

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

Declaration of Authorship

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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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 3 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 4 describes the found success factors. Implementation guidelines from an EA perspective operationalise the found success factors. Chapter 4 ends with an overview of found success factors of EA and antifragile that can contribute to the public sector to become antifragile. In Chapter 5 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 6. This thesis ends with Chapter 7 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. The regional and national governments are part of the environment (Section 1.4).

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.

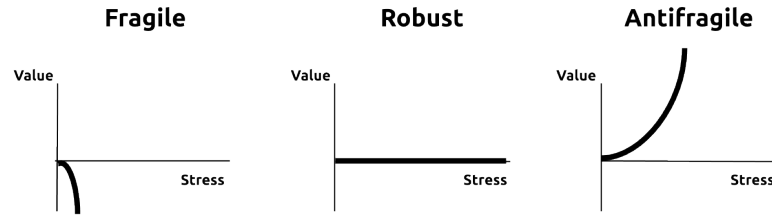


Figure 1.1.: Extended Antifragile Attribute List (EAAL) Triad (Botjes, 2020)

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 antifragility?

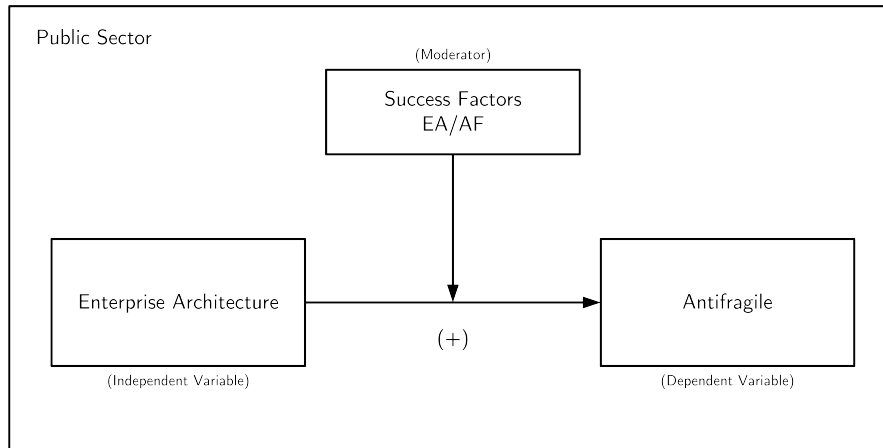


Figure 1.2.: Conceptual Research Model

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.

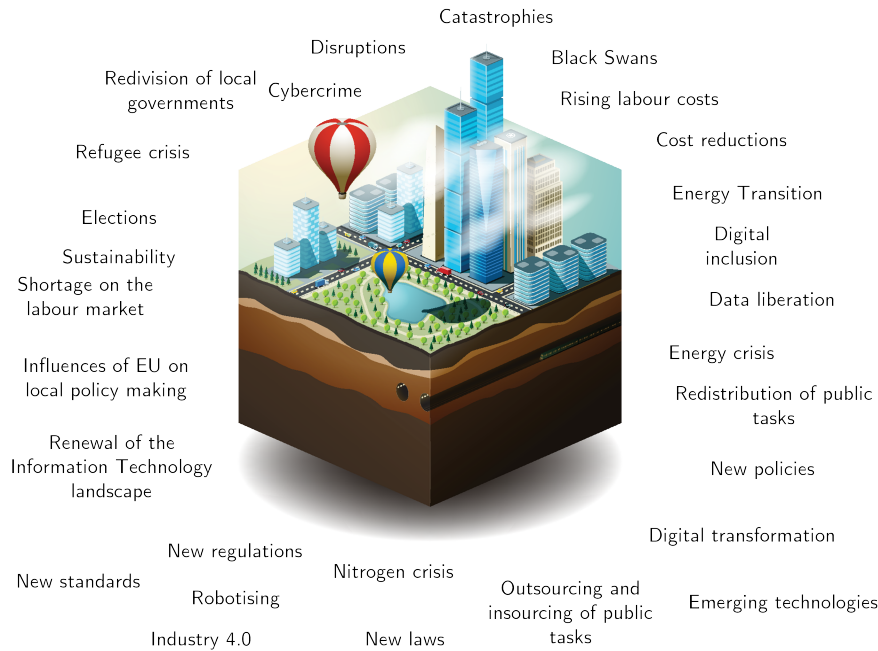


Figure 1.3.: Examples of stressors on the public sector

Because of the digital transformation, the pace of change is increasing rapidly. 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 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.

2.1. 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).

2.1.1. What is a stressor?

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

2.1.2. Volatile, uncertain, complex, and ambiguous

Volatile, uncertain, complex, and ambiguous.

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

antifragile with fragile, robust, resilient, and agile.

2.1.4. 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.

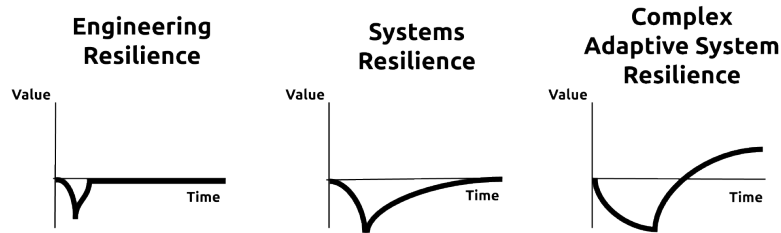


Figure 2.1.: Three types of resilience (Botjes, 2020)

2.1.5. Antifragile Systems Design

2.1.6. Residuality Theory

2.2. 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.

2.2.1. 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

2.2.2. Steering mechanisms

2.3. 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.

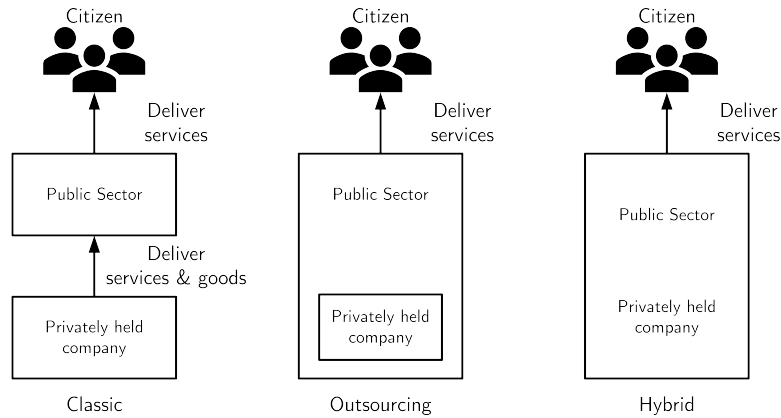


Figure 2.2.: Public sector collaboration models

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.

2.3.1. 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.

2.4. 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

2.4.1. 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)

2.4.2. Summary of the concept system

2.4.3. 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.

3. Research Methodology

3.1. 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.

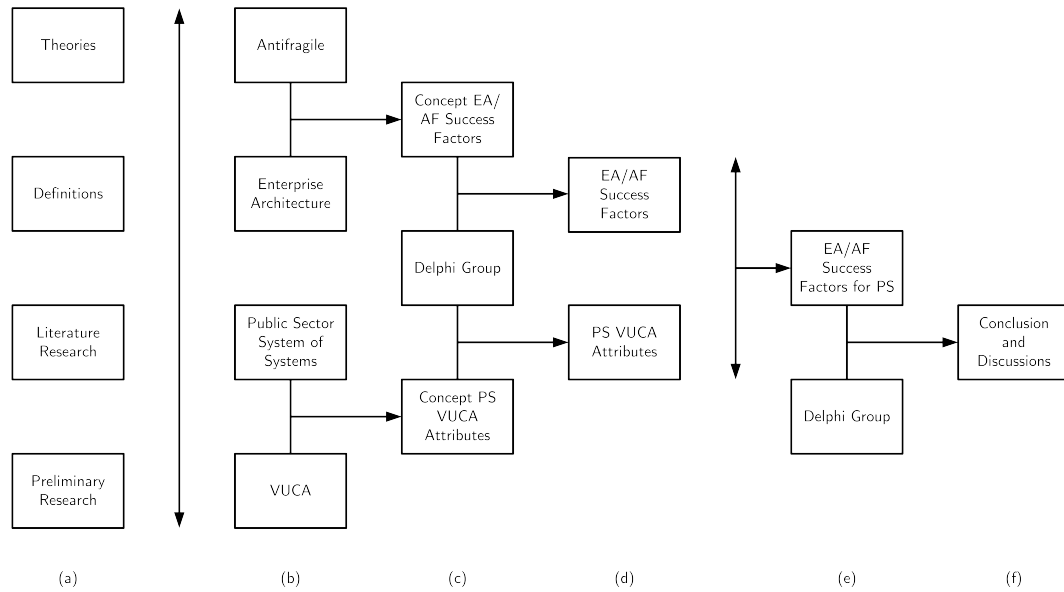


Figure 3.1.: Research Model

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).

3.2. Research quality

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

- Quality Principles of Recker (2013) (subsection 3.2.1).
- The FAIR Principles from Scientific Data (subsection 3.2.2).
- The Open Science Framework (subsection 3.2.3).

3.2.1. 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?

3.2.2. 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.

3.2.3. 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 3.5. Using this framework will help in achieving replicability, precision, and reusability.

3.3. 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 3.1) 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/>

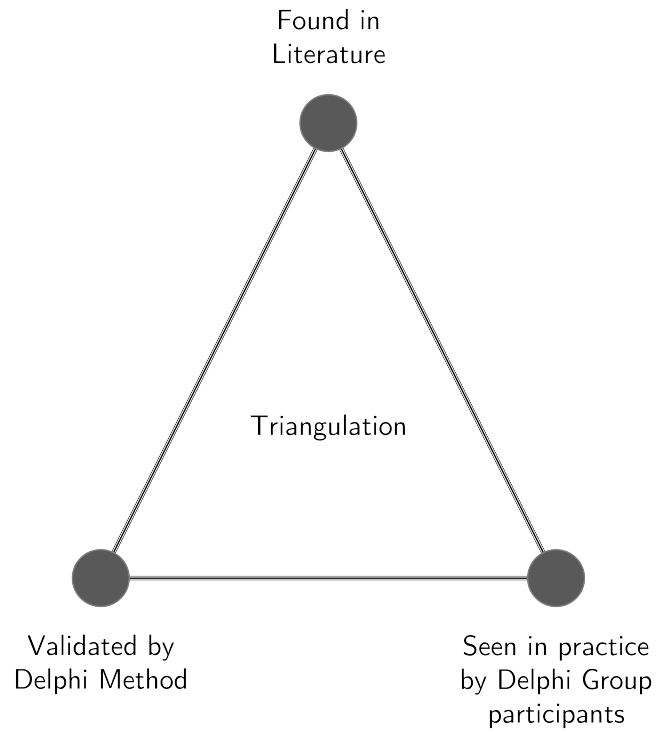


Figure 3.2.: Triangulation

| 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 3.1.: 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 3.2.: 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 3.3.: Meaning of the score of triangulation

3.3.1. 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.

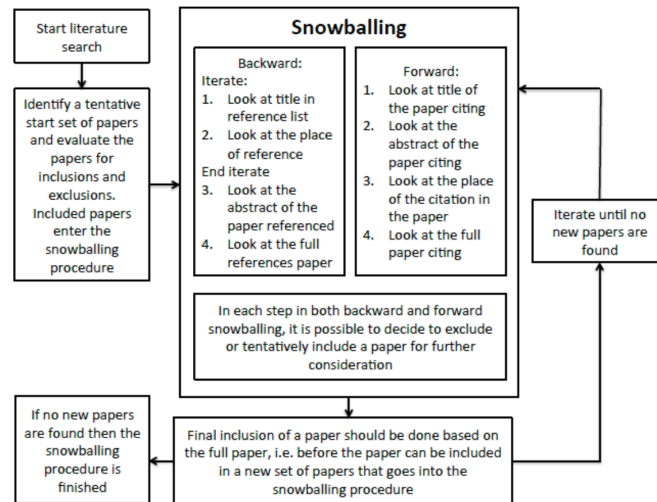


Figure 3.3.: Snowballing literature (Wohlin, 2014)

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 3.5.3 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 3.4.: Antifragile keywords

Enterprise Architecture

As described earlier in the subsection 2.2.1 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 3.5.: 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 3.6.: 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 3.7.: Public sector keywords

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

3.3.2. 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)

3.3.3. 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?

3.3.4. 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 3.2.1). 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.

3.3.5. Conclusion and discussion phase

The fifth phase (e)

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

3.4. Research type

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

3.5. 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.

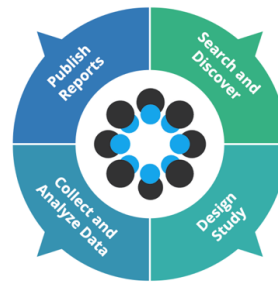


Figure 3.4.: Open Science Framework

3.5.1. 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.

3.5.2. 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.

3.5.3. 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.

3.5.4. 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 3.8.: 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/>

4. 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.

4.1. 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 4.1.: 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 fail0safe 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.

4.1.1. 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.

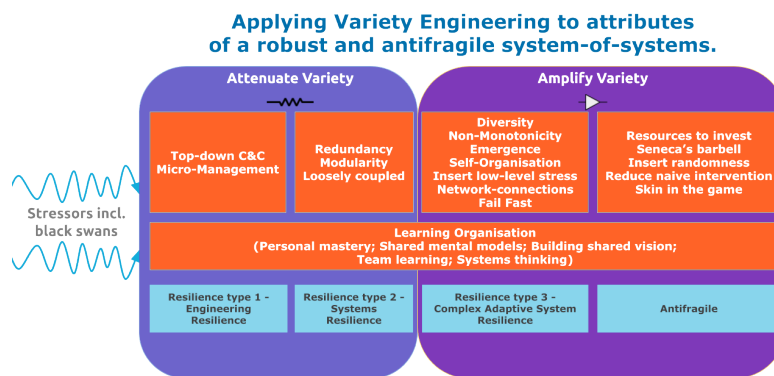


Figure 4.1.: EAAL (Botjes, 2020)

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.

4.1.2. 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.**

4.1.3. 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.

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

4.1.4. Summary of EA/AF

4.2. EA

4.2.1. Summary of EA/AF

4.3. Systems Theory

4.3.1. 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.

4.3.2. Systems-in-Environment

(Lapalme, 2012, p. 41)

4.3.3. 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.

4.3.4. Viable Systems Model

Viable Systems Model (VSM)

4.3.5. Organisation as a System

4.3.6. Summary of EA/AF

5. Delphi

5.1. Delphi Round One

5.2. Delphi Round Two

5.3. Delphi Round Three

5.4. Delphi Round Four

5.5. Delphi Round Five

5.6. Delphi Round Six

5.7. Result of Delphi Rounds

5.8. 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) | 2.1.5 | 1 | 1 | 1 | 3 |

Table 5.1.: Score of Success Factors

6. Conclusion and discussions

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6.1. Conclusion

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6.2. Discussions

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6.3. Reccomandations

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7. Retrospective

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- The added value of a Co-Promotor

8. Concepts

8.1. 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 8.1.: 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.

8.2. 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).

- 8.2.1. Interview Question 1
- 8.2.2. Interview Question 2
- 8.2.3. Interview Question 3
- 8.2.4. Interview Question 4
- 8.2.5. Interview Question 5

Bibliography

- ArapahoeLibraries. (2020). "The Only Constant in Life Is Change."- Heraclitus. Retrieved September 20, 2021, from <https://arapahoelibraries.org/blogs/post/the-only-constant-in-life-is-change-heraclitus/>
- Bennett, N., & Lemoine, G. J. (2014). What a difference a word makes: Understanding threats to performance in a VUCA world. *Business Horizons*, 57. <https://doi.org/10.2139/ssrn.2406676>
- Bertalanffy, L. v. (1968). *General system theory: Foundations, development, applications*. Braziller.
- Botjes, E. (2020). *Defining antifragility and the application on organisation design* (Master's thesis). Zenodo. <https://doi.org/10.5281/ZENODO.3719389>
- Brafman, O., & Beckstrom, R. A. (2007). *The starfish and the spider: The unstoppable power of leaderless organizations*. Turnaround.
- De Haes, S., Van Grembergen, W., Joshi, A., & Huygh, T. (2020). *Enterprise governance of information technology: Achieving alignment and value in digital organizations* [OCLC: 1121274337]. Retrieved November 26, 2020, from <https://doi.org/10.1007/978-3-030-25918-1>
- Denzin, N. K. (2017). *Research act: A theoretical introduction to sociological methods*. [OCLC: 1003798389]. ROUTLEDGE. <https://www.amazon.nl/Research-Act-Theoretical-Introduction-Sociological/dp/1138538191>
- Dersin, P. (2014, October 15). *Systems of systems* [IEEE reliability society]. Retrieved September 28, 2021, from <https://rs.ieee.org/technical-activities/technical-committees/systems-of-systems.html>
- Diamond, I. R., Grant, R. C., Feldman, B. M., Pencharz, P. B., Ling, S. C., Moore, A. M., & Wales, P. W. (2014). Defining consensus: A systematic review recommends methodologic criteria for reporting of Delphi studies. *Journal of Clinical Epidemiology*, 67(4), 401–409. <https://doi.org/10.1016/j.jclinepi.2013.12.002>
- Gartner. (n.d.). *Definition of enterprise architecture (EA) - gartner information technology glossary* [Gartner]. Retrieved April 5, 2021, from <https://www.gartner.com/en/information-technology/glossary/enterprise-architecture-ea>
- Greefhorst, D., & Proper, E. (2011). *Architecture principles: The cornerstones of enterprise architecture* [OCLC: ocn729345210]. Springer.
- Hole, K. J. (2016). *Anti-fragile ICT Systems*. Springer International Publishing. <https://doi.org/10.1007/978-3-319-30070-2>
- Hoogervorst, J. (2009, January). *Enterprise Governance and Enterprise Engineering*. <https://doi.org/10.1007/978-3-540-92671-9>
- Hoogervorst, J. A. P. (2009). *Enterprise governance and enterprise engineering*. Springer. <https://www.springer.com/gp/book/9783540926702>

- Jaaron, A., & Backhouse, C. (2014). Building Antifragility in Service Organisations: Going Beyond Resilience. *International Journal of Services and Operations Management*, 19, 491–513. <https://doi.org/10.1504/IJSOM.2014.065671>
- Kastner, D. (2017). *Antifragile organisation design: A framework of self-organisation practices in today's complex and unpredictable economy*. (Master's thesis). University of the Arts London. London. <https://www.amazon.com/Antifragile-Organisation-Design-Self-Organisation-unpredictable-ebook/dp/B0746J5RXJ>
- Lapalme, J. (2012). Three Schools of Thought on Enterprise Architecture. *IT Professional*, 14, 37–43. <https://doi.org/10.1109/MITP.2011.109>
- Lapalme, J., Gerber, A., Van der Merwe, A., Zachman, J., Vries, M. D., & Hinkelmann, K. (2016). Exploring the future of enterprise architecture: A Zachman perspective. *Computers in Industry*, 79, 103–113. <https://doi.org/10.1016/j.compind.2015.06.010>
- Lebel, L., Anderies, J., Campbell, B. M., Folke, C., Hatfield-Dodds, S., Hughes, T., & Wilson, J. (2006). Governance and the Capacity to Manage Resilience in Regional Social-Ecological Systems. *Ecology and Society*, 11, 19. <https://doi.org/10.5751/ES-01606-110119>
- Maier, M. (1996). Architecting Principles for Systems-of-Systems. <https://doi.org/10.1002/J.2334-5837.1996.TB02054.X>
- Mannaert, H., Verelst, J., & De Bruyn, P. (2016). *Normalized systems theory: From foundations for evolvable software toward a general theory for evolvable design*. nsi-Press powered bei Koppa.
- Mark, J. J. (2010). Heraclitus of Ephesus. Retrieved September 20, 2021, from https://www.worldhistory.org/Heraclitus_of_Ephesos/
- Martin-Breen, P., & Anderies, J. M. (2011). *Resilience: A literature review* [Accepted: 2014-03-27T18:00:48Z Publisher: IDS]. Retrieved July 31, 2021, from <https://opendocs.ids.ac.uk/opendocs/handle/20.500.12413/3692>
- Nurmi, J. (2021). *Enterprise architecture in public sector ecosystems: A systems perspective* (Doctoral dissertation). University of Jyväskylä. <https://jyx.jyu.fi/handle/123456789/73650>
- O'Reilly, B. (2019). No more snake oil: Architecting agility through antifragility. *Procedia Computer Science*, 151, 884–890. <https://doi.org/10.1016/j.procs.2019.04.122>
- O'Reilly, B. (2020). An Introduction to Residuality Theory: Software Design Heuristics for Complex Systems. *Procedia Computer Science*, 170, 875–880. <https://doi.org/10.1016/j.procs.2020.03.120>
- O'Reilly, B. (2021). The Philosophy of Residuality Theory. *Procedia Computer Science*, 184, 809–816. <https://doi.org/10.1016/j.procs.2021.03.101>
- PrivacySense. (2016). What is the Public Sector? Definition & Examples. Retrieved September 23, 2021, from <https://www.privacysense.net/terms/public-sector/>
- PsychTimes. (n.d.). *Metathesiophobia (fear of change)* [Psych times]. Retrieved November 12, 2021, from <https://psychtimes.com/metathesiophobia-fear-of-change/>
- Recker, J. (2013). *Scientific research in information systems: A beginner's guide* [OCLC: 812383075]. Springer.

- Richardson, K. (2004). Systems Theory and Complexity: Part 1. *Emergence: Complexity and Organization*, 6.
- Rickles, D., Hawe, P., & Shiell, A. (2007). A simple guide to chaos and complexity. *Journal of Epidemiology & Community Health*, 61(11), 933–937. <https://doi.org/10.1136/jech.2006.054254>
- Ross, J. W., Weill, P., & Robertson, D. (2014). *Enterprise architecture as strategy: Creating a foundation for business execution*. [OCLC: 1015886391]. Harvard Business Review Press. Retrieved June 20, 2021, from https://www.amazon.com/Enterprise-Architecture-Strategy-Foundation-Execution/dp/1591398398/ref=sr_1_1?dchild=1&keywords=Enterprise%20Architecture%20As%20Strategy%20Creating%20a%20Foundation%20for%20Business%20Execution
- Russo, D., & Ciancarini, P. (2017). Towards Antifragile Software Architectures. *Procedia Computer Science*, 109, 929–934. <https://doi.org/10.1016/j.procs.2017.05.426>
- Saint-Louis, P., Morency, M., & Lapalme, J. (2019). Examination of explicit definitions of enterprise architecture. *International Journal of Engineering Business Management*, 11, 184797901986633. <https://doi.org/10.1177/1847979019866337>
- Sinha, D., & Sinha, S. (2020). Managing in a VUCA World: Possibilities and Pitfalls. *Journal of Technology Management for Growing Economies*, 11. <https://doi.org/10.15415/jtmge.2020.111003>
- Skulmoski, G. J., Hartman, F. T., & Krahn, J. (2007). The delphi method for graduate research [Publisher: Informing Science Institute]. *Journal of Information Technology Education: Research*, 6(1), 1–21. Retrieved June 20, 2021, from <https://www.learntechlib.org/p/111405/>
- Taleb, N. N. (2008). *The black swan*. Penguin Books Ltd (UK). <https://www.amazon.com/Black-Swan-Impact-Highly-Improbable/dp/0141034599>
- Taleb, N. N. (2012). *Antifragile*. Penguin Books Ltd (UK). <https://www.amazon.com/Antifragile-Things-That-Gain-Disorder/dp/0141038225>
- Turner, J. R., & Baker, R. (2019). Complexity Theory: An Overview with Potential Applications for the Social Sciences. *Syst.* <https://doi.org/10.3390/SYSTEMS7010004>
- UNESCO. (2020). *Open science* [UNESCO]. Retrieved September 22, 2021, from <https://en.unesco.org/science-sustainable-future/open-science>
- van der Wal, Z., de Graaf, G., & Lasthuizen, K. (2008). Similarities and differences between the organizational values of the public and private sector. *Public Administration*, 86(2), 465–482. <https://doi.org/10.1111/j.1467-9299.2008.00719.x>
- Verschuren, P. J. M., & Doorewaard, H. (2016). *Het ontwerpen van een onderzoek* [OCLC: 1194479615]. Boom. Retrieved June 20, 2021, from <https://boeken.vakgebieden.boomportaal.nl/boeken/boek/9789462365070>
- White, S. K. (2018). What is enterprise architecture? Retrieved August 4, 2021, from <https://www.cio.com/article/3313657/what-is-enterprise-architecture-a-framework-for-transformation.html>
- Wohlin, C. (2014). Guidelines for snowballing in systematic literature studies and a replication in software engineering. *Proceedings of the 18th International Conference on Evaluation and Assessment in Software Engineering - EASE '14*, 1–10. <https://doi.org/10.1145/2601248.2601268>

Ylimäki, T., & Halttunen, V. (2005). Method engineering in practice: A case of applying the Zachman framework in the context of small enterprise architecture oriented projects. *Information Knowledge Systems Management*, 5, 189–209.

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Glossary of Terms

agile The ability to adjust before failure happens. 5, 7, 19

agility The state of being agile. 18

ambiguous Not expressed or understood clearly. 7

amplify variety Amplifying or increasing the possible outcomes / states. A light that can be turned on and off has the variety of 2. Introducing the possibility of setting the light intensity increases the possible states. 35

antifragile The ability to strive for and evolve under stress. 1–3, 5–7, 9, 11, 13, 17–20, 27, 28, 30, 44

antifragility The state of being antifragile. 4–6, 18, 19, 22, 27

architecture framework An enterprise architecture framework (EA framework) defines how to create and use an enterprise architecture. An architecture framework provides principles and practices for creating and using the architecture description of a system. It structures architects' thinking by dividing the architecture description into domains, layers, or views.. 3

attenuate variety Dampening or reducing the possible outcomes / states. A light that can be turned on and off has the variety of 2. Your hand during Rock, paper, scissors has the variety or 3. 35

building shared vision a practice of unearthing shared pictures of the future that foster genuine commitment and enrollment rather than compliance. 35

complex A whole made up of complicated or interrelated parts. 7

digital transformation Digital Transformation is the application of digital capabilities to processes, products, and assets to improve efficiency, enhance customer value, manage risk, and uncover new monetisation opportunities.. 6

domain A field of action, thought, influence, etc.: The Domain of Science. 11

Failure Mode Effects Analysis Is a Six Sigma technique that helps manage quality in a system by investigating how the system will cope with failure. 28, 44

fragile The quality of being easily broken or destroyed. 1, 3, 7

fragility The state of being fragile. 7

insert randomness When insert-low-level stress and fail fails delivers no issues the next step is to insert randomness into the systems. A great example of this is Chaos Engineering by Netflix or the HackerOne bug-bounty system.. 35

personal Mastery Personal mastery is a discipline of continually clarifying and deepening our personal vision, of focusing our energies, of developing patience, and of seeing reality objectively. 35

reduce naive intervention Intervention based on a model and reductionistic logic and ignoring the experience. An example is not listening to the experienced but not so articulate employee, or by ignoring the balance nature has found in a ecosystem.. 35

resiliency The state of being resilient. 27

resilient The ability to recover from failure. 1, 3, 5, 7, 9, 19, 20

resources to invest Oportonies can only be seized when there are resources free to do see. This can be money but also time and labour. To Survive a black swan investment should be possible.. 35

robust The ability to resist failure. 1, 3, 5, 7, 19

seneca's barbell To be antifragile you need a robust sub-system to which 80%/90% predictable value with low risk is situated. The 20%/10% should be used for high return on investment activities.. 35

shared mental models Mental models are deeply ingrained assumptions, generalizations, or even pictures of images that influence how we understand the world and how we take action. 35

skin in the game Make certain that the one making the decision and doing the work has a pain and gain relation with the outcome. This goes beyond having a feedback system in place. This is goed beyond having KPI's in place. An example is that when working Agile scrum, the product owner should be a co-worker in the team for whom the solution is being build.. 35

systems thinking The Fifth Discipline of Senge that integrates personal mastery, shared mental models, building shared vision, and team learning. 35

team learning Team learning starts with 'dialogue', the capacity of members of a team to suspend assumptions and enter into genuine 'thinking together'. 35

uncertain Not known beyond doubt. 7

volatile Likely to change in a very sudden or extreme way. 7

Abbreviations

ASD Antifragile Systems Design. 28

BoK Body of Knowledge. 4, 6

CAS Complex Adaptive System. 35

EA Enterprise Architecture. 1–9, 11, 13, 17, 19–22

EAAL Extended Antifragile Attribute List. 4, 9, 27

EEA Enterprise Ecological Adaptation. 9, 19, 41, 47

FMEA Failure Mode Effects Analysis. 28

IS Information System. 21

ISV Independent Software Vendor. 2, 21

SoS System-of-Systems. 27, 29, 30

VSM Viable Systems Model. 30

VUCA Volatility, Uncertainty, Complexity and Ambiguity. 1, 13, 17, 19, 20, 28, 30

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 |

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

| | Enterprise Integrating school of thought |
|------------|--|
| Skills | Jointly design all organisational dimensions 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 |
| Skills | Jointly design all organisational dimensions 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 Adaption | Ecological |
|---|---------------------------------------|------------------------------------|------------|
| 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 Steenberghe | | 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

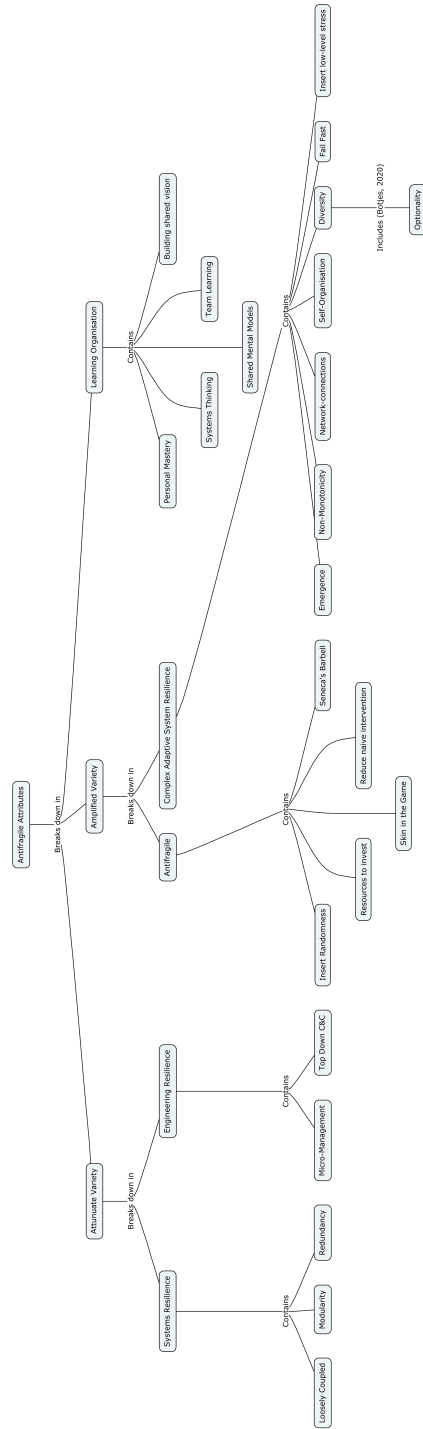


Figure D.1.: Concept map of Antifragile Attributes

E. Literature Selection

F. 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. |