine and depends on temporal and contextual attributes. Especially in the context of enterprise architecture, which as a concept has evolved and changed scope, and is still continuing to evolve. Thus, it is

difficult to say where the concept will develop. Nevertheless, at this point one can only do his or her best to contribute to current knowledge. Hence, a misperception is arguable only when the specific perception contradicts with a specified context and current knowledge. This means that an established and agreed upon definition is needed in order to determine whether an interpretation of it is justified or not.

Bernard (2012), the author of the EA^3 Cube Framework, takes a static viewpoint in his definition as well. He does include analysis and documentation as processes, but does not imply any further implementation based on these. His definition takes an internal and strategic view includes current and future states similarly as The Federal CIO Council. In spite of TOGAF being the industry standard for enterprise architecture, it does not define specifically enterprise architecture. However, because it is the practice oriented industry standard, it differs from others by nature and has grown from a framework to a comprehensive set of methods, guides, and tools embracing a number of other concepts, definitions, and practices such as, the enterprise continuum for example,[15] to ensure common understanding of TOGAF among practitioners (TOGAF 9.1 Core concepts). In addition, they collect user feedback and challenges that practitioners have had, develop, and update the framework periodically. This open mechanism ensures that they, first of all continuously develop, but also address current issues.

The Gartner definition of enterprise architecture (Lapkin et al. 2008, 2) differs most from the others; it includes the descriptive dimension, but presents a process with business objectives. More specifically the architectural representation is presented as a means to achieve successful change. It brings forth an important purpose for the descriptive part as enabling the enterprise's evolution (implicitly implying the importance of information in development) and states a wide scope of components and their interrelations also including their relationship to the environment. In addition, it adds a holistic managerial perspective that includes the aspect of enterprise architecture as a profession. All in all, enterprise architecture is defined in two core meanings: 1) as architectural representations or descriptions of an enterprise and/or 2) as some implementation of such descriptions.

The definitions presented in table 4 share several common characteristics that can be identified. All of the definitions contain a notion of a structure, which is the central feature in architecture and directly related to modelling systems and producing architectural descriptions. Main components of the organisation are also recognised either as such, or by listing examples (e.g. business processes, information systems, and infrastructure). The two main organisational components are business and IT. Strategy, business mis-

[15] For further information on TOGAF concepts see, definitions of core concepts of TOGAF 9.1 (http://pubs.opengroup.org/architecture/togaf9-doc/arch/chap02.html).

sion, target architecture, business objectives, and evolution, all imply planning and aligning resources and relate to strategic management. This research complies with both of the aforementioned core meanings of enterprise architecture; static (descriptive) and dynamic (normative), starting from creating the architectural representations by modelling different structures of the enterprise using the same specified modelling language that is, documenting the enterprise architectures. Only after creating the architectural representations can a process begin where value is created by utilising those architectures in the management approach.

Gartner Inc., an information technology research and advisory company that actively conducts research in the field of enterprise architecture, has specified its definition to represent by far the most comprehensive description of all the definitions presented in table 5. Actually, the most developed definitions all seem to be formed by practitioners. Within academia in turn, the discussed definitions are seldom referred to and due to so little basic research, academic research does not offer many alternatives. Instead, many authors reflect enterprise architecture to the definition of *architecture* in software-intensive systems standardised by the Institute of Electrical and Electronics Engineers (IEEE) (see e.g. Haki & Legner 2012, 182; Stelzer 2010, 12; Pulkkinen 2008, 44): "An architecture is the fundamental organization of a system embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution" *(ISO/IEC 42010:2007(E) IEEE Std 1471-2000, 2007)*.

Admittedly, the IEEE definition is a sound definition of architecture and is one of the most visible definitions in the field of enterprise architecture as well. However, for enterprise architecture it is too general in scope and therefore not a sufficient definition to describe the holistic concept or practice. This seems to be also the reason why the IEEE definition is most often accompanied by a *representative statement* of enterprise architecture for further description and clarification to the reader. Jonkers, Lankhorst, ter Doest, Arbab, Bosma, and Wieringa, (2006, 63–64) make an exception as they introduce the IEEE definition as one commonly used in the IT field and then describe enterprise architecture as a structure with vision in the level of an entire organisation and define it as Lankhorst et al. (2005, 3) do in table 4.

One of the findings in this research is that the most variety in interpretation of enterprise architecture appears within these representative statements of which examples are collected in table 5. Representative statements also appear in research much more often than definitions do.

Table 3 Representative statements of enterprise architecture

Representative description of enterprise architecture	**View**	**Reference**
"…an attempt to provide coherence to the expression and implementation of strategy"	strategic integration	Veasey (2001, 420)
"Enterprise Architecture approaches are used to provide rigorous descriptions of the organization-wide environment, manage the alignment of deployed services to the organization's mission, end ensure a clear separation of the concerns addressed in an architecture. Thus, an effective Enterprise Architecture approach assists in the management of relations and dependencies of any components of the organization environment and supports the integration and evolution of the architecture."	strategic management, alignment, integration, evolution any scope within the organisation	Antunes, Barateiro, Becker, Borbinha, Vieira (2011, 3)
"Enterprise architecture is the logic underlying a business"	business logic	Purao, Martin & Robertson (2011, 383)
"Enterprise Architecture is a high-level definition of the data, applications, and technology needed to support the business…"	IT/IS management	Erol, Mansouri & Sauser (2009, 3)
"Enterprise architecture (EA) is an approach to enterprise information systems management that relies on models of the information systems and their environment"	IS management	Källgren, Ullberg & Johnson (2009, 346)
"Enterprise architecture is first and foremost an output of a process."	process	Walrad et al. (2014, 43)
"Architecture is defined as the structure of components, their relationships, and the principles and guidelines governing their design and evolution over time (IEEE 1990). This is a structural definition. Functionally, an enterprise architecture explains how all information technology (IT) elements work together as a whole."	IT management	Morganwalp & Sage (2002/2003, 88)
"During the last decade, enterprise architecture has grown into an established approach for holistic management of the information systems in an organization." "The purpose of having enterprise architecture models and conducting analyses of these is to facilitate the making of rational decisions about information systems in an organization."	IS management	Johnson, Lagerström, Närman, Simonsson (2007)

"Enterprise architecture is a framework to develop and maintain IT, to achieve organizational goals and to manage resources of this technology." "Information technology enterprise architecture, in short enterprise architecture (EA)…"	IT management, strategy, technology	Khayami (2010, 1277)
"Enterprise Architecture (EA) is a business and IT management tool…"	business/IT mangement	Plazaola, Flores, Vargas, Ekstedt (2008, 1)
"Sometimes the term "Enterprise Architecture" refers to that group of people responsible for modeling and then documenting the architecture. Other times, the term denotes the process of doing this work. More commonly… …we are referring to the models, documents, and reusable items (as components, frameworks, objects, and so on) that reflect the actual architecture. However… … Enterprise Architecture is a framework or a "blueprint" for how the organization achieves the current and future business objectives."	modelling, documenting, process, architectural representations, framework/blueprint for strategy execution	Pereira & Sousa (2004, 1366)

Collecting and comparing examples of representative statements (table 3) create a view to the varying interpretations of enterprise architecture within academic research. In five out of 11 descriptions enterprise architecture is seen only as a matter of information systems or information technology. Four describe enterprise architecture as a business or strategic management issue and one aligns the two. Pereira and Sousa (2004, 1366) are one of the very few (see also Ohren 2005, 136) who explicitly acknowledge or mention the fact that there are different scopes and meanings for the term and concept.

The lack of consensus is one of the characteristics of the discipline's infancy however, the holistic scope to which the terminology refers seems to increasingly attract discussion and research publications indicate that development is heading towards a more balanced concept. Further attention on the definition and composition of enterprise architecture might slowly balance the dominance of IT and support further determining of the scope of holistic enterprise architecture.

Organisations such as, the Federation of Enterprise Architecture Professional organizations (FEAPO) with its member organisations collaborate for the purpose of establishing a qualified, self-governed profession for enterprise architects. Their view is that enterprise architecture's importance to business change requires enterprise architecture to mature in a much shorter time compared to the time formal professions have traditionally taken (cf. Gardner 2011) Thus, they have set a shared goal for the enterprise architecture profession to become mature and autonomous by 2017. (Walrad et al. 2014, 43.)

However, standardising the profession and creating service quality requires common agreement on the definition, composition and meaning of the concept.

4.3.2 Terminology

Another important factor in perceiving enterprise architecture is terminology or in this case mainly the use of terms. As mentioned earlier, terminology is an integral part of concepts and conception. The perception of highly abstract concepts is very much at the mercy of terminology. However, also terminology is subject to interpretation and thus, differs in many ways between individuals as well as scientific definitions and everyday-life understanding and usage. Terms are naturally interpreted differently across disciplines, due to different contexts. In research and literature many terms are used inconsistently within a particular subject. Here the importance lies in whether it is done knowingly or not. In the case of enterprise architecture, confusion stems partly from the use of same terms and concepts as in the IT discipline while establishing a new discipline with same terms, but in another context. In addition, these contexts are strongly intertwined with each other, whereas construction architecture is not likely confused with IT or IS architecture because they are so clearly different from each other.

Varying use of terms and ambiguous concepts can lead to misconceptions that may have severe consequences. Misconceptions may result to misled research or create high excess costs for businesses. Thus, defining the specific concepts that one uses in research is important in their role in representing the author's stand. Same terms used with various meanings challenge incorporating justified concepts and theories into practice. As argued earlier, knowledge diffusion, applicability, and development of the practical (empirical) world is in the long run dependent on theory and theoretical concepts. (Hirsjärvi et al. 2001, 138–140; Fisher 2004, 215–222; Uusitalo 2001, 36–39.)

Concepts are based on meaning. In the empirical world concepts have a purpose and a common or specific target they are applied to. In the Oxford Dictionary of English (2013) *architecture* is defined as "the complex or carefully designed structure of something. …the conceptual structure and logical organization of a…" The term *architecture* is generally used to describe the composition and structure of a system. The IEEE Standard definition of architecture is broader in scope and more complete compared to the traditional dictionary definition and thus, provides better guidance for applying architecture in general within a system. Originating from the world of physical construction i.e. buildings, architecture is used to describe the various elements and the design of a building in a way that an instantiation of that specified architecture could be created or implemented based on that specific architectural description.

The concept of architecture has been logically and successfully transferred to the context of information systems, where the architecture describes the construction and structure of for instance, a technical infrastructure or a software system and the behaviour and interactions of elements therein. For example, Bass, Clements, and Kazman (2003, 3) define that "The software architecture of a program or computing system is the structure or structures of the system, which comprise software elements, the externally visible properties of those elements, and the relationships among them."

Incorporating the idea and concept of architecture from concrete physical systems to abstract systems may be challenging. In spite of software systems containing an abstract or non-physical dimension, they still operate as logically designed technical systems. However, a majority of the aforementioned logic and consistency is absent in social systems that consist of subjective actors (i.e. humans) and where structures of cause and effect area non-linear (Combe & Botschen 2004, 501–502; Sterman 2000, 21.) Organisations, as sociotechnical systems, are combinations of these two systems that operate with different logic (Kloeckner & Birkmeier 2009, 23). Thus, the differences between these logics in thinking with their discipline-specific cultures create a type of an underlying mechanism that affects the behaviour and perceptions of individuals in different departments within the organisation. This is also the root cause for the common thought that business people and IT-people cannot communicate with each other in an understandable way.

The term and concept of architecture can basically be applied to any system that has some design and structure that interrelates regardless of the way that structure has formed that is, the structure being intentional or arbitrary. Hence, in Finland the term architecture has become somewhat of a buzz-word in the recent years and can be seen often in for instance, job announcements where suddenly many managerial or other roles that contain some responsibility of a function or process have become architects.

Since architecture is used in different contexts the term is commonly used together with a prefix to help determine the target and scope of the architecture in question. In enterprise architecture, the term architecture is used to describe the design of the enterprise itself as a system and the systems within the organisation or enterprise. Enterprise architecture encompasses a number of sub architectures of which each represents a specific function or viewpoint of the enterprise. The terms enterprise architecture domain, main component, sub architecture, or architectural layer are also used to describe these viewpoints.

An architectural representation can describe the organisation on different levels of detail. For example, enterprise architecture (broadest level) covers the whole enterprise and includes sub architectures that are systems within the enterprise such as, business architecture, information architecture and IT architecture. Each sub architecture contains their own respective systems that can be modelled to an architectural representa-

tion on the next level of detail. For example, IT architecture containing a hardware architecture. Similarly, building architecture or construction architecture describes the design of a building, its elements (e.g. rooms and spaces), the properties of those elements (e.g. functions and purpose of use such as, bedroom, bathroom) and so on. Thus, the level of detail determines the accuracy of the specific architecture and the specific purpose of that architecture determines the necessary level of detail thereof. The more the architectural representation contains detail the closer it is to practice and implementation. Hence, architectural representations can be seen as tools for deconstruction and analysis of the target system that is being architected.

The term *enterprise* is defined by the Oxford Dictionary of English (2013) as "A project or undertaking, especially a bold or complex one / a business or company". The definition of an enterprise and its umbrella-like role as embracing the systems therein builds an argument for the use of the term architecture with the enterprise prefix (figure 22).

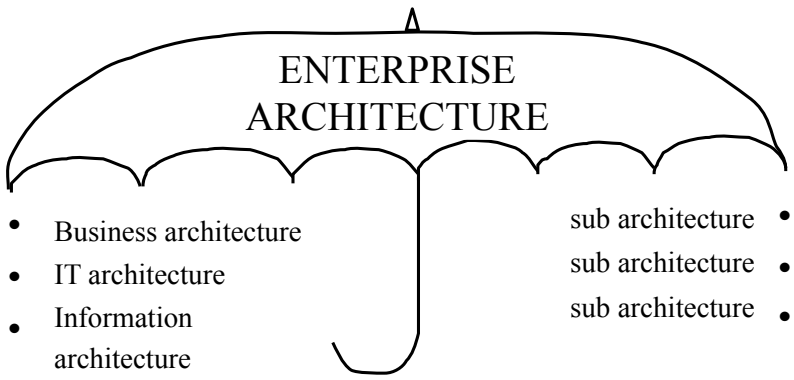

Figure 22 Umbrella-organisation of architectures (adapted from Tapio 2009, 19)

Logically, as the architectures that describe the main elements or systems within an organisation are sub architectures, the architecture of all of those systems that make the enterprise is enterprise architecture.

When enterprise architecture is described in research as merely the architecture of the enterprise's information systems, all the other systems within the enterprise are disregarded and the broadest term is used to describe something that is only a narrow part of the whole. The difference of taking a specific viewpoint in describing enterprise architecture compared to the viewpoints of organisation theory is that the descriptive part (architectural representations) of enterprise architecture directs the possible following implementation (process). These two phases are an essential part of the definition that makes the distinction between the static descriptive definition and the process definition for implementation (doing EA). In organisation theories, the different viewpoints are primarily used to describe and understand the organisation and based on these viewpoints, separate concepts for various implementation are used. Therefore, the multitude

of perceptions in organisation theories complement each other and create richer knowledge within the discipline.

In inconsistent use of terms regarding enterprise architecture, most often a broader term is used to describe a narrower concept. The other way round is more difficult to determine, although it is possible to say for example, business architecture and mean the whole enterprise architecture, but no indication of this have been identified in literature. Another observation from the research material is that sub architectures or enterprise architecture domains are often discussed separately and accurately regarding scope and terminology, but completely without any mentioning that it is one of the many parts of a larger concept (the enterprise) or in the best case enterprise architecture (see e.g. Reynolds 2010).

Enterprise architecture, whether being an architectural representation or a process, is always as complex as the enterprise itself is. Therefore, in case the objective is to create a holistic understanding of an enterprise and maximise the potential benefits of creating value through architectures, there are no shortcuts to take. The larger and more complex the organisation is, the more complex its architecture is. This is important to notice in the use of holistic terms and concepts. The description and practice of enterprise architecture can be applied to any enterprise, be it a department, a unit, a single project or any other undertaking that has a common goal (Schekkerman 2004, 22) however, in this case it must be understood when considering the results, goals, and benefits of that specific endeavour. The benefits of a holistic approach are restricted to the boundaries that determine the whole that is, enterprise architecture applied to a single unit does not bring colossal enterprise-wide results (cf. Källgren et al. 2009).

The argument is that in accord with the meanings of terms, enterprise architecture should be used only when meaning the complete architectural landscape of an enterprise that is, all of the sub architectures it (the enterprise) encompasses. As this research shows, the boundaries of the specific architecture that is meant can be determined and described by the term that is used as a prefix for the term architecture as illustrated in figure 23. The prefix for a sub architecture is the term that describes that particular organisational element. An element is for example, any area of business, processes, people or technology (Schekkerman 2004, 22). The terminology is clear and logical. It works well as long as it is used consistently according to its logic.

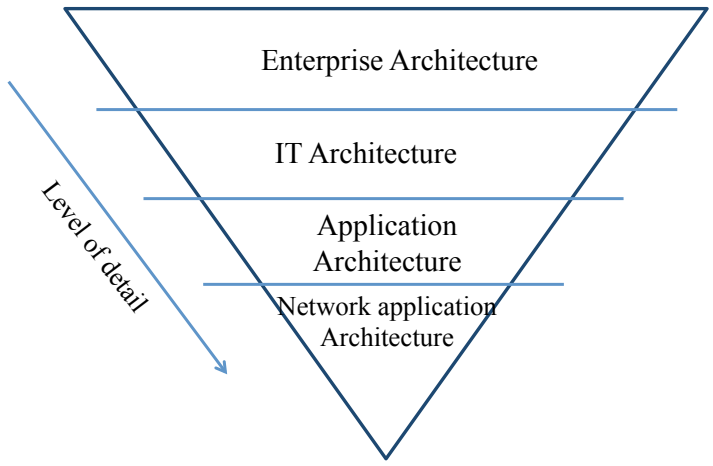

Figure 23 Use of terms by scope of concept

In addition to the specific prefix the particular architecture is determined with, it is also determined by the category of the broader sub architecture it is part of. With this logic, application architecture under IT architecture would contain all applications within the enterprise. However, application architecture under network architecture would be network application architecture and contain all applications that the network system contains.

Regardless of whether being used consistently or not, the field of enterprise architecture has a logical, descriptive, and relatively consistent terminology. Some say that confusion stems from the very reason that disciplines adopt terms and concepts from other disciplines however, when the concept is clear and adaptable as such it is better to use existing concepts applied in different contexts. On the contrary, without analogies it would hinder understanding and create even more confusion if each discipline would come up with new terms to describe similar phenomena, only in a different context. As suggested earlier, terminology has an important role in the perception of concepts and their meaning therefore, consistent use of terminology is the starting point in eliminating confusion and misinterpretation of enterprise architecture.

5 CONCEPTUALISING HOLISTIC ENTERPRISE ARCHITECTURE

Explicating means analysing and developing the subject matter in detail or analysing the subject matter in order to reveal its meaning. To explicate and reach a deeper understanding of enterprise architecture, a conceptual analysis of enterprise architecture and its domains is needed. Based on the analysis conducted, a conceptual model of enterprise architecture is created and described in its context. Understanding of the core logic and mind-set of enterprise architecture is then derived from a synthesis of the theoretical foundation and conceptual analysis of the subject matter.

5.1 Enterprise Architecture Domains – Architectural Representations

Terminology provides a good logic for enterprise architecture domains or sub architectures. As the terminology suggests, enterprise architecture encompasses the entire organisation and all of its architectures and can be thought of as a meta-structure or meta-architecture. Enterprise architecture domains are the main elements of the organisation. According to Schekkerman (2004, 22) these elements are "…all the elements that enclose the areas of people, processes, business, and technology". Within the organisation these are for example, units, domains, budgets, information, functions, processes, technology, services or communications. The structure of the organisation and viewpoints of the whole determine the scopes of the organisation's main elements and thus, the domains of enterprise architecture. In theory, the main elements within the concept should be defined in an adequately high level to ensure wide applicability regardless of the type, structure, and size of the organisation adopting the approach.

Different frameworks suggest different viewpoints to be the main domains of enterprise architecture. Accordingly, the frameworks then include different sub architectures. For example, the Extended Enterprise Architecture Framework (E2AF) differentiates the viewpoints of business or organisation, information, information systems, and technology infrastructure (Schekkerman 2004, 98). Iyer and Gottlieb (2004) suggest a Four-Domain Architecture (FDA) that includes a process domain, information/knowledge domain, infrastructure domain, and organisation domain. As an example of different domains, below is a categorisation of typical elements of the FDA.

- Process domain
  - business context engines
  - planning engine
  - visualisation engine
  - business tools

- information/knowledge domain
  - business data
  - business profiles
  - business models
  - data models
- infrastructure domain
  - computers
  - operating systems
  - display devices
  - networks
- organisation domain
  - people
  - roles
  - organisational structures
  - alliances.

The most commonly defined domains are those of the business, data, applications, and technology (TOGAF 9.1 Core concepts). In this case it is often interpreted that out of all four domains three concern mainly the IT department, which fosters the inappropriate division of roles and responsibility stressing the IT department without giving a proper idea of a truly holistic approach. In the holistic mind-set of this research, information and knowledge management are seen as vitally important and as something much more than just data management. Information, knowledge, and decision-making are based on data, but once in an organisation they become much broader functions of the sociotechnical system and are essentially important for an organisation that seeks to survive in the hectic economy. Therefore, it is preferred that information architecture is its own domain within the holistic enterprise architecture. Data architecture is extremely important; as the knowledge hierarchy shows information and knowledge are constructed of data thus, it is natural to place data architecture as a sub architecture of information architecture. However, because data has everything to do with technology, data architecture must have a technical architecture as well.

Enterprise architecture is always case-specific, which makes it more challenging to conceptualise based on information from practice. Case-specificity means that it is an accurate reflection of the organisation and therefore ultimately will include the specific architectures necessary for the specific organisation. On the conceptual level, the main elements of a phenomenon should be simple and comprehensible to support wider understanding and generalizability.

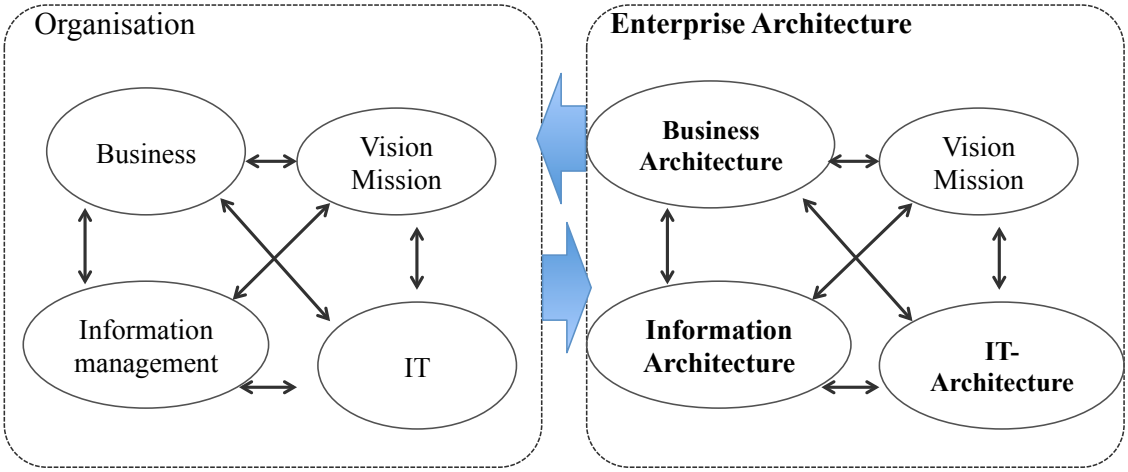

Figure 24 The organisation and its holistic enterprise architecture

Hence, this research suggests three domains namely, business, IT, and information to be the general main domains and starting point of the concept of enterprise architecture (figure 24). These three main domains are second-level sub architectures and are on the second level of detail after the meta-concept – enterprise architecture. To ensure targeted strategy execution, all of the domains are reflected to and aligned with the organisation's strategy, vision, and mission. As the main components or domains are concepts on a higher level of abstraction and conceptual scope they thus encompass the entirety of the whole organisation. Any viewpoint or element or system that is architected may be placed under one of these main domains. For example, geographical locations and alliances go under business architecture, communications under information architecture, and computers and applications under IT architecture.

Business architecture, in the top left corner in the organisation's enterprise architecture describes the business system including for example, the environment of customers and suppliers, business processes, people and roles within the unique organisation. IT, in the bottom right, includes all specific technological assets and infrastructure (e.g. hardware, software applications, UI frameworks, database management systems, and networks). Between business and IT is information architecture, which reflects the design of the information management domain and includes for example, information acquirement, organisation, distribution of information and knowledge, and communication. Architecting (mapping and modelling) the information structures of an organisation brings enormous possibilities for increasing operational effectiveness and reducing costs of operation. According to Schekkerman (2004, 14) enterprise architecture "enables organisations to reduce duplication and inconsistencies in information". The same principle as in business process reengineering (BPR) where duplication and inconsistencies in business processes can be reduced.

Regarding the nature of information and IT, their domains are not completely separable. The same applies to business and technology as has been discussed. Therefore, information management's role is also to link business and IT. Broader information systems (apart from their technology) are in the domain of information architecture. For example, organisational memory is part of knowledge management (information architecture), and well-designed IT systems are the essential enabler of data and information repositories, in other words, organisational memory. Information management can plan and design necessary information needs with the business and collaborate on implementation with IT. Hence, information management/architecture domain mainly plans, maps, and is responsible for non-technical information management, but overlaps and actively collaborates with business and IT to keep the enterprise architecture coherent and aligned. Information management is increasingly growing its importance as a strategic asset for organisations. Yet, much research on enterprise architecture disregard information and knowledge management or equate information architecture with data architecture.

5.2 Enterprise Architecture in Context

Enterprise architecture and its predecessors were initially created for the need to manage increasing structural and dynamic complexity in information technology systems. From information systems, enterprise architecture has evolved into a holistic approach that applies the idea of increasing efficiency and managing complexity to address the complete organisation instead of its information systems only. (Zachman 2008; Enterprise Architecture 2013.) *Approach* is a good term to describe the mind-set needed in holistic enterprise architecture, because a mind-set goes beyond descriptions and implementable methods as ultimately all the things that we do depend on the way we think.

As discussed, there are many ways in which the environment affects organisations. In general, increasing uncertainty creates an increasing need for information (Hatch 1997, 90–91), which is the essence of the current reality and highlights the importance of information management. Data are growing and therefore, data mining is a constantly growing and developing field (Shmueli et al. 2010, 5). As data processing and analysis are moving closer and closer to real-time analysis so is business as well. However, enabling real-time business, broad and sophisticated technology and information systems become vital for an organisation to have, but also vital to function flawlessly with their growing size and complexity. When properly designed, IT creates a powerful capability for organisations to manage information and build responsiveness to external, but also to internal demands.

The idea of enterprise architecture encompasses sophisticated IT and information systems for high quality information and knowledge management. By utilising the architectural descriptions enterprise architecture enables the organisation to better design, build, manage, and change its IT infrastructure. Still, in an organisation, IT enables and supports business execution, not vice versa. Within enterprise architecture complex organisational systems can be better aligned to the rest of the organisation and the architectures therein. Thus, enterprise architecture includes IT and information architectures to enforce their operational success and alignment within the organisation.

Because of the total scope of holistic enterprise architecture, top priority from higher management is mandated. In this respect, higher management should pay utmost attention on enterprise architecture as the overall mind-set and approach to successful management and business strategy execution. As IT professionals are already familiar with the concept of architecture within IT and IS they often look for enterprise architecture when trying to increase effectiveness and keep up with the growing business requirements for IT. Currently the initiative for enterprise architecture often comes from the IT department and IT viewpoint and therefore, seldom reaches the higher management as a holistic and strategic enterprise-wide management approach.

Being open systems in the big data environment and information age it is essential for organisations to excel in scanning their environment that is, data and information therein. However, being alert to challenges that are external to the organisation is not sufficient without self-awareness and ability to adapt internally as well. A systems view of the organisation supports the understanding and designing of an organisational structure that is optimised as a whole, including its constituent systems and their interrelations as well as their relations to the environment as in figure 25.

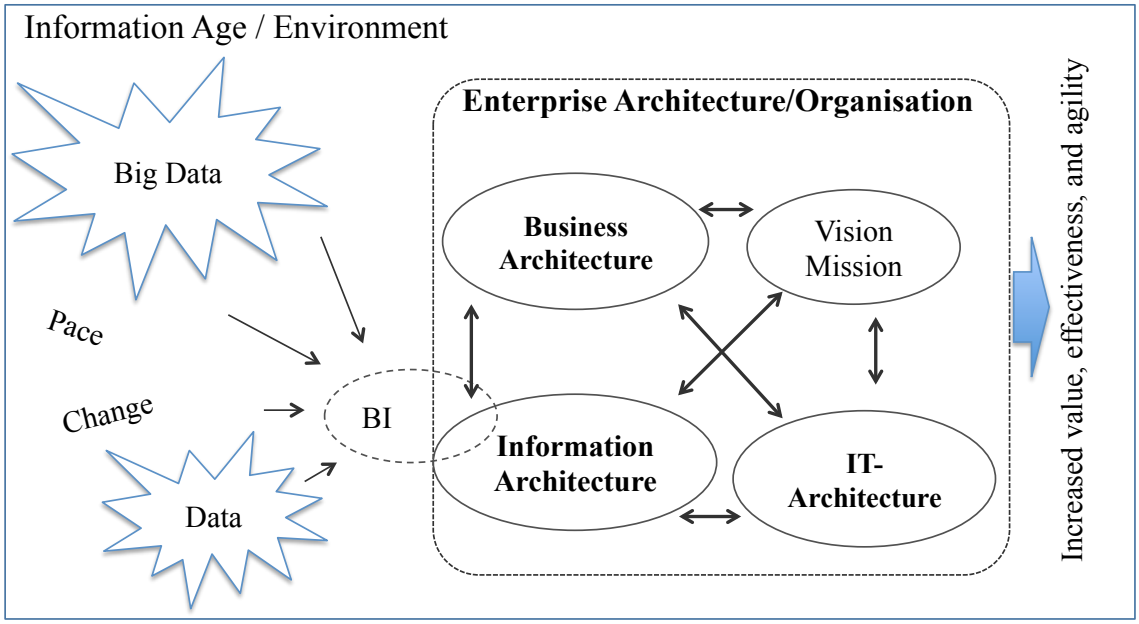

Figure 25 Enterprise architecture, its main elements, their interrelations, and relation to the environment

In figure 25 above, the organisation consisting of its main elements, their operation and interrelations, reflected by the enterprise architecture are set in context. The context of enterprise architecture however, can be determined in two scopes: 1) The narrower context is the organisation that the enterprise architecture depicts and 2) the broader context is the organisation embedded in its business environment as illustrated in figure 25.

Placing the organisation in the context of the digital information age highlights the essentially vital role of business intelligence (BI), information management, and knowledge management in maintaining the organisation's operation and capabilities. Tough competition requires organisational intelligence and to become an intelligent organisation a holistic approach that successfully integrates information and knowledge at all levels of the organisation needs to be adopted. Information architecture is a way to visualise the abstract dimension, functions, and even information flows as the integral part of the organisation. In addition to a technical part, the essential characteristic of information management is that it includes the social human aspect and is not concentrated solely on technical information issues (see e.g. Choo 2002, xiv).

Information management and IT share many functions and areas in the whole system and depending on the organisation's size and composition their roles overlap. In addition, there is strong *causality between all three domains*. In all cases, information management and IT are dependent on the business, but also the business is dependent on information and IT. The business determines the information that it needs. Information management is responsible for the information and IT is needed to implement systems

that can deliver the needed information. Thus, the main elements of enterprise architecture have high interdependence. The organisation and enterprise architecture should be initiated from the vision and be built to fulfil its mission. It is important that all of the main elements and their architectures are reflected to the organisation's strategy to ensure the right direction of operation. Concentrating on only one of the elements is a short-term objective and does not generate the desired total outcome. Thus, a long-term objective requires a holistic approach.

The gate between the organisation and its information-intensive environment is data collection, processing, and analysis – business intelligence. Business intelligence determines the organisation's ability to utilise external information within the organisation. Data quality (e.g. timeliness, accuracy) determine the quality of information the organisation uses to support their decision making and the knowledge its learning is based on. When the organisation is viewed as a system it supports also the understanding of enterprise architecture describing that system. As Zachman argues, the only situation where architecture is not needed is when one is able to comprehend the entirety of a system or artefact by a glance, being able to see, understand, and remember each element of that system, their roles, and interrelations (Zachman 2011).

In addition to analytics and business intelligence, information management and knowledge management address topics that are important in holistic enterprise architecture. Visualising the abstract construction of the organisation by creating the architectural descriptions or representations of its internal structures brings the organisation's self-awareness into a completely new level. Modelling those structures across the enterprise with a specified shared language brings the abstract structure into a concrete manageable form. In enterprise architecture the architectural representations are subject to constant change and each update creates a new description. Saving these descriptions in the organisational memory provides a basis for self-reflexivity and organisational learning by creating and revealing a comprehensive documentation of the organisation's evolution.

This record of evolution and changes is a central strategic asset that greatly supports the organisation's learning, development, and navigation in the global economy. Furthermore, building a well-designed system and structure for the organisation's internal communication and providing the staff with access to their architectural knowledge base would engage and commit individuals to a system that ultimately drives the strategic goals and facilitates the exposure and utilisation of tacit knowledge. Thus far, holistic enterprise architecture can be seen as a strategic method for business intelligence, knowledge management, and organisational learning – all essential features of an intelligent organisation.

5.3 The Dialogue Between Enterprise Architecture and Strategy

Usually a more or less arbitrary structure exists in an organisation prior to enterprise architecture. Therefore, the ability to optimise the organisation's composition and design and concentrating on structuring capabilities for apt operation, is done by building a strategic roadmap for architectural descriptions. Firstly, an "as-is" architecture is modelled, which describes the organisation's processes and structure in the state they are in. Based on the current structure a "to-be" architecture is formulated to enable organisational change in a managed way to guide the organisation's strategic operation (e.g. Giachetti 2012, 147–148). Thus, in the optimal state enterprise architecture is a comprehensive and effective means for an organisation's strategy execution.

Because of the holistic approach well-executed enterprise architecture creates comprehensive transparency, awareness, manageability, optimisation, and integration encompassing the whole organisation. The increased need for agility caused by the pace of change in organisations' environment requires the ability to respond to demands in any needed manner, which challenges the traditional strategic priorities (Holsapple, Jones & Singh 2007, 56–57). Strategy is too often formed as a separate comprehensive plan of action prior to implementation. Traditional strategy and ability to make possibly significant changes with a tight schedule while keeping course of operation do not fit together.

The nature of the organisation determines the appropriate method for its management. Managing and optimising complex organisations calls for systems thinking to create the agility and responsiveness organisations need today (Sheffield et al. 2012, 127). Figure 26 reflects this to the nature of strategy and elucidates how the adaptation to operating in the information age concerns strategy as well. Enterprise architecture is based on systems thinking an can be seen as an efficient strategy (Ross et al. 2006).

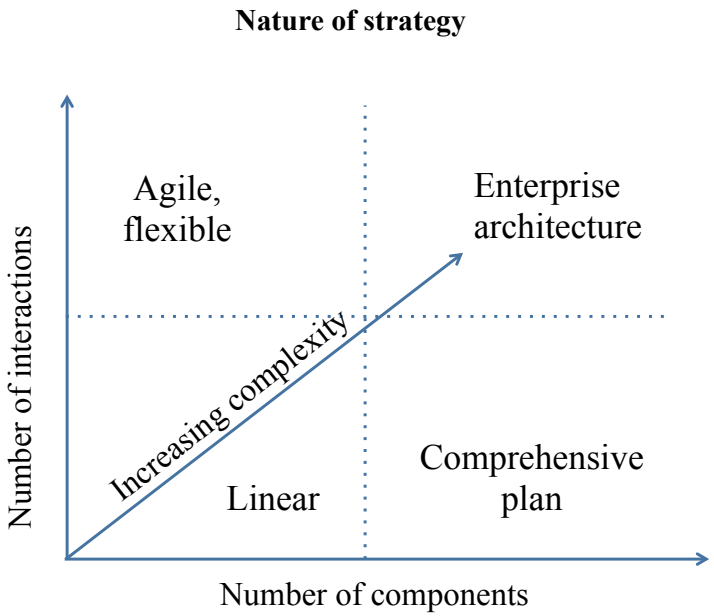

Figure 26 Enterprise architecture as strategy

Smaller and simpler organisations are more flexible and thus agile to adapt, because they require less effort to change. Thus also the nature of strategy is relatively agile and adjustable. When organisations grow to increasingly complicated systems the role of strategy and strategic management come to increasing importance. Strategy needs to be a comprehensive plan; it needs to take into account all the components in the organisation and plan how each of them contribute to achieving the vision. However, regarding a static strategy, the legend tells that the result of a massive strategy formulation endeavour, that takes a long time and consumes a lot of resources, often delivers a several hundred pages long opus to take shelf space in higher management offices. Nevertheless, a comprehensive static plan is difficult and costly to change often and often ends up being extra work on top of all the regular duties. When complicated heavy systems need to be changed often things become extremely complex and require a different logic in handling the whole entirety at once.

The purpose of architectural descriptions is to enable handling and optimisation of complex systems and structures. An aligned and optimised organisational design is the foundation for business capabilities. Thus, in the core logic of holistic enterprise architecture IT and systems thinking are used to bring forth the abstract complex system to enable handling and changing it in awareness of the entirety to enable sustainable operation and strategy execution in a turbulent environment. In enterprise architecture, the question is not how to transform strategy into the operation of the organisation. Enterprise architecture is a strategic way to operate and forming an enterprise architecture for an organisation includes its strategy as the starting point for designing and aligning the

architectures. As opposed to a separate static plan, enterprise architecture brings strategy to life.

5.4 Core Logic and Interdisciplinary Role of Enterprise Architecture

Because the means and tools for creating enterprise architecture are systemic and technical, they often lead to the IT department in an enterprise. When the lack of formal practices and standards is added (Walrad et al. 2014, 42) it is not surprising that many of the challenges and misunderstandings shadowing enterprise architecture arise from the fact that it is not clear whose territory this phenomenon should land on. Interdisciplinarity is important for successful organisations as innovations are often created across disciplines. However, the coalition of disciplines also produces challenges of which many are related to communication, because the unconscious level of culture, norms, traditions, logic, and personality affects human behaviour and communication. When these underlying mechanisms contradict the success of cooperation is challenged.

Today the two central disciplines that need to cooperate in increasing harmony are business and IT. Thus, in enterprise architecture research discussion circles around business and IT alignment (e.g. Wang et al. 2008). The idea of breaking silos has been introduced some time ago. To become manageable, large complex organisations or enterprises often perform their essential functions in silos that en up being too isolated from each other. However, this is a problem in many small or medium sized enterprises (SMEs) as well, highlighting the importance of internal communication and knowledge management. Enterprises and organisations need better tools to execute this idea in practice. The logic of enterprise architecture aims to break silos and connect all functions to an integrated whole despite of large size or high complexity. As figure 27 shows, interdisciplinarity is in the core logic of enterprise architecture.

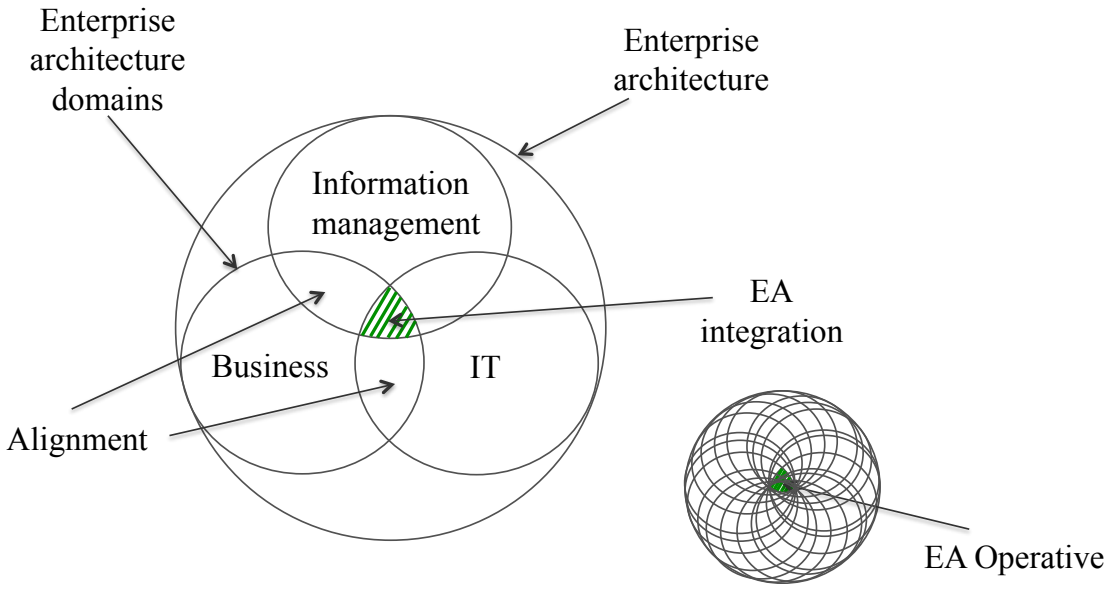

Figure 27 The core logic of enterprise architecture

Figure 27 depicts the core logic of holistic enterprise architecture. As emphasised, the central state pursued in enterprise architecture is coherence in the complex organisation by creating overall alignment and integration to better execute the business strategy. The concept of enterprise architecture is the meta-architecture and the overall approach for operating and managing an organisation. Within the meta-structure are the domains of enterprise architecture that represent the main viewpoints of the organisation as the sub architectures of enterprise architecture. To create coherence, these domains are aligned regarding each other and the strategy. Mapping and describing each domain with the same modelling language makes existing structures and connections visible and enables optimisation, integration, and alignment. Each sub architecture contains its own respective sub architectures and their details are determined by the state and structure of the specific organisation.

Enterprise architecture is an interdisciplinary approach that covers the complete organisation, integrates and aligns its structure and operations, and directs the whole organisation towards its objectives. In this logic, the conceptual model may be applied to any organisation where the case-specific sub architectures are determined regarding the unique organisation. The image in the bottom right corner in figure 27, illustrates the idea of the conceptual model including all the specified sub architectures integrated within the operative whole. The core logic is an essential part of the holistic mind-set for management characterised by this research.

6 CONCLUSIONS

Studying the information age and information society reveals the importance and abundance of data and information within the business environment, but also their importance for gaining competitive advantage and for the survival of organisations in the current time. Because the current time emphasises change, organisations' responsiveness, and agility, information and knowledge management must be given high priority. The central enablers of agility, responsiveness, and business intelligence are efficient and well designed IT and information systems. However, *true operational abilities that foster effective business strategy execution require architecture, integration, and a holistic management approach.*

An extensive collection of research material on enterprise architecture in turn, revealed the *inconsistent interpretation and immaturity of the concept.* The inconsistent interpretation results from the ambiguity of roles and core logic within the concept. Together with the fact that enterprise architecture implementation is always case-specific this explains the fragmented collection of frameworks and methods for implementing enterprise architecture. The vague core logic and purpose also hinder business- and top management's adoption of their central role and responsibility in enterprise architecture programs. Higher strategic- and business management's adoption is a must for the development of the holistic approach.

Research shows that basic and theoretical research on enterprise architecture are almost non-existent. Enterprise architecture is clearly a discipline that has developed in practice. Research on the subject is fragmented and a bit lost in detail and implementations, while *unable to provide a theoretical foundation or a commonly agreed concept and definition for enterprise architecture.* This is most likely the reason why the existing definitions are seldom used in research.

Enterprise architecture is often confused with IT architecture and IS architecture. However, thorough analysis suggests that both IT and IS architectures are a part of enterprise architecture, which is an enterprise-wide holistic approach to managing the complete organisation, not a holistic approach to managing enterprise-wide information systems, as often interpreted. This idea is also supported by 1) Zachman's original idea and seminal work on the concept, 2) the finding in this research that all other enterprise architecture frameworks are more or less based on Zachman's original idea, and 3) analysis of the enterprise architecture terminology.

The ambiguous concept of enterprise architecture can be explained by deriving its need from the nature of organisations as systems, the organisations' business environment, and by combining these with the operating logic of the concept. This research concludes that *enterprise architecture is best defined in two parts or stages.* Firstly, as a static description or architectural representation of the organisation and secondly, as a

holistic process of optimising, aligning, integrating, and managing an organisation or enterprise towards successful business and strategy execution by utilising the architectural descriptions and supported by sophisticated IT and IS that enable high quality business intelligence and information and knowledge management.

The inference is that the *role of enterprise architecture in organisations and for management requires a holistic and interdisciplinary mind-set and management approach. Enterprise architecture aims at successful strategy execution by addressing internal organisational challenges by the logic of architecture, enabling the organisation to address external challenges.* As a reflection of the organisation, *the context of enterprise architecture can be described in two dimensions:* The context can be limited to the organisation that the enterprise architecture reflects. However, as this research suggests, organisations should be considered as open systems embedded in their environment and thus, in a broader extent the context of enterprise architecture comprises also the organisation's context – the business environment.

The holistic approach creates *demanding interdisciplinary requirements for the enterprise architect*. When looking at all the functions in an organisation and all the dimensions of enterprise architecture through the holistic lens, what one sees is what the chief architect and his or her enterprise architecture team need to understand and master.

In general, the understanding of enterprise architecture is currently very heavily connected to the IT discipline, which is already familiar with the concept of architecture as applied to information systems. It is increasingly noted that enterprise architecture is not an IT -issue, but a business issue. This stems from the fact that the IT dominance in the field of enterprise architecture moulds the perception of enterprise architecture to something less holistic than it should be and too much under the scope and responsibility of IT. This type of conception impedes organisations from reaching the potential that the truly holistic enterprise architecture embraces and from achieving its full benefits. Similarly, it focuses research on issues outside the holistic understanding and thus, hinders the development of the concept to its full potential.

Enterprise architecture research is published mainly in professional IT journals and magazines. Books are written and directed to IT professionals and IT students. Additionally, enterprise architecture seems to appear only in technology related information systems and computing conferences. In Finland almost all material regarding enterprise architecture or closely related to it are placed in libraries of technical subjects. Enterprise architecture is socially so deeply embedded and associated with IT, that it too hinders the concept's development as a holistic management approach.

Despite the extensive research material, *a proper link between enterprise architecture and strategic management or organisational management* in general was not found. Based on the broad literature and in the understanding of this research, it is evident that enterprise architecture is interdisciplinary. In the long run, supporting interdis-

ciplinary knowledge and science and increasing business discipline's interest in enterprise architecture should be started from universities, libraries, and professional publications – places where discipline-specific cultures are built.

Wider general understanding of the subject would ease many implementation- and communication related challenges in enterprise architecture programs. Therefore, (and because it is a highly potential, logical and interesting concept) enterprise architecture should be much more strongly included in education, especially in strategy, business, and management curricula. Also in the IT and IS disciplines the holistic approach should be clearly included and separated from technical architectures in literature and education.

General familiarity and understanding of the theory and core logic would significantly help in overcoming current enterprise architecture challenges such as, lack of higher management commitment, misunderstandings between business and IT people, scope, roles, and responsibilities in implementation and budgeting and result expectations in enterprise architecture programs. The thesis of this research is that the discovered core logic and mind-set of holistic enterprise architecture are a prerequisite for any implementation.

Studying the interest groups and industry associations is important in a practice-oriented field and in this case it revealed that all of the active actors and influencers in the field are connected by a relatively small group of experts who also have established many of the associations. Also an analysis of the history and development of enterprise architecture revealed that the concept was born from Zachman's article in 1987. It started to develop mainly in the USA with strong contribution from the government adopting the idea, and strong influence by Zachman. Later on, development was also supported by practice and research conducted by consulting companies and global advisories. It also revealed a new understanding of the various frameworks; as all frameworks are based on the same core idea, it is not important to compare and evaluate them to find out the right, the easiest, or the cheapest method. Because enterprise architecture is always a reflection of the organisation adopting it, what someone else included in their framework becomes less important whereas the core logic and purpose become more important.

Moreover, problems in strategy execution traditionally include the challenge of implementing an abstract plan that is, embedding strategy into everyday operational tasks. By discovering, theorising, and justifying the core logic of enterprise architecture and the appropriate mind-set, this research argues that executing enterprise architecture with the core logic and truly holistic thinking, as described in this research, has the potential of bringing a business strategy to life. This is because holistic enterprise architecture addresses the organisation more comprehensively than other approaches or practices introduced to date. Enterprise architecture creates ability to manage the organisation in a

comprehensive scope and manner, integrating and aligning it to the vision and capabilities and is thus far, the most promising possibility for managing change and sustaining operation – executing strategy.

6.1 Theoretical Contribution of the Research

To generate new knowledge to enhance understanding and support development of enterprise architecture, this research studies and addresses issues that have not been found from existing research in spite of the extensive review of research and literature. This new contribution to the basic research of enterprise architecture includes:

- the thorough analysis of the history and development of enterprise architecture
- the thorough analysis of the connections between industry associations, interest groups, and other central industry actors
- the grounding and justification of the need and purpose of enterprise architecture
- the analysis of the underlying causes for common confusion and misinterpretation of the concept
- the analysis of enterprise architecture terminology
- the synthesis that places and explains enterprise architecture within its contexts
- discovery and analysis of the causality or interdependence between enterprise architecture domains, between enterprise architecture and information- and knowledge management, and between enterprise architecture and the business environment
- construction of a model of the core logic and mind-set of enterprise architecture

However, the ultimate theoretical contribution of this research stems from the discovery of and justification for the general core logic of enterprise architecture. It seeks *to change the way the concept is currently perceived and understood* from a technical and possibly partial project or implementation, separate from the organisation's core and without a central role in the entirety of the organisation into a holistic approach for designing, optimising, changing, and managing the entire organisation, which requires a completely new way of thinking – a new mind-set for running a business and managing an organisation as an integrated whole for the purpose of successful strategy execution using enterprise architecture.

6.2 Suggestions for Further Research

Enterprise architecture opens a great amount of subjects and aspects for further research. The low maturity and confusion shadowing enterprise architecture still needs to be addressed. The research discipline of enterprise architecture should not settle with using the standardised definition for system architecture, but should seek *common agreement on the concept*. In the light of this research, the roles and responsibilities of business and management should be further established and much more research from the *business point of view* is needed. Another interesting role is that of education in preparing future professionals with skills and understanding of holistic interdisciplinary enterprise architecture.

Embedding strategy and strategic management more closely to the enterprise architecture practice is important, because achieving the business vision is the justification for an organisation's existence. Thus, more interesting research subjects address the possibilities and means for improving internal communication through enterprise architecture. Also the connection and interdependence of enterprise architecture and knowledge management (KM) is important and interesting. Aligning workflows and improving internal communication opens a link for the study of enterprise architecture's effects on staff and employee well being and motivation, their roles, participation, and commitment to the enterprise architecture mind-set and program and hence, the organisation and its shared objectives. The dialogue between enterprise architecture and human relations (HR) and human relations management (HRM) is interesting.

Discourse on enterprise architecture does not address much SMEs and start-ups in the light of adopting the approach and practice in an early stage namely, building enterprise architecture starting from the organisation's inception to avoid the burden of modelling an existing complexity at once before being able to start the "to-be" architecture planning. Also the route to planning and implementing the "to-be" architecture should be emphasised after modelling the "as-is" architecture. Another interesting research subject is the effect of enterprise architecture on organisational growth; can enterprise architecture enable more efficient and stable growth and is an organisation that adopts the enterprise architecture approach to overall management a better and more potential target for investors? The possible connection and cooperation between enterprise architecture and ISO-Standards is also interesting as both include thorough mapping of processes. Further research on some categorisation and generalizable details or examples of sub architectures would support the planning and implementation phase, which follows the understanding of the purpose and core logic of enterprise architecture.

7 SUMMARY

Technological advancements have brought fundamental changes in the ways of thinking and acting. These changes are a part of a larger paradigm shift, often referred to as the information age. In the new society within the new era, technology, IT, information, and their utilisation and management have become increasingly important for businesses as the global information intensive business environment challenges their strategy execution. However, adaptation requires new ways to respond to the turbulent environment creating constant change, increasing complexity, and even information (and data) overload. In the information age organisations need to be integrated, coherent, intelligent and agile.

The idea of enterprise architecture was originally created by Zachman in 1987, by adopting the logic of classical architecture to designing and managing large information systems constantly growing in complexity. The creator of enterprise architecture sought to find ways to improve the efficiency, sustainability, and internal alignment of IS-intensive enterprises. Based on the history of science and current knowledge the idea of architecting an enterprise based on classical architecture and complex industrial engineering is well argued. However, strongly rooted in the IT- and IS disciplines, enterprise architecture is not yet a mature discipline nor is it an established practice or profession.

The concept of enterprise architecture has developed practice ahead. A majority of research on the subject is published after 2004 and enterprise architecture still lacks sufficient basic research and a commonly agreed composition and definition. The concept and its research are fragmented and full of varying frameworks and interpretations. A lot of important research has been conducted into enterprise architecture and subjects directly related to it, but a lot more is needed, especially basic research, in order to further develop enterprise architecture and discover the possibilities and opportunities in its field.

Enterprise architecture has a clear and logical terminology, but it is not regarded in research nor is it enough to guide the perception and use of the concept. Terminology is a good base to build on and the terms used with enterprise architecture are logical; it is merely the use of terms that seems inconsistent and confusing. The history and evolution reveals that Zachman has influenced the development of the concept throughout its history and thus, all frameworks are more or less based on his seminal work.

The concept of enterprise architecture can be understood using existing theories and concepts such as, organisation theory, systems theory, contingency theory, cybernetics, system complexity, knowledge management, learning organisation, and architecture. Because an enterprise architecture is a modelled representation of the organisation, it is always a reflection of the organisation itself. For a model however, generally applicable

main domains can be determined. Vital domains (sub architectures) are business, information, and IT, which are all aligned with the organisation's strategy.

Enterprise architecture has two contexts; on one hand, the organisation is the context where enterprise architecture is applied. On the other hand, the organisation is deeply embedded and dependent on its environment and once enterprise architecture is applied, the effects reach further into the organisation's business environment. Business intelligence and knowledge management are important links between the organisation and its environment.

Once the logic of enterprise architecture is applied to the entire organisation and utilised and maintained properly, the potential of successful strategy execution increases to its full length. Enterprise architecture has the potential of bringing a traditional strategy to life. Visualising and optimising the components in the organisation that execute strategy (all existing components) brings a new possibility to manage and integrate the organisation to a coherent whole. Because enterprise architecture is a holistic approach, it is interdisciplinary in nature and thus, cannot be assigned to the responsibility of any one of the departments in an organisation.

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APPENDIX 1 FURTHER HISTORY AND EVOLUTION

In 1990 Zachman founded the *Zachman International Inc.*[16] – an enterprise architecture education and consulting company dedicated to the research and advancement of the state of the art enterprise architecture (About Zachman International). In addition to Zachman's numerous seminar presentations and personal contribution in the advancement of enterprise architecture, Zachman International influences the field through a wide network of official educational, industry, and tooling partners presented in table 4 below.

Table 4 Zachman International educational partner network 19.10.2013 (Partners)

Educational partners		
FEAC (Federated Enterprise Architecture Certification) Institute	United States	Training and certification institution for Enterprise Architects.
iCMG	India	Full service enterprise & IT architecture firm. Provides consulting, training & certification, and research & advisory.
InfoSpec Sdn Bhd (Information Technology Specialists)	Malaysia	Accredited provider of professional business training courses.
Intervista Institute	Canada	Develops executive education programs and knowledge media on emerging concepts in enterprise strategy and innovation.
IRM UK	United Kingdom	Specialists in strategic IT training for IT & business professionals and managers.
Real IRM	South Africa	Leading South African EA specialist. Offers consulting services, outsourced EA practice, EA tools and education and training.

Zachman International is the owner of the *Federated Enterprise Architecture Certification (FEAC) Institute*, which in partnership with the California State University and the National University in San Diego train workshop, TOGAF 8 and TOGAF 9 attendees worldwide as well as trains and graduates Certified Enterprise Architects (CEAs). The FEAC Institute also offers customised enterprise architecture training and certification programs tailored to civilian government, Department of Defence (DoD), and the com-

[16] There are some websites such as <http://www.zachmaninternational.com> that publish, offer or sell unauthorised information of John A. Zachman or the Zachman Framework, which inevitably creates confusion when searching for information on the subject. The quality of information on the aforementioned site is unknown and therefore, do not qualify as a reference for academic research.

mercial sectors. (Who Are We?.) Zachman International cooperates with global companies and educational partners worldwide.

Table 5 Zachman International industry- and tooling partners 19.10.2013 (Partners)

Industry partners		
iCMG	Global partner	Full service enterprise & IT architecture firm. Provides consulting, training & certification, and research & advisory.
Business Rule Solutions LLC – Ronald G. Ross	United States	Author of eight professional books. Regular business rule presentations: seminars, conference appearances, webinars, and podcasts.
DAMA (Data Management International)	United States	Non-profit, vendor-independent, global association of technical and business professionals dedicated to advancing the concepts and practices of information and data management.
Entarco Inc.	United States	Provides education, training, enterprise architecture planning, engineering, and manufacturing based on their Methodology for Enterprise Architecture (MEA).
IES (Information Engineering Services Pty Ltd.	Australia	Provides world-wide skills-transfer education and consulting services largely based on the use of EA.
SIM (Society for Information Management)	United States	Premier network for IT leadership, community of thought leaders.
Tooling partners		
Casewise	United States	Business process analysis and management, business architecture, risk & compliance software and consulting solutions.
Sybase	United States	SAP Sybase PowerDesigner: industry-leading business process/data modeling software and metadata management solution for data-, information-, and enterprise architecture.

From 1986 until 1994 the United States Department of Defence was creating one of the earliest federal enterprise architectures: The *Technical Architecture Framework for Information Management (TAFIM)*. At that time, Zachman's thinking had a strong influence on the work and the TAFIM was finally introduced in 1994. (Coetzee 2009; Sessions 2007.) In parallel, the C4ISR Framework was created in the 1990s, which later developed into the well-known DoDAF (Department of Defence Architecture Framework) in 2003 (version 1.0) (McDaniel 2012, 2). In pursue of developing and modernising systems and improving the effectiveness of IT investments in all federal agencies, the US Congress enacted the Information Technology Management Reform Act of

1996, which was combined with the Federal Acquisition Reform Act and renamed as the Clinger-Cohen Act of 1996 (DoD Chief Information Officer: Laws, Regulations, and Policies 2009; Sessions 2007; Clinger-Cohen Act 1996). The Clinger-Cohen Act has then influenced on the adoption and development of architecture frameworks among the United States federal agencies. Hence, the significant enterprise architecture activity within the Federal Government has strongly contributed to the development of enterprise architecture in general and as a discipline of its own.

Two years after the Clinger-Cohen Act, in 1998, a CIO Council was formed to start working on the *Federal Enterprise Architecture Framework (FEAF)* and also in this project Zachman was strongly involved as being a member of a panel of experts within the endeavour. The FEAF, version 1.1 released in 1999, was largely based on the National Institute of Standards and Technology (NIST) Enterprise Architecture Model, but built to meet the organisational and management needs of a Federal Enterprise Architecture. (Federal Enterprise Architecture Framework 1999.) Furthermore, also the NIST Enterprise Architecture Model from 1989 was built on top of Zachman's Framework for Information Architecture (Fong & Goldfine 1989, 63–82.) Later, the FEAF was again further developed and renamed as the *Federal Architecture Framework (FEA)*. The FEA was released in 2002. The TAFIM (officially retired from the Department of Defence in 1998) was turned over to The Open Group and was encouraged and permitted by the Department of Defence to continue the work done on the TAFIM. Based on the TAFIM, The Open Group developed a standard for enterprise architecture and created *The Open Group Architecture Framework (TOGAF)*. (The common approach to federal enterprise architecture 2012; Sessions 2007; Welcome to TOGAF™ -- The Open Group Architecture Framework.)

The Open Group describes TOGAF as "...a framework - a detailed method and a set of supporting tools - for developing an enterprise architecture". The Open Group Architecture Forum has developed and published new versions of TOGAF at regular intervals. The first version of TOGAF, built on the sound foundation of the TAFIM, originates back to 1995 and by the time of this research, in 2014, the latest version The Open Group has published is TOGAF 9.1 (Welcome to TOGAF® Version 9.1 "Enterprise Edition"; Welcome to TOGAF™ -- The Open Group Architecture Framework). The TOGAF framework is built on a common standard and is a vendor-neutral framework, which as such enables wider usability. TOGAF is widely recognised and therefore, also stands out very strongly in the research material.

APPENDIX 2 FURTHER INDUSTRY ASSOCIATIONS

To further elaborate on these actors, some relevant examples have been gathered and presented in table 6. The examples therein have been identified as the most active, central, or relevant actors in the field in addition to Zachman International and The Open Group. However, the ESAII (Enterprise and Solution Architecture Institute International) and the EAPJ (Enterprise Architecture Professional Journal) are in turn, examples of an industry association and journal, that appear to be similar and are described as similar to the other actors, yet are less active or less central actors relative to the other examples.

Table 6 Enterprise architecture professional interest groups

Entity	Description
EACOE Enterprise Architecture Center of Excellence	A practitioner-based association for the EA profession. Sets professional standards, conducts research, provides information, and promotes professional and career development. Offers practice-based certification, professional networking, and knowledge development opportunities (About EACOE).
IFEAD Institute for Enterprise Architecture Developments	A not for profit research and information exchange organisation working on the future state of EA (IFEAD About).
AEA Association of Enterprise Architects	The definitive professional organisation for enterprise architects. Seeks to increase job opportunities for all members and increase their market value by advancing professional excellence, and to raise the status of the profession as a whole. Publishes the Journal of Enterprise Architecture (AEA About Us).
iEAi International Enterprise Architecture Institute Inc.	A non-profit corporation working for strengthening the enterprise architecture discipline. iEAi is a platform for collaboration around developing and consolidating EA as a metadiscipline for enterprises around the world. Works with curriculum development, knowledge and skills area definitions, and didactics in the field of EA training, certification, and education (Introducing the Institute).
Center for Enterprise Architecture	Gathers resources to define and tackle research problems in the EA domain, supports the development of a new professional EA related master's degree program, integrates academic units, research units, and EA practitioners (Mission).
GEAO Global Enterprise Architecture Organization	Merged with AOGEA and then with AEA (Open Group merger with… 2009).
AOGEA Association of Open Group Enterprise Architects	Merged with GEAO and then with AEA (Open Group merger with… 2009).

CAEAP Center for Advancement of the Enterprise Architecture Profession	Promotes the professional status of enterprise architects and works to ensure the legitimacy of the profession by distinguishing it from other professions and non-professionals (Welcome to the Center for the Advancement of…)
FEAPO The Federation of Enterprise Architecture Professional Organizations	A worldwide association of professional organisations to support, standardise, professionalise, and otherwise advance the discipline of Enterprise Architecture (About: What is FEAPO?)
ESAII Enterprise and Solution Architecture Institute International	A not-for-profit industry association serving the enterprise and solution architecture community as well as catering for technical streams in IT & telecommunications security and corporate executives with EA and SA responsibility (Welcome to the Enterprise & Solution…)

The above-mentioned ESAII is described in the bottom row in table 3 and is separated with a stronger line in order to depict the seeming inexistence of relations or connection to the other actors. The ESAII establishes an association with a consulting and training company EA Principals Inc. The ESAII's vision is to become the premier organisation in the world for enterprise architecture and enterprise solution architecture mentoring, training, certification, and consulting. Steve Else, the founder and CEO of EA Principals Inc. is a TOGAF trainer, also CEO at ESAII and Founder and Executive Editor at Enterprise Architecture Professional Journal (EAPJ). However, the current online presence identified for the EAPJ is limited to posting one volume of the journal in www.slideshare.net. The sole explicit connection identified between ESAII, EAPJ, and the other actors presented in table 3, is Else's connection to TOGAF. (EA Principals, Leaders; Welcome to the Enterprise & Solution…; Architecting the Cloud: Lessons Learned through Real-World Case Studies).

The Enterprise Architecture Center of Excellence (EACOE) has created its own *Enterprise Architecture Quick Start Methodology* and *The Enterprise Framework* with which they focus on model driven technology and business planning and executing architectures. In this context the term "architecture" is used more or less as a synonym for planning as the Center acknowledges that too many organisations use model driven approaches that do not properly separate planning (architectures) from implementation. (About EACOE.)

The IFEAD (Institute For Enterprise Architecture Developments) may be identified as having a different mission or focus in comparison with the others. Instead of offering training, certification, and consulting the stress is on conducting research and offering and exchanging information and knowledge related to enterprise architecture. IFEAD conducts research and further develops enterprise architecture trying to actively affect the evolution of the concept by working on the future state of enterprise architecture. Founded by Schekkerman, a known thought leader and author in the field, IFEAD works closely with other research organisations and universities and considers being one of the most important sources of information in the area of enterprise architecture.

IFEAD has developed the idea of an Extended Enterprise Architecture (E2A) based on which the Extended Enterprise Architecture Framework (E2AF) is built. Schekkerman is the author of several recognised enterprise architecture books such as the international bestseller "How to survive in the jungle of Enterprise Architecture Frameworks" and "Enterprise Architecture Good Practices Guide" (Enterprise Architecture Book 2013; IFEAD About.)

The International Enterprise Architecture Institute (iEAi) works for strengthening the discipline of enterprise architecture. However, iEAi does not only work in the fields of training and certification, but also addresses the important field of education by working with definitions, didactics and curriculum development. iEAi embraces the EA^3 cube approach to enterprise architecture introduced by one of the original founders of iEAi, Scott Bernard. The EA^3 cube approach is a quite pragmatic view of the complete enterprise architecture and its constituents and supports the iEAi view of six core elements of a complete approach to enterprise architecture. (Introducing the Institute 2013; EA^3 Cube Framework 2013; Bernard 2012.)

Another different example is the Center for Enterprise Architecture, which operates under Penn State's College of Information Sciences and Technology at Pennsylvania State University. It is very concentrated on research on enterprise architecture and other subjects that are closely related. Based on their description of the enterprise architecture research domain, The Center for Enterprise Architecture seems to have a comprehensive understanding of the array of disciplines that are to be combined in order to see all aspects of the whole enterprise architecture. Currently the Center works closely with the College of Information Sciences and Technology on the development of a master's degree program that concentrates on enterprise architecture.

Collaboration with the academic environment is extremely important for the enterprise architecture ecosystem. It supports the pragmatic field's development beyond the practical enterprise-specific cases and induces people who are committed to bringing enterprise architecture to reality. The Center for Enterprise Architecture is dedicated to gathering intellectual resources to address rising challenges, problems, and questions related to enterprise architecture. They take a deep multidisciplinary view in research and have an extensive advisory group as well as many industry association partners for balancing theory and practice in their research and for keeping the perspective wide and rich. (Center Overview 2013.)

The Association of Open Group Enterprise Architects (AOGEA) was launched by The Open Group in 2008 with 700 members. Three years later they had already over 18 000 members, a part of which came through the merger with Global Enterprise Architecture Organization (GEAO) in 2009. At the time they formed the largest professional body for enterprise architects serving over 9000 members in 72 countries. Moreover, Microsoft used to have a certification program of their own to validate technology ar-

chitects as The Microsoft Certified Master (MCM), Microsoft Certified Solutions Master (MCSM), and Microsoft Certified Architect (MCA). However, Microsoft started to concentrate on certifications that were more closely linked to their own technologies, discontinuing the vendor-neutral programs. Hence, retiring the MCM, MCSM, and MCA programs. Thereafter, Microsoft encouraged their certified architects to join the Open Group's AOGEA and offered support in membership fees for those who wanted to join, which meant more professional members for AOGEA. (Gardner 2011; Microsoft Certified Architect (MCA) 2013; Microsoft discontinues certified architect solutions and infrastructure certifications 2010.) AOGEA merged with the Association of Enterprise Architects (AEA) in 2010 forming an even greater industry association. A respected quarterly publication, The Journal of Enterprise Architecture is published by the AEA. (Gardner 2011.) Figure 28 below, illustrates the interconnections and further industry associations.

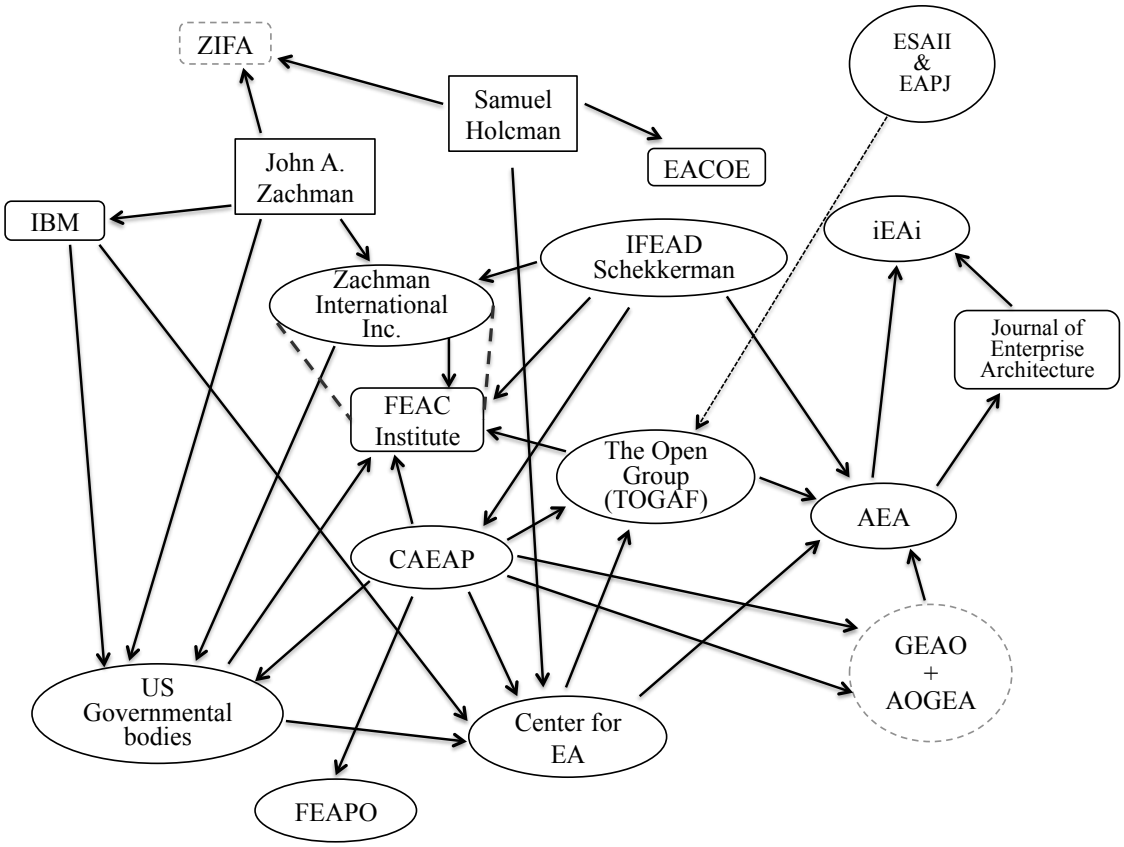

Figure 28 Enterprise architecture actor-influence network

The Zachman Institute for Framework Architecture (ZIFA) in the upper left corner in figure 28 was formerly a collaboration of John Zachman and Samuel Holcman. However, after conducting numerous education seminars and annual conferences for advancing state of the art enterprise architecture, their roads led separate ways and the ZIFA entity was discontinued in 2008 (What happened to ZIFA?; ZIFA FAQ). Thereafter, Sam

Holcman continued his work in The Enterprise Architecture Center of Excellence. EACOE in turn, is a subsidiary of Pinnacle Business Group Inc. – a company that last year gave a coursework donation worth $3.2 million to the Center for Enterprise Architecture (PennState Press release 9.5.2012). The wide advisory group and industry association partner network of The Center for Enterprise Architecture includes, among others, the IBM Corporation, The Open Group, several US Governmental bodies, the Center for the Advancement of the Enterprise Architecture profession (CAEAP), and Association of Enterprise Architects (AEA) (Industry Association Partners 2013; Advisory Group). Since its inception, the FEAC Institute has become a premier training and certification institution for enterprise architects. The FEAC partners with the US Government, CAEAP, Zachman International, The Open Group, and IFEAD and was acquired by Zachman International in 2012. In addition to the FEAC Institute, IFEAD also partners with Zachman International and AEA. The Center for the Advancement of the Enterprise Architecture Profession (CAEAP) seeks to advance the professional status of Enterprise Architects, create sustainability for the profession, promote the professional status of Enterprise Architects, and act as the primary advocate for the profession. CAEAP is one of the founding organisations of The Federation of Enterprise Architecture Professional Organizations (FEAPO), a worldwide association of professional organisations that work to advance the profession of enterprise architecture. (Welcome to the Center for the Advancement of…; About: What is FEAPO?)