

Accelerating in a world of chaos

by using Enterprise Architecture with the concept antifragile

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"It is quite perplexing that those from whom we have benefited the most aren't those who have tried to help us (say with "advice") but rather those who have actively tried - but eventually failed - to harm us."

- *Nassim Nicholas Taleb*

"A consistency proof for [any] system can be carried out only by means of modes of inference that are not formalized in the system itself."

- *Kurt Gödel*

"Reality is created by the mind.
We can change our reality by changing our mind."

- *Plato*


"But he who neither thinks for himself nor learns from others, is a failure as a man."

- *Hesiod*

"The only constant is change."

- *Heracitus*


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agile, agility, resilient, resiliency, robust, robustness, antifragility, antifragile, enterprise architecture, it architecture, architecture governance, architecture principles, enterprise engineering, public sector, independent software vendor, organisational design, delphi method, triangulation

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I, J.R. (René) Blikendaal, declare that this thesis, with the title "Accelerate in a world of chaos by using Enterprise Architecture with the concept antifragile", and the work presented in it are my own and has been generated by me as the result of my own original research.

I confirm that:

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"I have found out how little I actually know"

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Theo Peters

Accelerating in a world of chaos

by using Enterprise Architecture with the concept Antifragility

René Bliekendaal

Abstract

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1. Introduction

The Greek philosopher Heraclitus once said that one constant since the beginning of time is change. However, the fear of change is also a constant. His central claim is summed up in the phrase *Panta Rhei* ("life is flux"), recognising life's essential, underlying essence as change¹. Nothing in life is permanent, nor can it be, because the very nature of existence is change. Since times immemorial², humans have liked routine, making us feel in control of our lives. When that fear of change becomes irrational, our ability to control it becomes a phobia, particularly *Metathesiophobia*. A *Metathesiophobe* feels they have no control over their lives due to constant change. *Metathesiophobes* tend to live in the past and are unwilling to progress, often leading to depression, seriously impacting their professional and personal lives (PsychTimes, n.d.). If a society or country rejects the change, there is no growth and no progress. The inability to change, progress, or grow can result in stagnation. Stagnation rejects realising one's full potential. (ArapahoeLibraries, 2020; Mark, 2010)

A world that is continuously in flux is a volatile, uncertain, complex and ambiguous world. (Bennett & Lemoine, 2014; Sinha & Sinha, 2020) According to Bennett and Lemoine (2014) the world of Volatility, Uncertainty, Complexity and Ambiguity (VUCA) requires a new approach. *Disintermediation*³, globalisation, market upheaval, disruption, and technological advance all combine to produce an effect that is difficult to mitigate, impossible to predict, and arduous⁴ to detect (O'Reilly, 2019, p. 885). Taleb (2008) his definition of a black swan (see later in this chapter) is similar. To deal with the VUCA world, companies invested a great deal of time and money in becoming less fragile by being more robust and resilient. However, Taleb (2012) claims that by being more robust, or resilient, the company can only withstand the change but does not gain from it.

Taleb (2012) defines the opposite state of fragile, *antifragile* as an answer to what Taleb (2008) calls black swan events. Taleb (2012) states that resilient, robust (and company) are states that neither breaks nor improves. Taleb (2012) claims that *antifragile* is the state that gains and improves. *Antifragile* is the true opposite of fragile.

In this thesis, I define the Enterprise Architecture (EA) success factors for contribution to become *antifragile*.

¹<https://plato.stanford.edu/entries/process-philosophy/>

²Reaching beyond the limits of memory, tradition, or recorded history.

³*Disintermediation* is the process of cutting out one or more middlemen from a transaction, supply chain, or decision-making process.

⁴Hard to accomplish or achieve.

1.1. The author

I am working as a Chief Architect for an Independent Software Vendor (ISV) delivering products and services to the local governmental agencies in The Netherlands, such as municipalities, the local tax offices, and the social services. I am responsible for the architecture function in this company. With architecture we use an outside-in approach. We monitor our external environment, the public sector, and translate this into changes for our organisation, services and products. We do this to stay relevant in the market we serve, the public sector market. Until now we invested a lot in being more resilient and more robust to the changes from our environment but we are still not gaining from it. I want my organisation to gain from all those changes. Antifragile can help us to achieve this goal.

1.2. The structure of this thesis

In Chapter 1, the context of the research is set, the core concepts of EA and antifragility are introduced together with the the public sector. The Chapter states the problem statement, the research questions, and the substantiation of the relevance of the research. In Chapter 2, the background on the concepts is given. The lens of the public sector is defined. Chapter 4 explains the used research methodology and the approach for the research based on the FAIR¹ principles and the research properties of replicability, falsification, independence, and precision as described by Recker (2013). Chapter 5 describes the found success factors. Implementation guidelines from an EA perspective operationalise the found success factors. Chapter 5 ends with an overview of found success factors of EA and antifragile that can contribute to the public sector to become antifragile. In Chapter 7 the Delphi method is used to refine, validate, and extend the success factors. The success factors are weighted and screened to determine the concluding set of success factors by triangulation. Finally, the conclusion, discussion and recommendations are in Chapter 8. This thesis ends with Chapter 9 for a retrospective on the research and its process.

1.3. Introduction of the public sector

According to PrivacySense (2016) the public sector is comprised of organisations that are owned and operated by the government and exist to provide services for its citizens. Similar to the non-profit sector, organisations in the public sector do not seek to generate a profit. PrivacySense (2016) divides the public sector into three levels.

- **The national government**, such as the military, the tax authority, and homeland affairs.
- **The regional government**, such as the provinces, the police, and water management.

¹<https://www.go-fair.org/fair-principles/>

- **The local government**, such as the municipalities, the social services, and the local tax offices.

I use the local government as my lens for the research.

1.4. Introduction of the concept Enterprise Architecture

Lapalme et al. (2016, p. 104) says that EA should be understood as being constituted of the essential elements of a socio-technical organisation, their relationships to each other and their changing environment, as well as the principles of the organisation's design and evolution. Enterprise architecture management is the continuous practice of describing and updating the EA to understand the complexity and manage change. Architects use an architecture framework for describing EA. Most of the frameworks use a layered approach for specific viewpoints on a system. The most used layers are business, information, applications, and technology. Ylimäki and Halttunen (2005, p. 189) suggests that EA is an approach for controlling the complexity and constant changes in the business environment of an organisation, enabling alignment between the business vision, business requirements and information systems.

Remark. based on feedback Edzo. Add some examples to layering (TOGAF, Dieter his framework, etc...)

1.5. Introduction of the concept of antifragility

Taleb (2008) describes a black swan as an event that 1) is so rare that even the possibility that it might occur is unknown, 2) has a catastrophic impact when it does occur, and 3) is explained in hindsight as if it were actually predictable. For extremely rare events, Taleb argues that the standard tools of probability and prediction, such as the normal distribution, do not apply since they depend on large population and past sample sizes that are never available for rare events by definition. Extrapolating, using statistics based on observations of past events is not helpful for predicting black swans and might even make us more vulnerable to them. In his book Antifragile, Taleb (2012) states that the way to survive a black swan event is to be antifragile.

Most people answer that the opposite of fragile is robust, resilient, solid, or something of the sort. However, the resilient, robust (and company) are items that neither break nor improve, so you would not need to write anything on them — have you ever seen a package with robust in thick green letters stamped on it? Logically, the exact opposite of a fragile parcel would be a package on which one has written; please mishandle or please handle carelessly. Its contents would not just be unbreakable but would benefit from shocks and a wide array of trauma (Taleb, 2012). Botjes (2020, p. 32) mentions that almost all if not all papers on antifragility and resilience use the term stressor for an event from outside the system that causes stress.

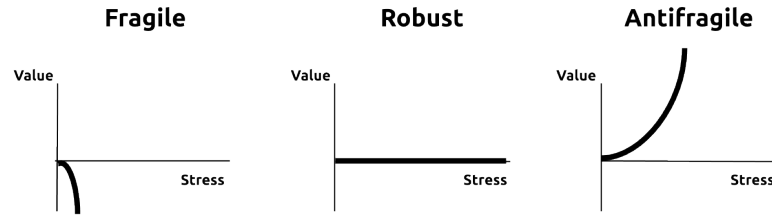


Figure 1.1.: Extended Antifragile Attribute List (EAAL) Triad (Botjes, 2020)

1.6. Problem statement

The concept of antifragility implies that organisations could benefit and strengthen from crises, volatility, errors and uncertainty and could also lead to opportunities for innovation (Kastner, 2017). EA is a discipline that helps organisations to reach their goals. As described in ?? with EA one would expect that an organisation uses EA to get more towards the state of antifragility. The already conducted research had its focus on the layers of application and information but not on EA. The problem is that the Body of Knowledge contains no direct knowledge on how to achieve antifragility with the use of EA.

1.7. The research subject

As described in Section 1.4 EA is an approach for controlling the complexity and constant changes in the business environment of an organisation, enabling alignment between the business vision, business requirements and information systems. So EA facilitates an organisation in assessing the impact of change and making recommendations for target states that support business objectives. EA can help organisations in changing towards the state of antifragility.

However, what are the success factors of EA that contribute to accomplishing anti-fragility?

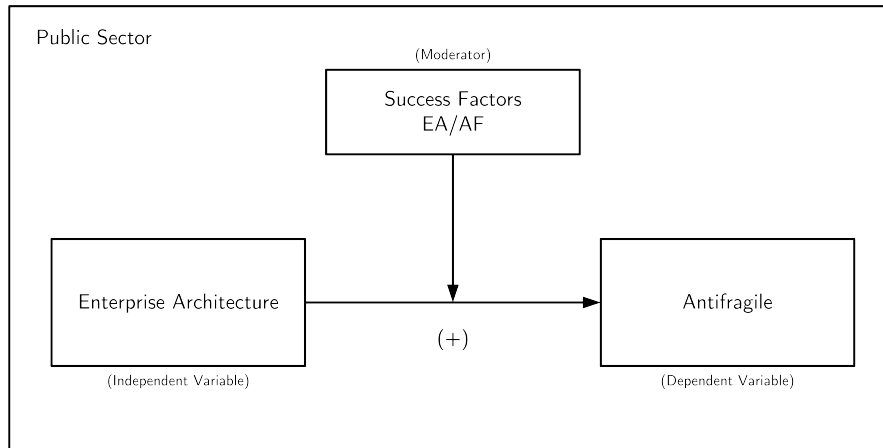


Figure 1.2.: Conceptual Research Model

The conceptual research model hypothesises that, in the context of the public sector, Enterprise Architecture success factors have a positive influence on the contribution of Enterprise Architecture in achieving antifragility in the public sector. From this conceptual research model, the research question is:

"What are the success factors of Enterprise Architecture for antifragility in the public sector?"

The sub-questions support the research question:

1. What is the literature saying about the public sector?
2. What is the literature saying about Enterprise Architecture?
3. What is the literature saying about the success factors of Enterprise Architecture?
4. What does the literature say about antifragile?
5. How can the success factors of Enterprise Architecture contribute to becoming antifragile?

1.8. Research relevance

EA has contributed to being more robust, resilient, and agile. Using EA in pursuing antifragility will add value to companies by accelerating and growing when there is a stressor or black swan event. The antifragile theory is young. Taleb published the theory in his book "Antifragile: Things that gain from disorder." in 2012. Studies conducted on EA with the concept of antifragile are almost non-existence. The conducted studies are primarily about making IT Systems antifragile. Botjes (2020) and Kastner (2017) are exceptions and have researched how to apply antifragile in an organisational context.

Nevertheless, both concluded that there is more research needed. The former used the lens of Enterprise Engineering, which is closely related to EA, together with complex adaptive system resilience, while the latter used mostly resilience as its lens. There is still no answer to how EA can contribute to becoming antifragile. Giving more insights on this subject will contribute to the BoK and help others get closer to antifragility by using EA.

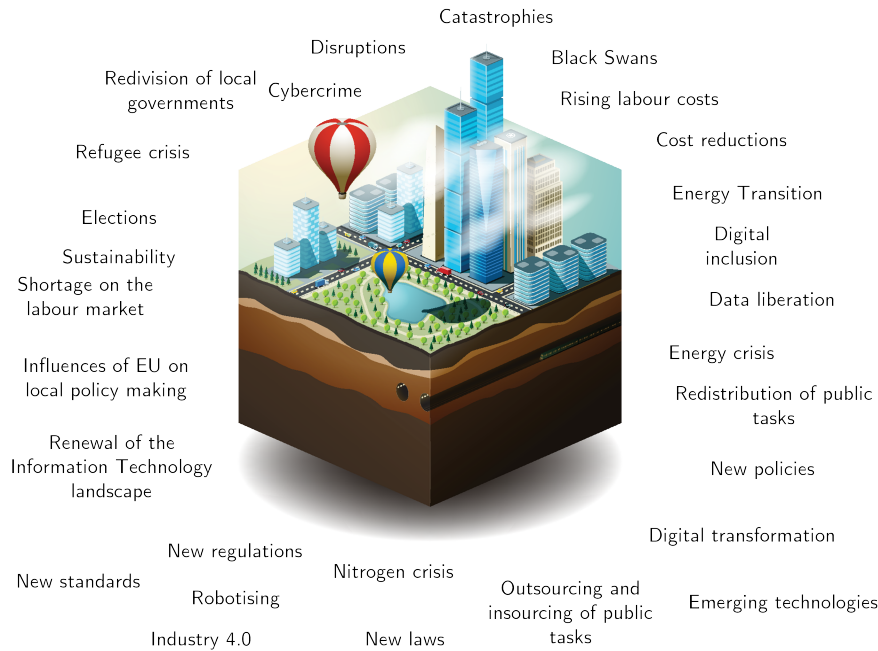


Figure 1.3.: Examples of stressors on the public sector

Because of the digital transformation, the pace of change is increasing rapidly. In a study by Eggers and Bellman (2015), 96% of respondents said digital technologies are significantly disrupting the public sector. The digital transformation is not the only stressor on the public sector. There are a lot of internal and external stressors. The public sector invested a lot in being less fragile by becoming more robust and resilient. By being more robust or resilient, you can only withstand the change or the stressor, but you do not gain from it. Governmental agencies in the public sector are searching for methods of dealing with this increased pace and the stressors. The relevance of this research is not only about the addition to the BoK but also to share the outcome with the public sector.

2. Theoretical background

This chapter defines the core concepts of the research. These concepts are the public sector, Enterprise Architecture, and antifragile. The concepts make use or contain the concept system. This chapter will also define the concept of system.

2.1. Antifragile

2.2. System

2.2.1. The boundary of a system

To what extent does something belong to a system. As defined by Gharajedaghi (2011, p. 182-183), the boundary of a system consists of all the variables that can be sufficiently influenced or controlled by participating actors. The variables that can not be influenced or controlled but impact the viability of the system are part of the context.

2.2.2. System of Systems

2.2.3. The public sector as a System of Systems

2.3. Public sector

As talked about in chapter Introduction the public sector is generally divided into three levels (PrivacySense, 2016).

- **The national government**, such as the military, the tax authority, and homeland affairs.
- **The regional government**, such as the provinces, the police, and water management.
- **The local government**, such as the municipalities, the social services, and the local tax offices.

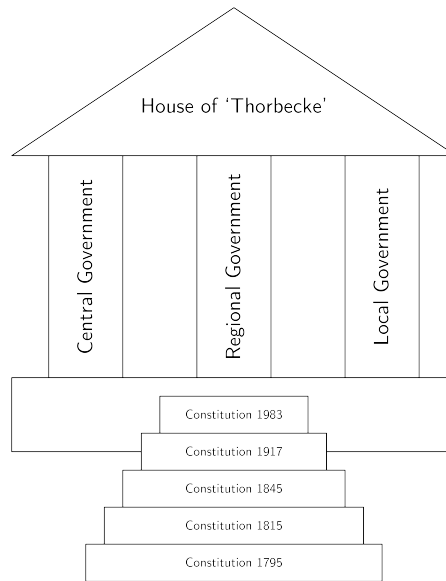


Figure 2.1.: The House of 'Thorbecke'

I will focus this research on the public sector level local government of the Netherlands. In ?? I will discuss the applicability on non Dutch public sectors.

2.3.1. Collaboration between public and private sector

More often the public sector is partnering with a privately held organisation to create a public-private partnership or (). These hybrid organisations work together to deliver a service or business venture to a community jointly. Through outsourcing, public sector organisations will often engage the private sector to deliver goods and services to their citizens.

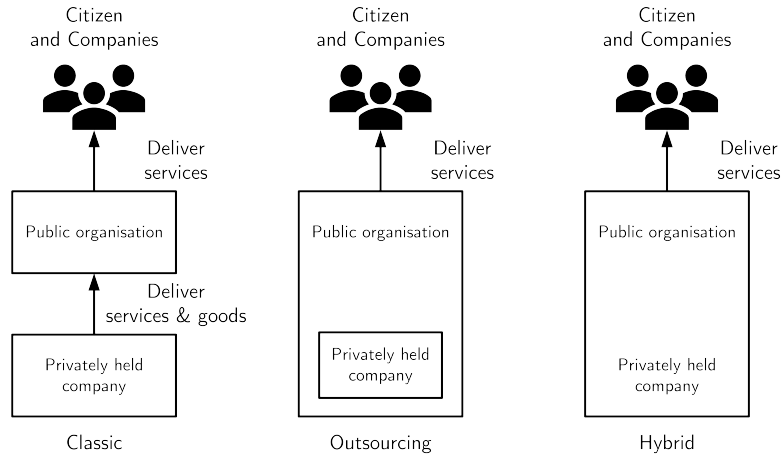


Figure 2.2.: Public sector collaboration models

I argue that, in the hybrid model, the definition of the public sector is not correct anymore. The part of a private company that is a part of a hybrid collaboration, in a joint venture, with the public sector should be part of the public sector system.

2.3.2. Differences with the Private Sector Market

The core values are different in the public sector than that of the private sector. The top five private sector core values are profitability, accountability, expertise, reliability, and effectiveness. The top five public sector core values are accountability, effectiveness, incorruptibility, reliability, and lawfulness. (van der Wal et al., 2008) Profitability is only a value for the private sector, and it does not exist as a value for the public sector. The public sector demands or even initiates changes without noticing the needed investments to execute these changes by the private sector.

2.4. Enterprise Architecture

There are various definitions of Enterprise Architecture, and there is no agreement on them. The various definitions are not always complimentary, and sometimes they are in opposite (J. Hoogervorst, 2009; Lapalme, 2012; Saint-Louis et al., 2019).

White (2018) states that the organisations business requirements guide EA. EA helps layout how information, business and technology flow together. While Gartner (n.d.) states that Enterprise Architecture is a discipline for proactively and holistically leading enterprise responses to disruptive forces by identifying and analysing the execution of change toward desired business vision and outcomes. EA delivers value by presenting business and IT leaders with signature-ready recommendations for adjusting policies and projects to achieve targeted business outcomes that capitalise on relevant business disruptions. Ross et al. (2014, p. 9) defines EA as the organising logic for business processes and IT infrastructure, reflecting the integration and standardisation requirements of the

company's operating model. The EA provides a long-term view of a company's processes, systems, and technologies so that individual projects can build capabilities and not just fulfil immediate needs. Following Graves (2009, p. 4) Enterprise Architecture (EA) is the discipline through which an enterprise can identify, develop and manage its knowledge of its purpose, its structure and itself. Some of that knowledge will be about IT, but it will also need to include many other concerns like (e.g.): "Business, Process, Security, Data, Application, and technology-infrastructure architecture as well as organisational structures, performance management, and business continuity & resilience planning (Graves, 2009, p. 4)."

By using the EA discipline EA provides decision-support for direction and change at any level of the enterprise (Graves, 2009, p. 4), e.g.: "The choices in the journey of an enterprise for an executive, the preferred technologies of process models for new developments for programme and portfolio management, as well plan as planning when to decommission, change or replace systems (Graves, 2009, p. 4)."

Mature EA can map interdependencies across almost every aspect of the enterprise (Graves, 2009, p. 5). A well defined and maintained EA is proven to be a critical factor in an organisation's agility, effectiveness and ability to respond to risk, opportunity and change (Ross et al., 2014). Graves (2009, p. 5) states somewhat the same with that EA assists in managing changes imposed on the organisation from outside, by the market, by regulations, or at an operations level, by system failures, environmental incidents or customer complaints.

When I consider, following Section 2.2.3, the public sector as a System-of-Systems (SoS) the definitions of EA of Gartner (n.d.) and Graves (2009) do align with SoS. If I take into account that Graves (2009) is one of the authors of the third school of thought, see for more details Section 2.4.1, I will use the definition of Graves for this research.

2.4.1. Approaches of Enterprise Architecture

There are several approaches to the practice of EA. Kotusev et al. (2015), Lapalme (2012) and Ylinen and Pekkola (2018, 2020) conducted research to these approaches. Ylinen and Pekkola (2018, 2020) found an approach in which they can distinguish two groups of EA experts. A modelling-focused group forms a comprehensive view of an organisation and a development-focused group using EA for organisational development.

Kotusev et al. (2015) distinguished three approaches. These three approaches are the traditional, the Massachusetts Institute of Technology (MIT), and the DYnamic Architecture (DYA) approach. The traditional approach, initially presented by Spewak (1993), to Enterprise Architecture Management (EAM), can be generally described as a four-step sequential process: -1- document the current (as-is, baseline) state, -2- develop the desired future (to-be, target) state, -3- develop the transition plan to migrate from the current to the future state, -4- implement the plan and then repeat the whole process all over again (Kotusev et al., 2015, p. 4071). The MIT, developed by Ross et al. (2014), approach advocates the development of a core diagram reflecting a long-term enterprise-level architectural vision. This abstract architectural vision should be later translated into concrete project-level decisions through IT governance mechanisms

involving business and IT managers on different organizational levels (Kotusev et al., 2015, p. 4072). DYnamic Architecture (DYA), initially presented by Wagter (2005), advocates “just enough, just in time” architecture, no EA is designed until there is a need for it. EAM activities in the DYA approach are triggered by concrete business initiatives appearing in the process of strategic dialogue. As a response to a new business initiative, architectural services update EA if necessary and prepare a project-start architecture for a new project in order to ensure that this new project fits nicely into existing EA and larger picture (Kotusev et al., 2015, p. 4072).

Lapalme (2012) is using a different approach. He defined three schools of thought on EA. The first school is about Enterprise IT Architecting. The first school is about aligning an enterprise’s IT assets to execute business strategy effectively and various operations using the proper IT capabilities (Lapalme, 2012, p. 38). With the first school of thought, EA is the glue between business and IT. The second school of thought is Enterprise Integrating. This school is about designing all facets of the enterprise. The goal is to execute the enterprise’s strategy by maximizing the overall coherency between all of its facets. This school is grounded in systems thinking. This school approaches enterprise design holistically or systemically (Lapalme, 2012, p. 40). For the second school, EA is the link between strategy and execution.

The last school of thought is Enterprise Ecological Adaptation (EEA). This school, EA is about fostering organisational learning by designing all facets of the enterprise, including its relationship to its environment, to enable innovation and system-in-environment adaptation. Creating the enterprise strategy and designing the organisation are top priorities. Like the enterprise integration school, this school is concerned with contradictions, not just within the organisation. The third school looks for incoherence in the bidirectional relationship between the enterprise and its environment (Lapalme, 2012, p. 40-41). For the third school of thought, EA is the means for organisational innovation and sustainability. For detailed properties of the schools of thought, see Appendix ‘Properties of the Enterprise Architecture schools of thought’.

Lapalme (2012) defined the scope of EEA “the enterprise in its environment, including not only the enterprise but also its environment and the bidirectional relationship and transactions between the enterprise and its environment” with the purpose to “help the organization innovate and adapt by designing the various enterprise facets to maximize organizational learning throughout the enterprise.” As Botjes (2020) concluded with his EAAL model the attribute learning organisation is of importance for being resilient or antifragile. If the learning organisation is one of the conditions to be antifragile the practice of EA should be of the school of EEA.

3. Theoretical background2

This chapter defines the core concepts of the research. These concepts are Public Sector, antifragile, and Enterprise Architecture. Because the concepts often use the concept system the concept system is also defined in relation to Public Sector, antifragile, and EA.

3.1. Antifragile

Antifragile loves both randomness and uncertainty.

- Randomness
- Variability
- Hormesis / Mithridatisation (by taleb) / Antidotum Mithridatium

It is important to realize that the degree of fragility of a system is often a function of its internal structure. The ability of a system to change under stress is governed by the interconnectedness of its parts, how strongly they are tied to each other, and how much change ripples through the system (O'Reilly, 2019, p. 886).

3.1.1. What is a stressor?

As Taleb (2012, p. 54) points out "Stress is knowledge (and knowledge is stress)."

3.1.2. Volatile, uncertain, complex, and ambiguous

Volatile, uncertain, complex, and ambiguous.

3.1.3. Relation between antifragile, fragile, robust, resilient, and agile

antifragile with fragile, robust, resilient, and agile.

3.1.4. Resilience

Martin-Breen and Anderies (2011, p. 5-7) distinguishes three types of resilience:

- **Engineering Resilience.** Bounce back faster after stress, enduring greater stresses, and being disturbed less by a given amount of stress.

- **Systems Resilience.** Maintaining system function in the event of a disturbance. Systems resilience has been applied in governance and management, where it is often called robustness.
- **Resilience in Complex Adaptive Systems.** The ability to withstand, recover from, and reorganise in response to crisis. The function is maintained by the system structure may not be. The main differentiator is the adaptive capacity or adaptability of the system.

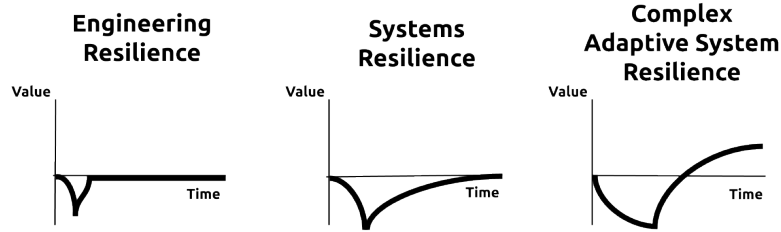


Figure 3.1.: Three types of resilience (Botjes, 2020)

3.1.5. Antifragile Systems Design

3.1.6. Residuality Theory

3.2. Enterprise Architecture

Remark. For example, Ylinen and Pekkola (2018, 2020) recognized two distinct groups of EA experts: a modeling-focused group forming a comprehensive view of an organization and a development-focused group using EA for organizational development. (Nurmi, 2021, p. 16)

Kotusev et al. (2015) reviewed the relevant literature and found three approaches to EA management (EAM): traditional, Massachusetts Institute of Technology (MIT), and dynamic. As discussed by Kotusev et al. (2015), the traditional approach to EAM consists of four phases: documenting the current state, developing the future state, and developing and implementing a transition plan. The MIT approach “advocates the development of a core diagram reflecting a long-term enterprise-level architectural vision.” Finally, the supporting core of the dynamic approach is “just enough, just in time,” meaning no EA is designed until there is a need for it. (Kotusev et al., 2015, p. 4072.)

There are various understandings of Enterprise Architecture and there is no agreement on them. The various definitions are not always complementary but sometimes in opposite (J. Hoogervorst, 2009; Lapalme, 2012; Saint-Louis et al., 2019).

White (2018) states that the organisations business requirements guide enterprise architecture — it helps layout how information, business and technology flow together. While Gartner (n.d.) states that Enterprise Architecture is a discipline for proactively

and holistically leading enterprise responses to disruptive forces by identifying and analysing the execution of change toward desired business vision and outcomes. EA delivers value by presenting business and IT leaders with signature-ready recommendations for adjusting policies and projects to achieve targeted business outcomes that capitalise on relevant business disruptions. Ross et al. (2014, p. 9) defines EA as the organizing logic for business processes and IT infrastructure, reflecting the integration and standardization requirements of the company's operating model. The enterprise architecture provides a long-term view of a company's processes, systems, and technologies so that individual projects can build capabilities—not just fulfill immediate needs. Greefhorst and Proper (2011, p. 24) defines EA as those properties of an enterprise that are necessary and sufficient to meet its essential requirements.

3.2.1. Three schools of thought on Enterprise Architecture

There are three schools of thought on Enterprise Architecture (Lapalme, 2012):

- **Enterprise IT Architecting.** Inputs are business strategy and objectives.
- **Enterprise Integrating.** It is grounded in systems thinking. It has a holistic view. The link between strategy and execution. Inputs are business strategy and objectives.
- **Enterprise Ecological Adaptation (EEA).** Fostering organisational learning by designing all facets of the enterprise, including the relation to its environment.

Lapalme (2012) defined the scope of EEA "the enterprise in its environment, including not only the enterprise but also its environment and the bidirectional relationship and transactions between the enterprise and its environment" with the purpose to "help the organization innovate and adapt by designing the various enterprise facets to maximize organizational learning throughout the enterprise." As Botjes (2020) concluded with his EAAL model the attribute learning organisation is of importance for being resilient or antifragile. If the learning organisation is one of the conditions to be antifragile the practice of EA should be of the school of EEA.

The properties of an EEA are:

For the properties of EEA Section A.3

3.2.2. Steering mechanisms

3.3. Public sector

Sometimes the public sector will partner with an organisation in the private sector to create a public-private partnership. These hybrid organisations work together to deliver a service or business venture to a community jointly. Through outsourcing, public sector organisations will often engage the private sector to deliver goods and services to their citizens.

Remark. Ref to ibestuur en i strategie.. it will happen more and more often... Also Numir mentioned something about the ecosystem. We see this happen also in NL.

I argue that, in the hybrid model, the definition of the public sector is not correct anymore. The part of a private company that is a part of a hybrid collaboration with the public sector should be part of the definition of the public sector.

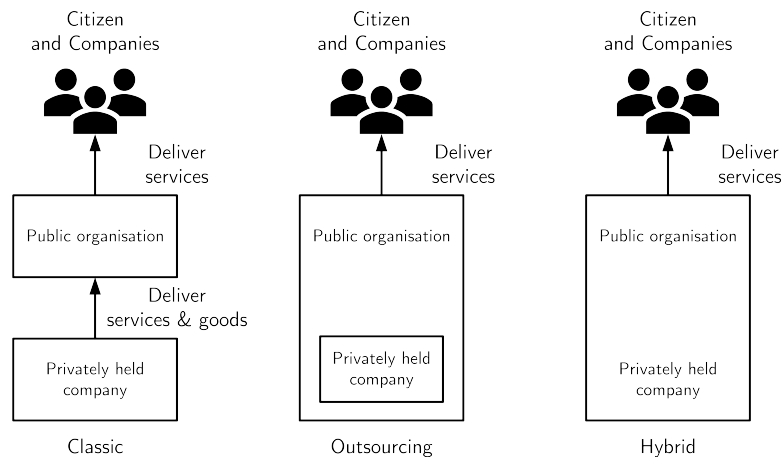


Figure 3.2.: Public sector collaboration models

The public sector is divided into three levels (PrivacySense, 2016):

- **The national government**, such as the military, the tax authority, and homeland affairs.
- **The regional government**, such as the provinces, the police, and water management.
- **The local government**, such as the municipalities, the social services, and the local tax offices.

I will focus this research on the public sector level local government of the Netherlands. In ?? I will discuss the applicability on non Dutch public sectors.

Remark. For hybrid collaborations and partnerships add the reference to iBestuur congress of 2021 about the necessity for the public and private sector to work closely together. Public Sector sees this as necessary to speed up innovation. The reference is expected first week of October 2021.

Remark. The analysis of the 3 types of collaboration should go to the theoretical background. Is necessary to state that the public sector includes privately held companies in some way. Possible even a System-of-Systems.

Remark. Local government is influenced by national government because of policies and regulations.

3.3.1. Differences with the Private Sector Market

The core values are different in the public sector than that of the private sector. The top five private sector core values are profitability, accountability, expertise, reliability, and effectiveness. The top five public sector core values are accountability, effectiveness, incorruptibility, reliability, and lawfulness. (van der Wal et al., 2008) Profitability is only a value for the private sector, and it does not exist as a value for the public sector. The public sector demands or even initiates changes without noticing the needed investments to execute these changes by the private sector.

3.4. What is a system?

This research on the concepts EA and antifragile uses the concept system. The concept system is overused with many different meanings within many different domains. The concept system has various definitions, and many types. Rickles et al. (2007) mentions some of them like, open and closed systems, linear and nonlinear systems, dynamic systems, and deterministic systems.

Mannaert et al. (2016, p. 13) isolates a part of reality in which we are interested and calls that a system. Rickles et al. (2007, p. 933) defines a system as the name given to an object studied in a field. The two definitions are very similar. Mannaert et al. (2016, p. 13-14) acknowledged that a system selected in this way is not isolated and that we have to take into account explicitly the interactions of the system and parallel systems which are operating in the environment. This is what Bertalanffy (1968, p. 32) calls an open system. An open system is a system that exchange matter with its environment (Bertalanffy, 1968, p.32) as where a closed system is considered to be isolated from its environment (Bertalanffy, 1968, p. 39). I argue that the definition of the system as Mannaert et al. (2016) defines a system is an open system following the definition of (Bertalanffy, 1968).

Rickles et al. (2007, p. 934) defines a nonlinear system as a system for which the inputs are not proportional to the outputs.

Systems Holism

3.4.1. Open vs Closed vs Adaptive systems

Complex adaptive system (CAS)

Quote from AMS011: (Turner & Baker, 2019)

"The whole is different from the sum of its parts and their interactions" [61] (p.77) Though emergence, the whole cannot be reduced to the original parts, the whole is considered a new entity or unit. The whole is "qualitatively different from their parts ... The cannot be meaningfully compared-they are different" [61] (system holism)

CAS is going against the second law of thermodynamics.

Bertalanffy (1968, p. 32)

3.4.2. Summary of the concept system

3.4.3. To be worked upon

- Senge (systems theory)
- Cynefone (systems theory)
- Seneca's Barbell (Hydra's Body) (Antifragile)
- Diversity is a thing of reality and needed.

4. Research Methodology

4.1. Research Model

The method of Verschuren and Doorewaard (2016) is used for the research model. This method gives me a step-by-step plan for the research.

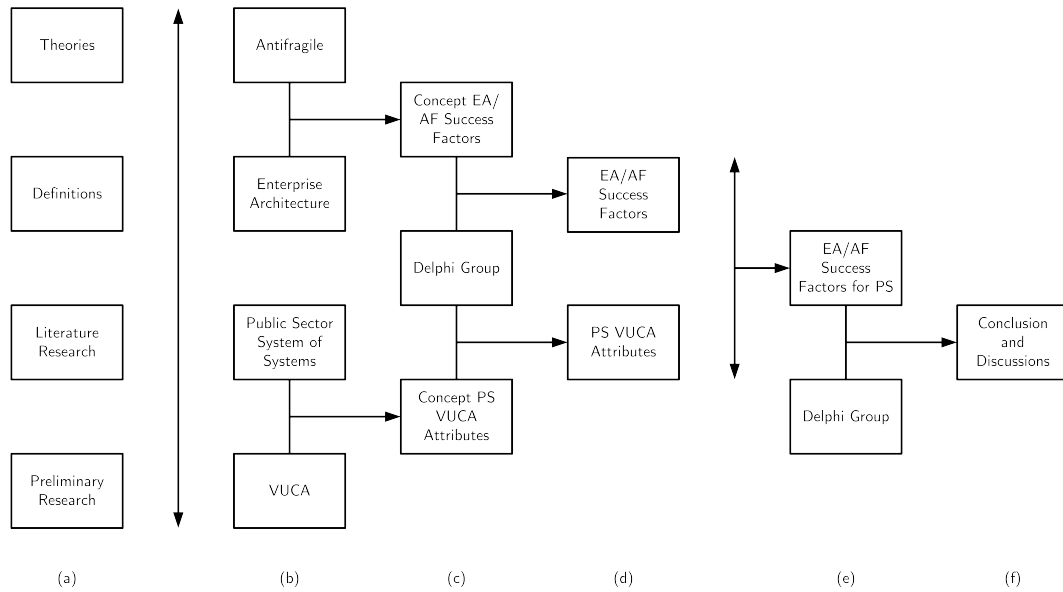


Figure 4.1.: Research Model

In the first phase of research (a), I conduct preliminary research and I study different theories and definitions of the involved concepts. The output of the first phase is the definitions and theories relevant to this research, such as antifragile, Enterprise Architecture, the public Ssector market, and VUCA. In the second phase of research (b), I confront antifragile with Enterprise Architecture and the public sector market with VUCA. I am using interviews to validate the confrontation between the public sector Market with VUCA. The outcome of the second phase is the initiation of analysis on success factors of Enterprise Architecture relevant for contribution to antifragile and analysis on attributes of the public sector market influenced by VUCA (c). In the fourth phase (d), I used the output of the analysis to confront the success factors with a Delphi Group for validation through the Delphi Method to conclude and discuss his research (e).

Remark. Missing the outcome of the confrontation of (a) that is used by all concepts in (b).

4.2. Research quality

I use three frameworks to guide me to increase the rigorousness of the research.

- Quality Principles of Recker (2013) (subsection 4.2.1).
- The FAIR Principles from Scientific Data (subsection 4.2.2).
- The Open Science Framework (subsection 4.2.3).

4.2.1. Quality Principles of Recker

The first framework is that of Recker (2013, p. 16-17) who uses four important principles:

- **Replicability** is a term that characterises the extent to which research procedures are repeatable. The principle states that the procedures by which research outputs are created should be conducted and documented in a manner that allows others outside the research team to independently repeat the procedures and obtain similar, if not identical, results.
- **Independence** is closely related to reliability. It concerns the extent to which the research conduct is impartial and freed from any subjective judgment or other bias stemming from the researcher or research team itself.
- **Precision** states that in all scientific research the concepts, constructs, and measurements should be as carefully and precisely defined as possible to allow others to use, apply, and challenge the definitions, concepts, and results in their own work.
- **Falsification** describes the logical possibility than an assertion, hypothesis, or theory can be contradicted by an observation or other outcome of a scientific study or experiment.


Remark. Howto falsify?

4.2.2. Fair Principles

In 2016, the 'FAIR Guiding Principles for scientific data management and stewardship' were published in Scientific Data. The authors intended to provide guidelines to improve the Findability, Accessibility, Interoperability, and Reuse of digital assets. The research is using the FAIR Principles¹ to increase the quality of the published thesis.

- **Findable.** The first step in (re)using data is to find them. Metadata and data should be easy to find for both humans and computers. Machine-readable metadata are essential for automatic discovery of datasets and services. The thesis, research and used datasets are containing keywords, links, and structures that can be indexed.

¹<https://www.go-fair.org/fair-principles/>

- **Accessible.** Once the user finds the required data, she/he/they need to know how can they be accessed. The thesis, research and used datasets are published on GitHub, Zenodo, and Researchgate based on Open Access. I create objects containing a location on where the data can be acquired if it cannot be published because of author rights.
- **Interoperable.** The data usually need to be integrated with other data. In addition, the data need to interoperate with applications or workflows for analysis, storage, and processing. This principle is not relevant for this research. The data are qualitative data sets based on literature, interviews, and questionnaires.
- **Reusable.** The ultimate goal of FAIR is to optimise the reuse of data. To achieve this, metadata and data should be well-described so that they can be replicated and/or combined in different settings. The thesis, research and used datasets are published under the  CC-BY-SA 4.0 license. It is allowed that the thesis, research, and datasets are shared and are adapted (even commercially) as long as the original author is attributed and the possible derivative is published under the same license.

4.2.3. The Open Science Framework

One of the starting points of the research is Open Science. The idea behind Open Science is to allow scientific information, data and outputs to be more widely accessible (Open Access) and more reliably harnessed (Open Data) with the active engagement of all the stakeholders (Open to Society) (UNESCO, 2020). The Center for Open Science¹ supports this way of research by supplying guidelines and even a toolkit. For this research the toolkit is used to support Open Access, Open Data and Open to Society. One of the tools in the toolkit is a reference model to select tools for the four main phases of research: Search and Discover, Design Study, Collect and Analyse Data, and Publish Reports. I use this reference model in section 4.5. Using this framework will help in achieving replicability, precision, and reusability.

4.3. Research approach

In this section, I describe the approach of the research. This description helps to increase replicability, independence, and reusability. For this research approach, I follow the research model (figure 4.1) and the research (sub)questions (section 1.7). The research model contains five phases in the research. The five phases are used to describe the research approach. The five phases are (a) Desk research, (b) Confrontation, (c) Analysis, (d) Validation, and (e) Conclusion and discussions.

Validation by Triangulation

¹<https://www.cos.io/>

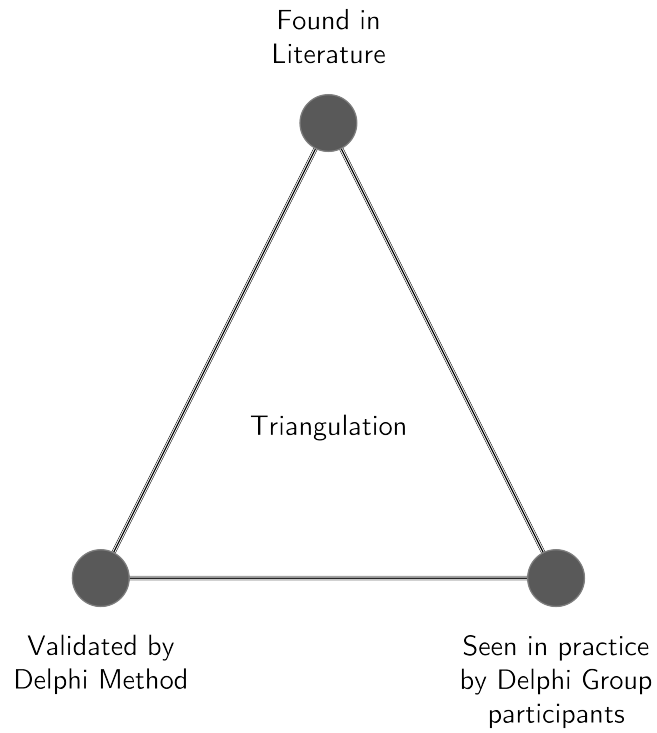


Figure 4.2.: Triangulation

EA/AF Success Factor	Literature	Delphi Group	Seen in Practice	Total
X	1	1	1	3
Y	1	1	0	2
Z	0	0	1	1

Table 4.1.: Example score triangulation

Score	Meaning of score
1	It is not likely that it is an EA/AF success factor.
2	It is somewhat likely that it is an EA/AF success factor. Additional research is required.
3	It is likely that it is an EA/AF success factor.

Table 4.2.: Meaning of the score of triangulation

Score	Meaning of score
1	There is no sure indication of an EA/AF Success Factor.
2	There is, with some certainty, an indication for an EA/AF Success Factor. Additional research is required to validate the EA/AF Success Factor.
3	There is undoubtedly an indication of an EA/AF Success Factor.

Table 4.3.: Meaning of the score of triangulation

4.3.1. Desk research

The first phase of the research model emphasises desk research on the relevant concepts, theories and definitions. Desk research is conducted based on a literature study. The main concepts of antifragile, EA, VUCA, and the public sector are studied. This first phase (a) will answer the sub-questions of:

- What is literature saying about antifragile?
- What is literature saying about the public sector?
- What is literature saying about Enterprise Architecture?
- What is literature saying about the success factors of Enterprise Architecture?

Literature research

For the literature research two primary methods are used. The first method is (forward and backward) snowballing of already acquired literature. The second method is the use of online scientific libraries.

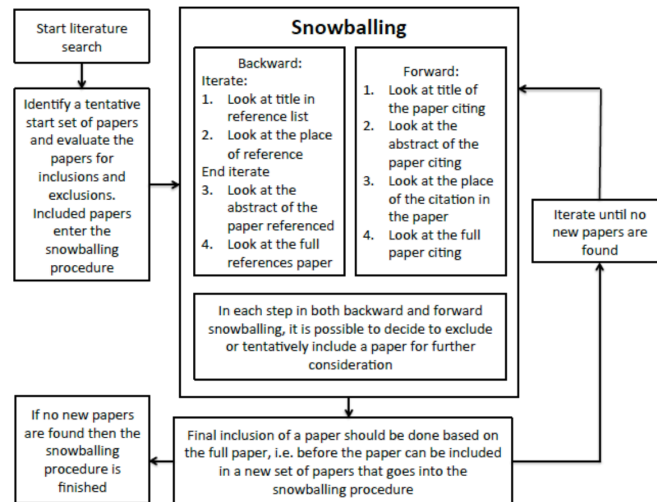


Figure 4.3.: Snowballing literature (Wohlin, 2014)

For finding relevant literature online scientific libraries are used. The online scientific libraries are Web of Science, Research Gate, and Google Scholar. The full concept name is used and the known abbreviations of the concept (e.g. Enterprise Architecture and EA). The list of abbreviations contains the used abbreviations. Literature is only accepted if the literature complies with quality attributes. These attributes are accuracy, authority, objectivity, currency, and coverage¹. All found literature is administrated for replicability, independence, precision, accessibility, and reusability. Section 4.5.3 describes how literature registration and administration is executed.

Antifragile

The literature study on antifragile makes use of four primary sources. The first primary source is the book "Antifragile: Things that gain from disorder" (Taleb, 2012). Taleb (2012) is the progenitor of the antifragile theory. The second primary source is the master thesis "Defining Antifragility and the application on Organisation Design" (Botjes, 2020). Botjes studied the literature, extensively, in the field of antifragile and the application in the context of an organisation. By using the thesis of Botjes the literature study of this study concentrates on the literature after 2018. The last two primary resources are the articles "No More Snake Oil: Architecting Agility through Antifragility" and "The Philosophy of Residuality Theory" (O'Reilly, 2019, 2021). Botjes (2020) did not use the articles of O'Reilly. The theories of O'Reilly were less of interest for the subject of Botjes. While for this research the Residuality Theory of O'Reilly (2021) has added value since it targets system architecture.

Remark. Need to add second book from Taleb (Black Swan) since Antifragile is an answer to black swan events.

¹<https://libguides.library.cityu.edu.hk/litreview/evaluating-sources/>

Need to add book of Hole as it is one of the sources referenced by many.

The first method for literature study is snowballing. Snowballing of these sources is used to determine other important literature on antifragile. Forward snowballing is used for the source of Taleb. Since Taleb is the progenitor, it is not necessary to do a backward snowballing. Backward snowballing is used for the sources from Botjes and O'Reilly.

The second method for literature study is the use of online scientific libraries. For these libraries the following set of keywords or key sentences are used.

antifragile	antifragile robust resilient agile
antifragile Enterprise Architecture	antifragile public sector
antifragile success factors	residuality theory
antifragile residuality theory	Volatility, Uncertainty, Complexity and Ambiguity
antifragile system	

Table 4.4.: Antifragile keywords

Enterprise Architecture

As described earlier in the subsection 3.2.1 the definition of the Enterprise Architecture (EA) school of Enterprise Ecological Adaptation (EEA) is the school that fits in with antifragility. Lapalme (2012, p. 42) states that there are seven dominant authors in the school of EEA. The literature study on EA will focus on these authors. These authors are:

Jamshid Gharajedaghi	Tom Graves
Jan Hoogervorst	James Martin
Kevin Smith	James Lapalme
Donald de Guerre	

Table 4.5.: EEA authors

The book of J. A. P. Hoogervorst (2009) on Enterprise Governance and Enterprise Engineering, and Lapalme (2012) on the three schools of EA are used as a starting point of the literature study.

The first method is snowballing. The two sources will be used for forward and backward snowballing. The second method for literature study is the use of online scientific libraries. For these libraries the following set of keywords and key sentences are used:

Enterprise Architecture	Enterprise Architecture	sucess factors
Enterprise Architecture antifragile system	Enterprise Architecture	steering mechanism
intentional emergent Enterprise Architecture	Enterprise Architecture	Business Strategy
Enterprise Architecture public sector	Enterprise Architecture	system-in-environment

Table 4.6.: Enterprise Architecture keywords

Public sector

The literature study on public sector makes use of one primary source. van der Wal et al. (2008) is an article on the differences between the public and private sector based on the core values of these sectors. This article is used for forward and backward snowballing. The last method for literature study is the use of online scientific libraries. For these libraries the following set of keywords and key sentences are used:

Difference public and private sector	public sector antifragile
Collaboration public and private sector	public sector resilient
public sector VUCA	

Table 4.7.: Public sector keywords

Remark. The preliminary research on the topic public sector is not started yet. Maybe some primary sources will emerge.

4.3.2. Confrontation

For the confrontation of VUCA with the public sector interviews are used to....
For the confrontation of EA with EA a framework/model is needed! (part of Theoretical background)

Remark. What is the model for confrontation? I have to determine the lens I am going to use.

The second phase (b)

4.3.3. Analysis

Remark. What is the model for Analysis? I have to determine the lens I am going to use.

The third phase (c)

How can the success factors of Enterprise Architecture contribute to becoming anti-fragile?

4.3.4. Validation

The success factors are validated by the means of the Delphi Method.

Delphi Method

The Delphi method is an iterative process to collect and distil the anonymous judgments of experts using a series of data collection and analysis techniques interspersed with feedback. The Delphi method is well suited as a research instrument when incomplete knowledge about a problem or phenomenon. The Delphi method evolved into a flexible research method appropriate for many Information System (IS) research projects, such as determining the criteria for IS prototyping decisions, ranking technology management issues in new product development projects, and developing a descriptive framework of knowledge manipulation activities. The Delphi method is a flexible, effective and efficient research method that can be successfully used by IS graduate students to answer research questions in IS and to advance the IS Body of Knowledge rigorously. (Skulmoski et al., 2007)

The group participants are mutually unknown, I am the only one who knows who the participants are. When it cannot be proven that the artefact is incorrect, it must be correct. This method is the principle of falsification. To reach a consensus, I use questionnaires. To reach a consensus, I am working iterative and adjusts the artefact after the feedback. I expect consensus on the artefact after two to six rounds of questionnaires. The goal of the Delphi Rounds is that it cannot be proven that the success factors are incorrect. This method is the principle of falsification (subsection 4.2.1). However, when is there a consensus? Diamond et al. (2014, p. 404) concludes in his research for over more than 100 cases that the median of the percentage of consensus 75% is. I state, as a result of the research of Diamond et al. (2014), that consensus is reached with the threshold of 75%. I state with some degree of certainty that the artefact is correct with a consensus of 75%.

I defined domains for the group composition based on the context of the research. These domains are Independent Software Vendor (ISV), Municipality, National Government, VNG-Realisatie (the association of Dutch municipalities), and Academics. Participants are members of one or more of these domains and have an affinity with Enterprise Architecture and the public sector. I invite at least three participants per domain ($n=3$). The result is a total population of at least fifteen ($n=15$). The approach followed Denzin (2017) multiple triangulation approach, which encourages several methods to collect data and multiple investigators with varied expertise.

For the Delphi Group composition domains are defined based on the context of the research. These domains are Independent Software Vendor (ISV), Municipality, National Government, VNG-Realisatie (the association of Dutch municipalities), and Academics.

The participants have affinity with EA. The participants validate the artefact their context and domain.

Meeting Wizard is the service for sending out the questionnaires and execute the analysis of the outcome of the questionnaires. The participants get an invite by email to fill in the questionnaires. I analyse the results after every round and communicates the outcome as soon as a consensus is reached.

4.3.5. Conclusion and discussion phase

The fifth phase (e)

What are the success factors of Enterprise Architecture for antifragility in the public Sector?

4.4. Research type

Remark. Qualitative vs Quantitative! (use (Recker, 2013))

4.5. Research infrastructure and tooling

For selecting the suitable instruments for the research, the Open Science Framework¹ is used. The Open Science Framework consists out of 4 stages in a research project. Those stages are: "Search and Discover, Design Study, Collect and Analyse, and Publish Reports." The Open Science Framework proposes specific infrastructure and tools per stage. The transparency in the used infrastructure and tools increases the quality of the research. It increases the replication factor, findability, accessibility, interoperability, and reusability.

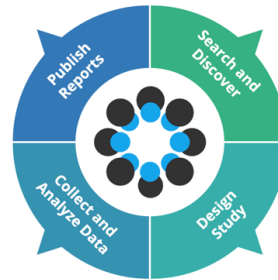


Figure 4.4.: Open Science Framework

4.5.1. Thesis creation

I used my corporate laptop (Dell Latitude 7200 2-in-1²) with Windows 10 Professional installed for creating the thesis. The thesis is created with the markup language \LaTeX ³. The used typesetting environment is TexLive⁴ with the document type of "Report" from

¹<https://www.cos.io/products/osf>

²<https://www.dell.com/en-us/work/shop/dell-laptops-and-notebooks/latitude-7200-2-in-1-laptop/spd/latitude-12-7200-2-in-1-laptop>

³<https://www.latex-project.org/>

⁴<https://www.tug.org/texlive/>

KOMA-Script¹. TexStudio² is the used L^AT_EX Editor. It supports syntax-highlighting, has an integrated viewer, reference checking and numerous wizards. For the creation and administration of references BibL^AT_EX³ is used with the reference manager JabRef⁴ with the citation style of APA 7th Edition⁵ and with web browser integration. The files are stored on a personal Dropbox⁶ that is used by GitHub Desktop⁷ to synchronise with a public GitHub repository⁸. GitHub⁹ is used for source control but also for reviewing and discussing the topics with the (Co-)Promotor and the planning of the master thesis project. The thesis source files are copied to an Amazon S3 Blob¹⁰ for backup. The backup rotation is seven versions. Cloudberry Explorer Freeware for Amazon S3¹¹ is used for backup. Grammarly¹², with the paid subscription service, checks the thesis for spelling, grammar, style, and plagiarism. The used goals for Grammarly are audience=knowledgeable, formality=formal, and domain=academic. Microsoft Visio Professional¹³ is used to create figures. The GitHub repository contains all the sources.

4.5.2. Research administration

The research administration, which includes documentation containing privacy-sensitive information, like the name and contact information of the Delphi Group participants, is stored on a non-public GitHub Repository¹⁴. The private GitHub Repository is also for staging thesis parts that still need to be anonymised. For taking notes Leuchtturm1917¹⁵ Notebooks are used with mechanical pencils of Faber-Castell¹⁶ and pens from Sakura¹⁷ with long-lasting ink.

4.5.3. Research execution

For the execution of the research, Microsoft Excel¹⁸ is used for the administration of the literature research. For the administration of the literature research, the following headers are used: ID (for a unique ID per item), search terms used, scope, title, subtitle, author(s), year, type, BibL^AT_EX citation key, title relevance, abstract relevance, content

¹<https://ctan.org/pkg/koma-script>

²<https://www.texstudio.org/>

³<https://ctan.org/pkg/biblatex/>

⁴<https://www.jabref.org/>

⁵<https://apastyle.apa.org/>

⁶<https://www.dropbox.com/>

⁷<https://desktop.github.com/>

⁸<https://github.com/JRBliekendaal/master-thesis>

⁹<https://github.com/>

¹⁰<https://aws.amazon.com/s3/>

¹¹<https://www.msp360.com/explorer/windows/amazon-s3.aspx>

¹²<https://www.grammarly.com>

¹³<https://www.microsoft.com/en-ww/microsoft-365/visio/>

¹⁴<https://github.com/JRBliekendaal/master-thesis-administration>

¹⁵<https://www.leuchtturm1917.us/notebook-classic.html>

¹⁶<https://www.fabercastell.com/products/tk-fine-vario-l-mechanical-pencil-10mm-135900>

¹⁷<https://www.sakuraofamerica.com/product/pigma-micron/>

¹⁸<https://www.microsoft.com/en-us/microsoft-365/excel>

relevance, found at, doi/isbn, url, date found, duplicate, date used, use for, and notes. Researchgate¹, Web of Science², and Google Scholar³ are the main sources for searching for literature. PaperPanda⁴ is used for hard to find literature. The literature administration is, together with the publicly available literature, stored in the repository of the master thesis. For non-public available literature, the administration contains the location where the literature is retrievable. All the literature is added to a bibL^AT_EX file for future reference. For traceability the entries in the bibL^AT_EX file contain the Unique ID in the notes field. JabRef is used to sort the references by using subgroups to support the workflow. The subgroups used are: "evaluate, rejected, and used." Only the literature in the subgroup used are transferred to the bibliography file of the thesis. This prevents cluttering. For working as paperless as possible all the literature, where possible, is in pdf or in ebook format. For reading Acrobat Reader DC⁵ is used for reading the PDF, and an Amazon Kindle Oasis⁶ for eBooks. With the Amazon Kindle the highlight feature is used. This is not stored on GitHub since the highlights are under copyright of the author(s).

For the execution of the Delphi Method, Meetingwizard⁷ is used for questionnaires and the analysis of the questionnaires. The license for using Meeting Wizard is supplied by the Antwerp Management School.

4.5.4. Summary of used infrastructure and tooling

Search & Discover	Design Study	Collect & Analyse Data	Publish Reports
Web of Science	1	JabRef	L ^A T _E X
ResearchGate			TeXstudio
Google Scholar	2	PaperPanda	ORCID
Z	0	bibL ^A T _E X	ResearchGate
Z	x	Meetingwizard	Zenodo
Z	x	Microsoft Excel	Grammarly
Y	2	GitHub	Microsoft Visio
Y	2	Cloud Berry Explorer for S3	

Table 4.8.: Used infrastructure & tooling

¹<https://www.researchgate.net/>

²<https://app.webofknowledge.com/>

³<https://scholar.google.com/>

⁴<https://paperpanda.app/>

⁵<https://get.adobe.com/reader/>

⁶<https://www.amazon.com/dp/B07L5GJD99>

⁷<https://www.meetingwizard.nl/>

5. Enterprise Architecture/Antifragile Success Factors

Introduction

Remark. Lets call the output of the research guidelines!!!!

Remark. Normalized Systems Combinatorial Effects in relation with Antifragile

Can the same principles on Concerns and Cohesion be used to cope with stressors or black swans (for the stable part of Seneca Barbell)? What is the relation of Modularity with the Variation (and that other one) of Antifragile.

5.1. Antifragile

(Taleb, 2012, p. 23-27)

	Exposure	Note
Mythology Greek	Hydra	blah
Mythology New York and Brooklyn	Fat Tony, Yevgenia Krasnova	blah
Black Swan	Exposed to positive Black Swans	

Table 5.1.: Antifragile Exposures

"Define antifragility as a property of a system" (Jaaron & Backhouse, 2014). Kastner (2017) created a framework for designing an antifragile organisation: Antifragile Organisation Design Framework. The framework consists out of 4 main principles:

- **Self Organisation.** Decentralisation can be seen as a strategy for organisational survival (Brafman & Beckstrom, 2007).
- **Ownership.** Result based and 'Skinin the game'.
- **Diversity of cells and organisational learning.**
- **DNA - Shared purpose, values and culture.**

Decentralised Systems, using self organising capabilities might not only survive disruptions but could even prosper (Brafman & Beckstrom, 2007). The only real difference with Complex Adaptive System and antifragile of Taleb (2012) is that with antifragile stressors, disruptions, errors, volatility, randomness, chaos and uncertainty are seen as 'desired events' in order to strengthen and evolve the system (Jaaron & Backhouse, 2014).

To build an antifragile system there are three main concepts to follow (Russo & Ciancarini, 2017).

- Since antifragile means to benefit more than to lose (positive asymmetry), the first step is to reduce possible losses.
- The second step is to avoid disastrous scenarios by hedging correctly risks.
- The last step is to embed adaptive fault tolerance.

Some authors propose also a fault injection approach, to increase the numbers of errors to enhance the learning capabilities (Russo & Ciancarini, 2017).

Remark. This is the method of Antidotum Mithridatum (Taleb, 2012).

Remark. for systems resilience Kastner loc 327 contains three references that have to be used for reference on robustness.

Three key systems properties contribute to its resilience (Martin-Breen & Anderies, 2011, p. 9):

- Diversity and Redundancy
- Modular Networks
- Responsive, regulatory feedbacks.

For resilience one not only needs to answer the questions "Resilience of what?" and "Resilience to what?", but also "Resilience for whom?" (Lebel et al., 2006, p. 21). One can apply basic critical systems design principles to spot ways to maintain any system's function in the event of a crisis (Martin-Breen & Anderies, 2011, p. 10):

- Maintain a diversity of mechanisms to provide identical functions.
- Make sure networks (social or otherwise) are modular enough so damage or "infection" of one portion does not immediately propagate to all others.
- Maintain or establish feedbacks to, in the simplest case, establish fail-safe mechanisms in case of malfunction.

One can maximize efficiency over all of these variables; however, such optimisation assumes full working knowledge of the system.

Remark. Enterprise architecture can be used to give this full working knowledge of the system.

The term resilience (including all three examined concepts) focuses on the avoidance of harmful stressors and failure; and uncertainty and volatility. Moreover, these are even constructed to reduce vulnerability as much as possible (Martin-Breen & Anderies, 2011).

Remark. add extra references from Kastner to this cite.

5.1.1. EAAL Model

Botjes (2020) has conducted literature research for his master project. This literature research was used to define the definitions of antifragility and to define attributes relevant to antifragility. The outcome of this research is the Extended Antifragile Attribute List (EAAL) model. The outcome of the research of Botjes (2020) also stated that the attributes of antifragility are additional to those of resiliency. Therefor EAAL model contains an overview on not only the attributes of antifragility.

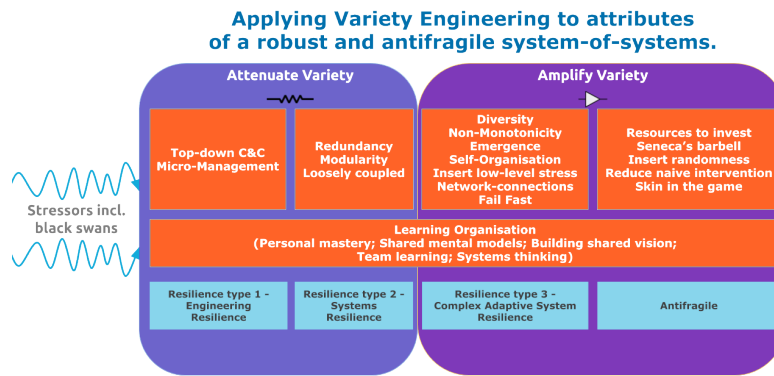


Figure 5.1.: EAAL (Botjes, 2020)

The EAAL model of (Botjes, 2020) uses Variety Engineering (**NEEDS REF**) as his base. The variety engineering consists out of two different varieties. The Attenuate Variety, and the Amplified Variety.

- **Attenuate Variety.**
- **Amplified Variety.**

The more amplified variety a SoS has the more antifragile the SoS is (**NEEDS REF**). **Remark.** Need more information to be elaborated on this. The information should be from the source of Edzo.

Edzo his paper contains references to ashley and beer about these kinds of variety!

The research of Botjes (2020) is recent and contains a good overview of needed attributes for a system-of-systems to become more antifragile.

5.1.2. Antifragile Systems Design

Antifragile Systems Design (ASD) (O'Reilly, 2019, p. 886-888) requires an organization to move as one toward solving the problem of complexity, which means changing the perspective from “us vs. them” (IT vs. business) to simply “us” (business). Business leaders, business/ enterprise architects, and software architects all need to engage with the process to make it work. This requires a new approach from both architects and business leaders (O'Reilly, 2019, p. 886).

Remark. Bridge to Business & IT Alignment of COBIT/EGIT (De Haes et al., 2020)? Is this a condition before you can start with antifragile? Mention it high level but exclude the application of COBIT in the research.

Architects need to work with the business to describe the VUCA environment, translate the impacts on the software decomposition, and even assist in business level mitigations (O'Reilly, 2019, p. 886).

Remark. Is this only about software systems or also other systems like an organisation? Can it be generalised?

O'Reilly (2019, p. 886) states that the four important principles for the design of an antifragile system, as described by Hole (2016, p. 35-39), are of great importance for ASD.

1. **Modularity.** Consisting of separate, linked components.
2. **Weak Links.** A low level of interconnectedness between components.
3. **Redundancy.** The presence of more than one component to cope with failure.
4. **Diversity.** The ability to solve a problem in more than one way with different components.

The process of ASD consist out of four steps:

1. **VUCA Analysis.**
2. **System Decomposition - Flow First Design.**
3. **Design Testing.**
4. **Modified Failure Mode Effects Analysis (FMEA)**

Remark. Needs some extra explanation per item

Going forward, architects should consider the following actions (O'Reilly, 2019, p. 889):

- **Practice VUCA Analysis on the initiative's Business Model.**
- **Become an expert in system decomposition.**
- **Learn different methods for system decomposition.**
- **Learn to use modified FMEA to improve system designs.**

5.1.3. Residuality Theory

Resilient systems are, by definition, able to survive disruption and eventually regain function. Beyond resilience is the idea of antifragility – that systems actually learn from their exposure to stress and become stronger because of it (Taleb, 2012) (O'Reilly, 2020, p. 876). Residuality theory reveals a system as actually being made up of a stack of shadows which we cannot see without turning various lights on and off. We do this through a stressor analysis (O'Reilly, 2020, p. 877).

Remark. The stack of shadows is related to "the darkness principle" (Richardson, 2004, p. 78) from complexity science. This can be replaced with the original source!

Remark. Barry will be contacted for some elaboration on the subject of the residuality theory.

barry@blacktulip.se

Twitter: <https://twitter.com/technologytulip>

5.1.4. Summary of EA/AF

5.2. EA

5.2.1. Summary of EA/AF

5.3. Systems Theory

5.3.1. Systems of Systems

Maier (1996) states that a System-of-Systems (SoS) should be distinguished from large but monolithic systems by the independence of their components, their evolutionary nature, emergent behaviors, and a geographic extent that limits the interaction of their components to information exchange. Maier (1996) states five principal characteristics, Dersin (2014) refers to these characteristics as the "Maier's criteria", are useful in distinguishing very large and complex but monolithic systems from true SoS. These five characteristics are:

- **Operational independence of the elements:** if the SoS is disassembled into its component systems the component systems must be able to usefully operate independently. The system-of-systems is composed of systems which are independent and useful in their own right.
- **Managerial independence of the elements:** The component systems not only can operate independently, they do operate independently. The component systems are separately acquired and integrated but maintain a continuing operational existence independent of the system-of-systems.
- **Evolutionary development:** The SoS does not appear fully formed. Its development and existence is evolutionary with functions and purposes added, removed, and modified with experience.

- **Emergent Behavior.** The system performs functions and carries out purposes that do not reside in any component system. These behaviors are emergent properties of the entire SoS and cannot be localized to any component system. The principal purposes of the SoS are fulfilled by these behaviors.
- **Geographic Distribution.** The geographic extent of the component systems is large. Large is a nebulous and relative concept as communication capabilities increase, but at a minimum it means that the components can readily exchange only information and not substantial quantities of mass or energy.

5.3.2. Systems-in-Environment

(Lapalme, 2012, p. 41)

5.3.3. Complexity Theory

Quote from AMS011:

The interactions within organisations are complex and can be explained better through the lens of complexity theory and CAS than by the other theoretical system approaches (Turner & Baker, 2019, p. 15).

Consider the concept of the Platonic fold, [7] which tells us that the act of modeling the world simplifies it to the point where any decisions made based on that model are misinformed due to details omitted for the sake of hiding complexity. This is also called ‘Hidden Intelligence Syndrome’ [8]. When humans build complex systems, they tend to fail, often catastrophically, because of Platonic folding. The solution to the Platonic fold requires accepting complexity as something we can neither predict nor control, along with accepting the limitations of modeling and risk management. Instead of pursuing correctness in these areas, we should aim to build systems that are antifragile to fluctuations in the VUCA elements (i.e., the system becomes stronger as the business environment warps and changes with time). (O’Reilly, 2019, p. 885)

Remark. Must elaborate more on this.

5.3.4. Viable Systems Model

Viable Systems Model (VSM)

5.3.5. Organisation as a System

5.3.6. Summary of EA/AF

6. Interview results

6.1. Interviews

The interviews are in the format of semi-structured. I used a minimal set of questions. Based on the answers, the technique of hitchhiking was applied when there was a suspicion of extra information about EA and antifragile attributes. The interview summaries can be found in Chapter F.

Number	Question	Concept
1a.	How is your organisation applying EA?	EA
1b.	Who is accountable for EA in your organisation?	EA
1c.	How is EA enabling your organisation to quickly adapt to changes (external influences)?	EA
2a.	Does the operational model of the public sector foster agility?	Antifragile
2b.	How is the EA of your organisation contributing to foster agility in the public sector?	EA
3a.	How does the public sector deal with uncertainty?	Antifragile
3b.	How is the EA of your organisation contributing to dealing with uncertainty in the public sector?	EA
4a.	How is the public sector dealing with unexpected events?	Antifragile
4b.	How is EA of your organisation contributing to dealing with unexpected events in the public sector?	EA
5a.	Could you describe the risk appetite of the public sector?	Antifragile
5b.	How does the EA of your organisation match the risk appetite of the public sector?	EA
6a.	How is diversity and optionality used in the public sector?	Antifragile
6b.	How does EA of your organisation support diversity and optionality in the public sector?	EA
Closing	Did you miss an important subject or do you want to add something else?	non-specific

Table 6.1.: Interview questions

7. Delphi

7.1. Delphi Round One

7.2. Delphi Round Two

7.3. Delphi Round Three

7.4. Delphi Round Four

7.5. Delphi Round Five

7.6. Delphi Round Six

7.7. Result of Delphi Rounds

7.8. Enterprise Architecture/Antifragile Scores

Success Factor	<i>Reference</i>	<i>Found in literature</i>	<i>Validated by Delphi Group</i>	<i>Seen in practice</i>	<i>Score</i>
Blah 1		1	0	1	2
Blah 2		1	1	1	3
Blah 3		1	0	0	1
Enterprise Governance (of IT)	3.1.5	1	1	1	3

Table 7.1.: Score of Success Factors

8. Conclusion and discussions

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8.1. Conclusion

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8.2. Discussions

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8.3. Recommendations

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9. Retrospective

"I have found out how little I actually know"

- The added value of a Co-Promotor

10. Concepts

10.1. Antifragile Attributes

Attribute	Variety	Behaviour	Sources
Top Down C&C	Attenuate variety	Engineering Resilience	(Botjes, 2020)
Micro-Management	Attenuate variety	Engineering Resilience	(Botjes, 2020)
Redundancy	Attenuate variety	Systems Resilience	(Botjes, 2020)
Modularity	Attenuate variety	Systems Resilience	(Botjes, 2020)
Loosely coupled	Attenuate variety	Systems Resilience	(Botjes, 2020)
Diversity	Amplify variety	CAS Resilience	(Botjes, 2020)
Optionality	Amplify variety	CAS Resilience	(Taleb, 2012)
Non-Monotonicity	Amplify variety	CAS Resilience	(Botjes, 2020)
Emergence	Amplify variety	CAS Resilience	(Botjes, 2020)
Self-Organisation	Amplify variety	CAS Resilience	(Botjes, 2020)
Insert low-level stress	Amplify variety	CAS Resilience	(Botjes, 2020)
Network-connections	Amplify variety	CAS Resilience	(Botjes, 2020)
Fail Fast	Amplify variety	CAS Resilience	(Botjes, 2020)
Resources to invest	Amplify variety	Antifragile	(Botjes, 2020; Taleb, 2012)
Seneca's barbell	Amplify variety	Antifragile	(Botjes, 2020; Taleb, 2012)
Insert randomness	Amplify variety	Antifragile	(Botjes, 2020; Taleb, 2012)
Reduce naive intervention	Amplify variety	Antifragile	(Botjes, 2020; Taleb, 2012)
Skin in the game	Amplify variety	Antifragile	(Botjes, 2020; Taleb, 2012)
Personal Mastery	Attenuate variety & Amplify variety	Learning Organisation	(Botjes, 2020)
Shared mental models	Attenuate variety & Amplify variety	Learning Organisation	(Botjes, 2020)
Building shared vision	Attenuate variety & Amplify variety	Learning Organisation	(Botjes, 2020)
Team learning	Attenuate variety & Amplify variety	Learning Organisation	(Botjes, 2020)
Systems thinking	Attenuate variety & Amplify variety	Learning Organisation	(Botjes, 2020)

Table 10.1.: Concepts of Antifragile

While (Botjes, 2020, p. 66) defined optionality as part of diversity the definitions are slightly different. In the case of this research it is applicable to use both the concepts.

Remark. Needs some references to taleb and others to do so in the case of my research.

10.2. Questions for Interviews

The questions for the interviews are limited by the constraint of time of an interview. Because of this time constraint I limited the number of questions to five. However the five questions do cover the attributes of antifragile and the concept of Enterprise Architecture (EA).

- 10.2.1. Interview Question 1
- 10.2.2. Interview Question 2
- 10.2.3. Interview Question 3
- 10.2.4. Interview Question 4
- 10.2.5. Interview Question 5

10.2.6. Interview CTO of ISV

Question 1 / Enterprise Architecture

Question 2 / Agility of the public sector

Question 3 / Dealing with uncertainty

Question 4 / Dealing with unexpected events

Question 5 / The risk appetite of the public sector

Question 6 / Using diversity and optionality in the public sector

Closing statements

10.3. Summary of interviews

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Appendices

A. Properties of the Enterprise Architecture schools of thought

A.1. The properties of Enterprise IT Architecting

	Enterprise IT Architecting school of thought
Motto	Enterprise architecture is the glue between business & IT
Objectives and concerns	Effectively enable the enterprise strategy Support IT planning and reduce cost Enable business
Principles and assumptions	Apply reductionist (mechanistic) stance Don't question business strategies Design organisational dimensions independently Don't worry about non-IT dimensions; they are not your concerns
Skills	Have technical competence and engineering knowledge
Challenges	Convince the organisation to accept the designed plans
Insights	Permits the design of robust and complex technological solutions Fosters the creation of high-quality models and planning scenarios
Limitation	Can produce inadequate or unfeasible solutions for the larger organizational context Struggles with solution acceptance and implementation barriers Susceptible to "perfect" designs that support unsustainable strategies

Table A.1.: Properties of Enterprise IT Architecting (Lapalme, 2012, p. 39)

A.2. The properties of Enterprise Integrating

	Enterprise Integrating school of thought
Motto	Enterprise architecture is the link between strategy and execution
Objectives and concerns	Effectively implement the enterprise strategy Support organizational coherence
Principles and assumptions	Apply a holist (systemic) stance Don't question business strategies and objectives Manage the environment Jointly design all organisational dimensions
Skills	Facilitate small-group collaboration Apply systems thinking
Challenges	Understand organizational systemic dynamics Collaborate across the organization Encourage systems thinking and paradigm shifts
Insights	Permits the design of comprehensive solutions Enables significant organizational efficiency by eliminating unnecessary contradictions and paradoxes
Limitation	Susceptible to "perfect" designs that support unsustainable strategies Requires a paradigm shift from reductionism to holism

Table A.2.: Properties of enterprise integrating (Lapalme, 2012, p. 39)

A.3. The properties of Enterprise Ecological Adaptation

The properties of an EEA are:

	Enterprise Ecological Adaptation school of thought
Motto	Enterprise architecture is the means for organizational innovation and sustainability
Objectives and concerns	Innovate and adapt Support organizational coherence Encourage system-in-environment coevolution
Principles and assumptions	Apply a holist (systemic) stance System-in-environment coevolution Environment can be changed Jointly design all organisational dimensions
Skills	Foster dialogue Apply system and system-in-environment thinking Facilitate larger-group collaboration
Challenges	Foster sensemaking Encourage systems thinking and systems-in-environment paradigm shifts Collaborate across the organisation
Insights	Fosters system-in-environment coevolution and enterprise choherency Fosters organisational innovation and sustainability
Limitation	Requires many organisational preconditions for management and strategy creation

Table A.3.: Properties of Enterprise Ecological Adaptation (Lapalme, 2012, p. 39)

B. Authors of the Enterprise Architecture schools of thought

Lapalme (2012, p. 42) Mapping enterprise architecture authors according to the three schools of thought.

Enterprise IT Architecting	Enterprise Integrating	Enterprise Ecological Adaption
Clive Finkelstein	Peter Bernus and Colleagues (editors)	Jamshid Gharajedaghi
Inge Hanschke	Ronald Giachetti	Tom Graves
Col Perks and Tony Beveridge	Leon Kappelman (editor)	Jan Hoogervorst
Jeanne Ross and colleagues	Martin Op't Land and colleagues	James Martin
Steven Spewak and Steven Hill		Kevin Smith and Tom Graves
Martin van den Berg and Marlies van Steenberg		James Lapalme and Donald de Guerre

Table B.1.: Authors of the Enterprise Architecture schools of thought (Lapalme, 2012, p. 42)

C. Overview of Laws

The research references to several laws. This appendice gives a small explanatory overview of these laws.

- 2nd Law of Thermodynamics
- Conways Law
- Metcalfe's Law
- Law of Municipalities
- Lehmans Law of Increasing Complexity

C.1. 2nd Law of Thermodynamics

The '2nd Law' was formulated after nineteenth century engineers noticed that heat cannot pass from a colder body to a warmer body by itself. It states that in any closed system the amount of order can never increase, only decrease over time. Another way of saying this is that entropy always increases.

C.2. Conway's Law

Any organization that designs a system (defined broadly) will produce a design whose structure is a copy of the organization's communication structure.

C.3. Metcalfe's Law

Metcalfe's Law¹ states that a network's impact is the square of the number of nodes in the network. For example, if a network has 10 nodes, its inherent value is 100 ($10 * 10$). The end nodes can be computers, servers and/or connecting users.

C.4. Thorbecke's Law

C.5. Lehman's Law of Increasing Complexity

As an evolving program is continually changed, its complexity, reflecting deteriorating structure, increases unless work is done to maintain or reduce it.

¹<https://www.techopedia.com/definition/29066/metcalfes-law>

D. Conceptmap of antifragile attributes

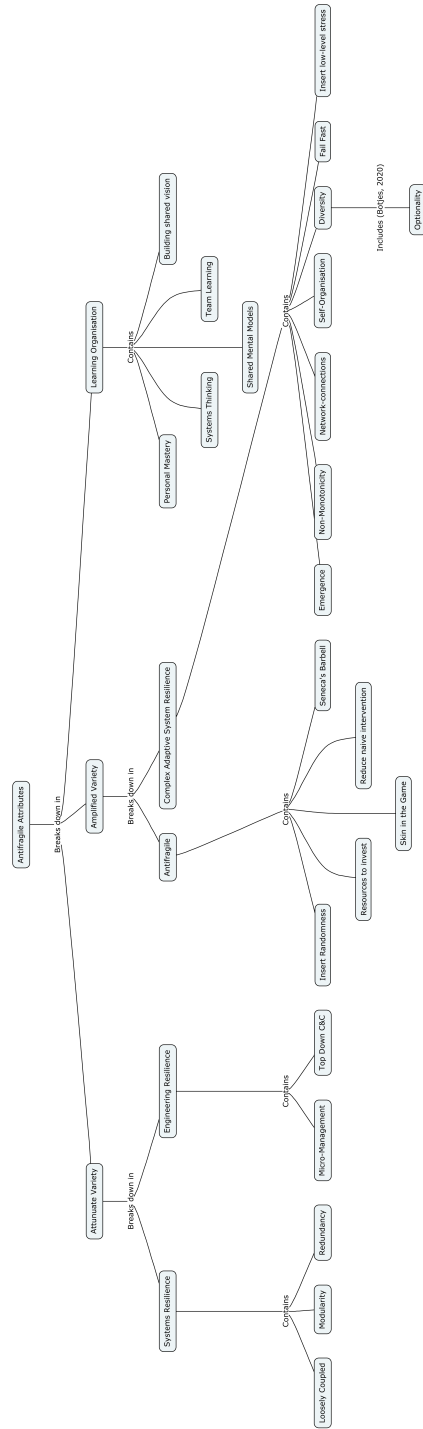


Figure D.1.: Concept map of Antifragile Attributes

E. Literature Selection

F. Interview summaries

F.1. Interview central government

Question 1 / Enterprise Architecture

EA is not used and we are not agile. EA is too difficult for the public administrators. In addition, we are also responsible for other sectors. There is not one architecture. We have multiple reference architectures. What we have to do in the public sector depends on the political decision making within the period of governing (four years until new elections). EA is at the end of the chain of administrative decision-making.

Question 2 / Agility of the public sector

It is hard to be agile within the public sector. Everything needs to be predefined and planned. Agile working is very difficult within the government. The end goal is not very clear with agile working. It is unclear how the public money is spent on precisely what.

Question 3 / Dealing with uncertainty and unexpected events

The public sector cannot deal with uncertainty. Everything must be predefined and planned. There must be accountability for how public money is spent. All missteps are magnified. There is a quick result in crises, but with possible consequences later on because of "Bureau ICT-toetsing" (BIT) audits or parliamentary inquiries.

Question 5 / The risk appetite of the public sector

There is no risk appetite. Everything must be known and explainable in advance. If it is found that the procedures are not used, it can result in political consequences later on. Afterwards, positive lessons learned are not used to make adjustments within the public sector. Experimentation is (almost) not possible. (note: blaming culture)

Question 6 / Using diversity and optionality in the public sector

It would be nice to work with optionality and smaller units within the public sector and EA to make it easier to adapt. Think about in EA disposable microservices. Nevertheless, it remains that EA is not important. It is at the end of the chain and is not used in administrative decision-making. Enterprise architecture is confronted with decision-making.

Closing statements

Antifragile is not directly applicable for the central government, but it can have a lot of benefits for suppliers in the public sector. Do not advertise it but exploit it to become better. In the case of an Independent Software Vendor (ISV) think about many disposable microservices so it will be easier to deal with the public sector.

F.2. Interview local government

Question 1 / Enterprise Architecture

There is somewhat of an EA, but we are not using it that broadly. As an organisation, we do not have a real EA. Our organisation is best compared to that of a consultancy firm. Our core task is lobbying advocacy. We guide the things we do, and then again, it concerns the things we do for municipalities or on behalf of municipalities. We have a multi-year vision. We use guiding principles for the things we do. Nevertheless, there are processes in the making for portfolio management. What do we do, what don't we do, and how do they relate to each other. There is not one responsibility on the EA. It is a stepped responsibility that lies with committees and the services board. When it comes to IT, the responsibility lies with the Directory of Information Society. EA is used for assay the request for subsidy. When there is a request for a subsidy that is not in line with the goals, it is not requested by the (European) government. The case of how EA contributes to the agility of the public sector is complicated. The public administrators are not architects and vice versa. EA is hard to understand. EA does not provide answers for the problems of today. Ultimately EA should deliver this so the change can start tomorrow. It is essential to clarify the problems that public administrators are having. Both the facts as well the underlying causes. EA should clarify the differences. Make it clear where we need to go and map out a path to get there, based on little steps that ultimately lead to the goal. Moreover, in the language public administrators understand. The architect must use the language of the stakeholders to make EA successful (note: success factor).

Question 2 / Agility of the public sector

The public sector is more about risk aversion. Legality is about holding on to what is known. So, it is exactly known what the municipalities do, and we know precisely what the Land Registry does. All the subsystems of the public sector have a defined assignment. Moreover, it would be best if it stayed between the lines. Think, for example, about purpose limitation. Purpose Limitation will hold it back when public sector wants to be agile. The public sector cannot experiment that easily with rules like these. It will put experimentation at the edge. The operating model of the public sector does not offer the freedom to do so that easily. The public sector can not experiment, discover and then say this was a nice experiment; let us go further. It is impossible to take decisions on the whole, such as within the social domain. If you have the right to confiscate a car, you cannot decide that there need to be a taxi to drive kids to school. It is a responsibility

of a different part of the public sector. This all has to do with the House of Thorbecke¹ together with the current legislation and regulations. It does not mean that the public sector does not want to be more agile. It is not about separate parts of the government anymore. There is more and more collaboration based on federation. The public sector wants to be more agile. It is often a subject of conversation. Nevertheless, it gets stuck in the administrative decision-making processes.

Question 3 / Dealing with uncertainty

The reflex on uncertainty of the public sector is that the public sector gets very insecure from uncertainty. So the public sector does not know how to deal with uncertainty. The common reflex is to push the uncertainty back to robust/resilient, so it is under control again. Robust & resilient is back to its previous state but then sturdier, more robust (note: Risk avoidance). However, the public sector claims that they can deal with it. See, for example, the energy transition. The public sector defined the framework for this transition. It can contribute to the economy with many new jobs and a new knowledge model. We did see that also in the past with road and waterway engineering. Nevertheless, then they forget about the mechanisms needed to accomplish it. So the public sector does want to deal with uncertainty, but the public sector is not creating the right conditions or the freedom of acting to be able to do so. The available EA's within the public sector do not help either. It does not contribute to accept uncertainty. At the most, our new vision on Information, Common Ground², is contributing to this. An important principle in that vision is the "community" principle that could help with this uncertainty (note: shared mental models). This principle states that municipalities, chain partners, market parties and the VNG-R work together as a community in realisation. It is the certainty that it is uncertain. There are always new issues, and organising collaboration will help us to better deal with this uncertainty, especially in the public sector.

Question 4 / Dealing with unexpected events

We, fortunately, live in a country where the public sector is staffed with good people who understand what citizens need or what is needed in a disaster area. So help is available pretty quickly. For example the fires at Moerdijk³, near Rotterdam. Or the plane crash of Turkish Airlines⁴ at Schiphol. Before we knew it, the fires were already distinguished. However, the public sector is not able to ascertain if it is an incident or a structural problem. If the problem takes too long, we see the reflex to control it again, so we fall back to our past habits. Adopting newly learned patterns is hard with the current legislation and regulations. Maybe we must be in a continuous crisis, so we have the freedom to do what we have to do. It is easier to be more agile in a crisis. With the

¹https://www.denederlandsegrondwet.nl/id/vieqcpdzf0gw/bestuurlijke_indeling

²<https://commonground.nl/>

³https://nl.wikipedia.org/wiki/Brand_Moerdijk_5_januari_2011

⁴https://en.wikipedia.org/wiki/Turkish_Airlines_Flight_1951

local governments, there is only one who can decide what to do in a crisis, and this is the mayor as part of the triangle¹. It seems that the local governments have two organisation & operational models. A model for running the municipality in a normal state and one in a state of crisis. (note: Seneca's Barbell?)

Question 5 / The risk appetite of the public sector

Drive and urge for innovation and change, which could perhaps be another interpretation of the word risk. People in the public sector want to find out if it can be done differently, but it is very dependent on the person. So actually, that depends on people in the public sector. Not on the public sector as a whole, based on intrinsic motivation to make things better for citizens and entrepreneurs. We have even set up our organisation in such a way that we can support this. Nowadays we have a department for research and innovation. But after something new is thought of it will go to the department to create it and finally to a department to maintain it. Sometimes we are limited because it influences the standing legislation and regulations.

Question 6 / Using diversity and optionality in the public sector

The public sector is not supporting diversity and optionality, but on the other hand the public sector is based on the absolute premise that all organisations are autonomous. (note: with a clear goal per organisation so no options). The implementation of the policies is extremely diverse. For example, there are various approaches known for people who are unemployed. One municipality forces people to perform work before they receive benefits, while another municipality supports them to be financially healthy again. Both achieve the obligation to provide care to a citizen so that the citizen has an income again. Diversity and optionality are less important. The local authorities simply have to implement the policies. It is all set down in the law and regulations. There is quite a diversity in how municipalities organize things. One municipality collects the household waste itself, while another has outsourced it. In both cases, the collection of household waste is arranged. Nobody prescribes how you arrange it, as long as it is arranged. You see the same thing within IT. However, you see here that for transitions and transformations an EA is enormously needed to support the new world.

Closing statements

The government will not disappear, but that trust in the government will. Some government organizations or parts of them can undoubtedly disappear. (note: does not fit with the questions but find it an important statement). The public sector needs a cross-sector EA. It's no longer just about your organization. You have to work together more and more. The EA can then be further tailored to your own organization.

¹[https://nl.wikipedia.org/wiki/Driehoek_\(overheid\)](https://nl.wikipedia.org/wiki/Driehoek_(overheid))

F.3. Interview ISV

Question 1 / Enterprise Architecture

Enterprise Architecture is developed to bring the business units together under one single architecture firstly. A common architecture brings synergy. It is reusing common components. Develop common language (note: Learning Organisation attribute shared mental model). It will bring us efficiency. Starting with architecture as a steering mechanism (note: engineering resiliency attribute Command & Control) and currently focusing on the internal organisation, the enterprise (note: mostly the first school of thought of EA (Lapalme, 2012)). It is emerging that the current architecture is used as a communication mechanism to the external context (note: first steps into the second school of thought of EA (Lapalme, 2012)). Our EA is supporting us with the transformation towards a Software-as-a-Service (SaaS) provider. The EA is used more and more used as a mechanism for explaining. The focus of the EA is at this moment 80% on the internal organisation and 20% on the external context (note: not yet the third school of thought of EA). EA is the responsibility of the Chief Operations Officer (COO) but the group of executive management is accountable. This group contains the Chief Executive Officer (CEO), the COO and the Chief Commercial Officer (CCO). (note: with placing the responsibility on EA with the COO the primary purpose of EA will be efficiency). The interviewee (CEO) does not worry about this because in the end everything ends up with the EA. EA must be part of the executives. EA is essential for business operations. Our EA supports us to be agile. Our crown jewels (our applications) are a stable core around which we can be flexible and agile to follow external contexts such as new laws and legislation. Think about the Application Programming Interface (API) layer (note: systems resiliency attribute Loosely Coupled) that is being built that makes it easier to respond to these changes. Eventually, our EA must enable us to change to support our customers with their social tasks. We are not there yet. The transformation towards Software-as-a-Service (SaaS) alone takes us multiple years. This is, at this moment, not a problem yet. The public sector is even moving slower, and there is not that much competition, but it is changing rapidly. The pace of change is increasing. It can be said that sometimes there is already a permanent state of change. Take the replanning of the municipalities and shifting tasks from the centralised government to the local government. The role of technology gets even more critical, the civilians are getting more empowered, and the participation rate in society increases. The influence of the external contexts does have more and more influence. Only the digital transformation itself is a stressor on the public sector. It already was there, but we see an increase. At this moment, the policymakers (politics) limit the speed of change. These are not isolated incidents. An example is the "Digitaal Stelsel Omgevingswet", which is again being postponed. This is not sustainable in the near future. If this does not change, the public sector will get stuck.

Question 2 / Agility of the public sector

The current operational model of the public sector is old and moves slowly because of the regulations, legislation and qualified-majority decision-making. However, when there is a crisis, everything is possible. But only under extraordinary conditions. The should be in a continuous crisis (note: looks like the antifragile attribute of insert randomness). After a crisis, lessons learned are not used to improve the public sector (note: attribute part of the learning organisation). There is no feedback loop. The system is not supporting this. Changes to the current systems are slow, complex and large. Because of this, there are not that many suppliers on some solutions. For several solutions, there is only a choice between two (note: the CAS attribute diversity and optionality is not available.). In the worst case, there is only one solution, like with the taxes administration of the Ministry of Finance. The architectures in the cannot support it because it misses alignment with business language. It misses stakeholder specific views in the language of the stakeholders. A good example is the Interactive Dynamic Enterprise Architecture (idEA)¹ method of the government. However, they stopped using it. Most IT management in the Public Sector is not IT Savvy. It would be better to have IT Savvy Management experienced with policymaking. The IT Systems contain much technical debt. To the extent that the systems with new functionality often use encapsulation. Adjusting IT Systems take much time with many risks. The impact of a new coalition agreement is high. With a coalition agreement, many high-impact system adjustments must be made. The policymakers expect changes to be executed in only a couple of days. In the past, public sector organisations were loosely coupled and were highly cohesive (clear goal). With all those policy changes, organisations even got strangled and cannot be adjusted that easily anymore, like with the taxes administration of the Ministry of Finance as an Example. The taxes administration was specialised in collecting taxes (note: Systems Resilience attribute Loosely Coupled (High Cohesion)). Policymakers also forced them to disbursement (note: Systems Resilience attribute antipattern with result tightly coupled with low cohesion). The same departments, processes and systems were used.

Question 3 / Dealing with uncertainty

You cannot define uncertainty on the public sector as a whole. The average size of municipalities is growing because of the reordering of Municipalities. Municipalities that are too small are merged (note: decrease of modularity, self-organisation and diversity). The scaling of municipalities is not always in the best interest of the civilians. It does not always improve the services to the residents of the municipalities. There are cases where a civilian needs to cycle 10km for a passport while it was less in the old situation. The services given are more business-like without a personal touch. If you look at the public sector for the last 200 years, the public sector is capable of adjusting when it needs to be adjusted (note: resilient/robust). The public sector can deal with uncertainty. However, if the way the public sector deals with uncertainty is the most efficient way

¹<https://www.ictu.nl/projecten/idea-beeldtaal-maakt-it-infrastructuur-begrijpelijk>

is the question. The social cohesion that the civil servants of the public sector have is enormous. The public sector can handle uncertainty. The will is intrinsic available. If they get an assignment, they are going for it. If it must be done within four years (the duration of a coalition agreement), they will go for it. Even if the change is too big or complex and the planning is not realistic. An example of the effect is that of the childcare benefits scandal¹. Decentralisation of governmental tasks was the cause of this. Because of the absence of EA and the usage of EA within the domains, such as social domain, taxes, finance, a.o., these examples are not an incident. EA can prevent these causes and effects. The fact that the public sector did not organise EA is a cause of the incidents. The actual absence is an EA process that guides the governments. This behaviour is especially shown with the local governments. They are continuously reinventing the wheel (note: No overarching Command & Control). The public sector has to go back to the drawing board for every change to develop a new approach.

Question 4 / Dealing with unexpected events

The public sector is handling unexpected events better than uncertainty. The public sector handles unexpected events better than the political decisions made by coalition agreements. In a crisis situation, the public sector is capable of working very effectively. Should the public sector be in an ongoing crisis? No. The public sector is in need for antifragile solutions. Better is to continuously add a small amount of stress to the public sector system (note: antifragile attribute insert randomness). This is in contrast to sitting back and watching until something happens. It seems that the rules do not apply anymore with an unexpected event. The public sector has many talents to deal with these situations, but they all seem too busy with their careers, salaries, what should go to which ministry, and others. This is the thing that needs to be solved. Strange because most of the time, the employees in the public sector enjoy working in a crisis. It makes them feel proud that they accomplished something. There were initiatives to use EA, and it proved to be supporting the changes. Overarching examples are, for example, the consolidation of 66 datacenters to two private and two public datacenters (note: diversity and optionality), the common desktop standard (project "goud") (note: part of the stable part of Seneca's barbell strategy). Re-usability, an ICT dashboard, and many more initiatives were worked on. Later on, these initiatives fell apart, and the ministries picked it up again in their silo. It all was carried by a select group of people in the public sector. It all fell apart when some of them left the public sector. If it does not have assignments from the government members, it is dependent on the willingness to cooperate. The dominance of the separate ministries take the overhand, and people fall back in the old habits. To sustain the use of EA it should not depend on a selective group of people but on the public sector itself (note: success factor). The mutual differences are gone when there is a common enemy (an unexpected event). At that moment, the solution will overarch the public sector. Changes following the process have less effect than changes initiated by chaos. The feedback from unexpected events is not fed into the system so that it can be changed (note: learning organisation not in place).

¹https://en.wikipedia.org/wiki/Dutch_childcare_benefits_scandal

Question 5 / The risk appetite of the public sector

For the risk appetite of the public sector, the government members have an essential role. At this moment, there is no culture of risk-taking. Even worse, taking risks can have serious consequences. Think about, for example, commission "Elias"¹. Because of this commission, a new department, "Bureau ICT-toetsing" (BIT), was started as part of the Ministry of Home Affairs with the assignment to assess all the IT Projects within the centralised government (note: Engineering Resilience attribute Command & Control). Because of this, people are not willing to take risks anymore (note: insert randomness, tinkering, naive interventions, monotonicity, fail-fast, and others). Some are busy shielding their bosses and managers for possible errors (note: antifragile attribute: (no) skin in the game). At this moment, the public sector is showing risk avoidance behaviour. The base attitude of the public sector is that it does not have a risk appetite. Partly because of public opinion. It is all about the use of public funds. Before you know it, there will be negative attention in the media. EA is mostly used in a prescriptive way (note: Engineering Resilience attribute Command & Control). The public sector is not foster a safe environment for experimentation. Even when a good solution is implemented in a time of crisis (unexpected events), punishment will happen afterwards because it did not comply in the way it usually should. The public sector public sector created an environment in which the public sector is a fragile "glass house" together with a culture of blaming. So the risk appetite is getting less and less.

Question 6 / Using diversity and optionality in the public sector

Optionality does not have a chance in the public sector because of european tender obligations. The european tenders are mostly about risk reduction. The european tenders contain many legal conditions. But not only legal conditions but also a lot of technical conditions. Everything is defined in a way that you have no options anymore. The conditions are even so that you cannot choose, for example, multiple suppliers so you will have options during the contract periods. The private sector has this already for a long time. There are private companies who have multiple suppliers for a domain. If one supplier is not delivering the quality anymore another supplier is taking over. European tenders did not help us to become more flexible, resilient, and agile. But there are changes. It would be nice to see if the "Vereniging Nederlandse Gemeenten - Realisatie" (VNG-R) will be thinking of a broker construction with multiple suppliers. By using this strategy the local governments can choose a supplier by only using bids. It is easier to switch and having options. Another thing that can help optionality is defining right Key Performance Indicator (KPI)'s. If you define a KPI in such a way that the performance of a supplier is measured by the ease of transitioning to another supplier it will get easier to switch suppliers. This has a positive influence on executing optionality. But this way of working is not sustained in, for example, the EA.

¹https://nl.wikipedia.org/wiki/Parlementair_onderzoek_ICT-projecten_bij_de_overheid

Closing statements

The digital transformation must be important to everyone and not only to a minister of digital affairs. How do you make sure that business management of the public sector find it normal to discuss IT, budget, personnel, organisational configuration, and others? If they start thinking like this, they will find out what EA can do for them. If we know how to close this gap, digital transformation will get the proper attention. We also have to thank ourselves for this because of the use of non-business language.

F.4. Interview consultancy firm

Question 1 / Enterprise Architecture

Question 2 / Agility of the public sector

Question 3 / Dealing with uncertainty

Question 4 / Dealing with unexpected events

Question 5 / The risk appetite of the public sector

Question 6 / Using diversity and optionality in the public sector

Closing statements

G. Validation

H. Research Log

Date	What
24/11/21	Initial research subject proposal to AMS.
25/11/21	Initial research subject proposal sent to Hans Mulder & Yuri Bobbert.
30/11/21	First meeting with Hans Mulder to explore the subject.
12/02/21	AMS Master Project Coaching.
10/03/21	Second meeting with Hans Mulder. Definitive Area of Research selected. The success factors of EA for Business Agility/Resilience/antifragility.
11/03/21	Elaborated with COO Centric Public Sector Solutions on antifragility.
14/03/21	Started research on the concept of antifragility.
03/04/21	One Pager on the concepts Enterprise Architecture, Public Sector, Independent Software Vendor, and Antifragility.
04/04/21	Deskresearch on concept Antifragility
10/04/21	Reading Taleb.
25/05/21	Third meeting with Hans Mulder.
20/06/21	Creating 5 pager. Sent 5 pager presentation for review to Hans Mulder, Dienneke Schouten, and Maarten Hillenaar. Promotor suggestion Roland Ettema, Martin Op 't Land, Bas van Gils or Hans Mulder. Suggested Hans Mulder as promotor with Edzo Botjes as co-promotor.
21/06/21	Requested Maarten Hillenaar as Sponsor, Dienneke Schouten as Second Reader, Jan Ploeg as participant in Delphi, Christiaan Konstapel as interviewee.
24/06/21	Presentation of the Five Pager at the Master Consultancy Coaching masterclass at AMS.
29/06/21	Created the LaTeX skeleton.
06/07/21	Meeting with Edzo Botjes to get acquainted. Edzo Botjes accepted co-promotorship. Definitive Promotor and Co-Promotor are known. Hans Mulder and Edzo Botjes.
07/07/21	Setting up GitHub Environment for collaboration with (Co-)Promotor.
14/07/21	Selected the appropriate License for the thesis. **CC BY-NC 4.0**
16/07/21	Webinar Value from being resilient (Xebia/Edzo)
17/07/21	Requested Sponsor in helping selecting the Delphi Group Participants. The network of Sponsor is extensive.
24/07/21	Analysed Thesis of Edzo Botjes. Created literature administration based on template of Yuri Bobbert (Added unique Key/ID, Relevance of Titel, Abstract and Contents, bib _{LaTeX} citation key, notes field, and used search strings). Changed the license in a less restricted license **CC BY-SA 4.0**

Date	What
01/08/21	Analysed Thesis of Edzo Botjes. Snowballing from Thesis of Edzo Botjes. Administration on Literature to be read.
02/08/21	Contact with research sponsor about invites for the Delphi Group. Contacted an academia for participation in the Delphi Group. Created ORCID, Zenodo, and Researchgate account. Sorted Literature. Searched for missing references with PaperPanda. Wrote little scribbles on Research methodology. Discussed participants from VNG-Realisatie (not that many candidates for the Delphi Group). Decided with Sponsor that VNG-Realisatie can be seen as a Municipality (VNG is the association of dutch municipalities).
03/08/21	Worked on Literature approach, literature administration, and the Methodology (research infrastructure and tools).
04/08/21	Worked on the literature administration and finished the methodology of the research infrastructure and tools. Moved text blocks from earlier reports into the thesis for refinement. Moved the literature to the public repository and moved copyright and disclosed materials to the private repository. Changed the L ^A T _E X template so that the paragraph indents are as they should be. Added multiple Cite in the chapter template as an example.
05/08/21	Invited EA of a Municipality, and two academia to join the Delphi Group from which one academia and the EA already confirmed their participation. Added extra literature to be evaluated based on a mailing list of BiZZdesign (State of Enterprise Architecture, volume 2021). Added a conference article from EDOC on Architecture Principles for supporting large-scale agile transformations. This cloud give insights on how to use Principles in an transformation to Antifragile. Found this document through the ORCID of Henderik Proper (co-author of the book Architecure Principles).
06/08/21	The second academia confirmed the participation in the Delphi Group. Wrote the template the sponsor can use to invite people for the Delphi Group. The template (Dutch) is stored in the administrative repository.
11/08/21	Worked on literature study on vacation. Dropbox broke so had to pull to locally.
12/08/21	Worked on literature study.
15/08/21	Worked on literature study. More and more about CAS and Resilience. Not that much known on Antifragility yet. Still snowballing the current available Body of Knowledge.
31/08/21	Organised a meeting with Promotor and Co-Promotor on the 9th of September 2021 at the Antwerp Management School from 11:30 until 13:30 before master-classes about Agile Enterprise Architecture & Enterprise Engineering.
01/09/21	Meeting with Co-Promotor about being stuck in the literature study part of the research. Talked about narrowing the scope, defining important keywords and possible only searching for relevant literature after 2019 (study of Co-Promotor). Some new direction given from the Co-Promotor. He did not use the articles by Barry M. O'Reilly from the ANT conferences but it may be the right direction for the research.

Date	What
03/09/21	Research on the ANT conferences and pulled some relevant articles into the research. Administration of Literature study.
04/09/21	Literature study. Read the articles of Barry M. O'Reilly. Shared the articles of Barry M. O'Reilly with colleagues responsible for Software Development and Architecture.
05/09/21	Literature study and structure of thesis. Worked on the introduction and added some new relevant information to the theoretical background.
06/09/21	Literature study.
08/09/21	Administration and preparations for meeting with Promotor and Co-Promotor on the 9th of September at the AMS.
09/09/21	Alignment with Co-Promotor and Promotor at the AMS. Administration on given answers. Requested the sponsor to take his place at the jury.
10/09/21	Literature study.
15/09/21	Visited the iBestuur congress for information on the public sector market and to network for the study/research.
16/09/21	Literature study. Writing on Chapter 1 and 2.
19/09/21	Writing on Chapter 1, 2 and 3. Refine email for sponsor for invitations of delphi group participants. Sponsor accepted his jury position.
20/09/21	Finalising Chapter 1 for 10 pager AMS. Last refinement for Sponsor invitation email after meeting by telephone.
21/09/21	Wrote Barry O'Reilly an email with the request to meet and elaborate on the residuality theory.
22/09/21	Structuring and writing.
23/09/21	Structuring and writing. Created a frozen release on GitHub of this release. Send the same compiled version of the thesis to the sponsor and the second reader.
24/08/21	Master Project Coaching. Status update on Thesis.