

Accelerating in a world of chaos

by using Enterprise Architecture with the concept of antifragile

René Bliekendaal

Promotor Prof. Dr. Ing. Hans Mulder
Co-Promotor Edzo Botjes, MSc.

A thesis submitted in fulfillment of the requirements
for the degree of Master of Enterprise IT Architecture (MSc)



Antwerp Management School
Belgium
15th April 2022

”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*

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

- *Plato*

”The only constant is change.”

- *Heraclitus*

Thesis Information

| | |
|------------------|---|
| Title: | Accelerate in a world of chaos by using Enterprise Architecture with the concept of antifragile |
| Language: | British English |
| Reference Style: | APA Reference Style 7.0 |
| DOI: | tbd |
| DOI Reference: | tbd |
| Copyright | © 2022 J.R. Bliekendaal |
| License: |  This work is licensed under a CC-BY-SA 4.0 license. |

Thesis Project

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

Author

| | |
|-----------|---|
| Name: | René Bliekendaal, BSc. |
| ORCID: |  0000-0002-5449-6449 |
| Email: | jrbliekendaal@gmail.com |
| LinkedIn: | https://www.linkedin.com/in/bliekendaal/ |

Promotor

| | |
|-----------|--|
| Name: | Prof. Dr. Ing. Hans Mulder |
| ORCID: |  0000-0002-3304-9711 |
| Email: | Hans.Mulder@ams.ac.be |
| LinkedIn: | https://www.linkedin.com/in/jbfmulder/ |

Co-Promotor

| | |
|-----------|---|
| Name: | Edzo A. Botjes, MSc. |
| ORCID: |  0000-0003-0097-7375 |
| Email: | e.a.botjes@gmail.com |
| LinkedIn: | https://www.linkedin.com/in/edzob/ |

Sponsor

| | |
|-----------|---|
| Name: | mr. Maarten Hillenaar |
| LinkedIn: | https://www.linkedin.com/in/maarten-hillenaar/ |
| Company: | Centric Public Sector Solutions |
| Website: | https://www.centric.eu |

Keywords

agile, agility, resilient, resiliency, robust, robustness, antifragility, antifragile, enterprise architecture, public sector, system-in-environment, co-evolution, success factors

Declaration of Authorship

I, J.R. (René) Bliekendaal, declare that this thesis, with the title "Accelerate in a world of chaos by using Enterprise Architecture with the concept of 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:

- This work was done wholly or mainly while in candidature for a master degree at the Antwerp Management School;
- Where any part of this thesis has previously been submitted for a degree or any other qualification at the Antwerp Management School or any other institution, this has been clearly stated;
- Where I have consulted the published work of others, this is always clearly attributed;
- Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
- I have acknowledged all main sources of help;
- Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
- Either none of this work has been published before submission, or parts of this work have been published as:
 - ...
 - ...

Date: _____

Signature: _____

Acknowledgements

”I have found out how little I actually know”

Edzo Botjes

Hans Mulder

Maarten Hillenaar

Dieneke Schouten

Krista Bliekendaal

Ron Roozendaal

Theo Peters

Accelerating in a world of chaos

by using Enterprise Architecture with the concept Antifragility

René Bliekendaal

Abstract

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

Table of Contents

| | |
|--|-----|
| Acknowledgements | i |
| Abstract | ii |
| Table of Contents | iii |
| 1. Introduction | 1 |
| 1.1. The author | 1 |
| 1.2. The structure of this thesis | 2 |
| 1.3. Introduction of the public sector | 2 |
| 1.4. Introduction of the concept Enterprise Architecture | 3 |
| 1.5. Introduction of the concept of antifragility | 3 |
| 1.6. Problem statement | 4 |
| 1.7. The research subject | 4 |
| 1.8. Research question | 5 |
| 1.9. Research relevance | 5 |
| 2. Background | 7 |
| 2.1. System | 7 |
| 2.1.1. System-of-Systems and System-in-Environment | 8 |
| 2.1.2. Ecosystem | 8 |
| 2.2. Antifragile | 9 |
| 2.2.1. The Extended Antifragile Attribute List | 10 |
| 2.2.2. Antifragility vs Agility | 11 |
| 2.3. Public sector | 11 |
| 2.3.1. Collaboration between public and private sector | 12 |
| 2.3.2. Differences with the Private Sector Market | 13 |
| 2.3.3. The public sector as a System of Systems | 13 |
| 2.4. Enterprise Architecture | 13 |
| 2.4.1. Approaches of Enterprise Architecture | 14 |
| 3. Methodology | 16 |
| 3.1. Research Model | 16 |
| 3.2. Research quality | 16 |
| 3.2.1. Quality attributes | 16 |
| 3.2.2. The FAIR Guiding Principles | 17 |
| 3.2.3. The Open Science Framework | 18 |

| | |
|---|-----------|
| 3.2.4. Triangulation | 18 |
| 3.3. Research approach | 20 |
| 3.3.1. Desk research | 21 |
| 3.3.2. Confrontation | 24 |
| 3.3.3. Analysis | 24 |
| 3.3.4. Validation | 25 |
| 3.3.5. Conclusion and discussion phase | 26 |
| 3.4. Research type | 26 |
| 3.5. Research infrastructure and tooling | 26 |
| 3.5.1. Thesis creation | 26 |
| 3.5.2. Research administration | 27 |
| 3.5.3. Research execution | 27 |
| 3.5.4. Summary of used infrastructure and tooling | 28 |
| 4. Attributes | 29 |
| 4.1. Attributes of antifragile | 29 |
| 4.2. Attributes of Enterprise Architecture | 29 |
| 4.2.1. Enterprise Architecture schools of thought | 29 |
| 4.2.2. Enterprise IT Architecting | 29 |
| 4.2.3. Enterprise Integrating | 29 |
| 4.2.4. Enterprise Ecological Adaptation | 29 |
| 4.2.5. Summary of EA/AF | 29 |
| 4.3. EA | 29 |
| 4.3.1. Summary of EA/AF | 29 |
| 4.4. Systems Theory | 29 |
| 5. Validation by interviews | 31 |
| 5.1. Interviews | 31 |
| 5.2. Summary of interviews | 32 |
| 5.3. interview results | 32 |
| 5.3.1. Engineering Resilience | 32 |
| 5.3.2. Systems Resilience | 32 |
| 5.3.3. Complex Adaptive System Resilience | 33 |
| 5.3.4. Antifragile | 33 |
| 5.3.5. Learning organisation | 34 |
| 5.3.6. Enterprise Architecture schools of thought | 34 |
| 5.3.7. Findings | 35 |
| 5.4. Identified success factors | 35 |
| 5.5. Findings | 35 |
| 6. Validation by Expert Group | 37 |
| 7. Final analysis | 38 |
| 7.1. Identified success factors | 38 |

| | |
|---|-----------|
| 7.2. Scoring of Success Factors | 38 |
| 7.3. Possible success factors | 38 |
| 8. Conclusion and discussions | 43 |
| 8.1. Conclusion | 43 |
| 8.2. Discussions | 43 |
| 8.3. Recommendations | 43 |
| 9. Retrospective | 45 |
| 10. Theoretical background2 | 46 |
| 10.1. Antifragile | 46 |
| 10.1.1. What is a stressor? | 46 |
| 10.1.2. Volatile, uncertain, complex, and ambiguous | 46 |
| 10.1.3. Relation between antifragile, fragile, robust, resilient, and agile | 46 |
| 10.1.4. Resilience | 46 |
| 10.1.5. Antifragile Systems Design | 47 |
| 10.1.6. Residuarity Theory | 47 |
| 10.2. Enterprise Architecture | 47 |
| 10.2.1. Three schools of thought on Enterprise Architecture | 48 |
| 10.2.2. Steering mechanisms | 48 |
| 10.3. Public sector | 48 |
| 10.3.1. Differences with the Private Sector Market | 49 |
| 10.4. What is a system? | 49 |
| 10.4.1. Open vs Closed vs Adaptive systems | 50 |
| 10.4.2. Summary of the concept system | 50 |
| 10.4.3. To be worked upon | 50 |
| 11. Concepts | 51 |
| 11.1. Questions for Interviews | 51 |
| 11.1.1. Interview Question 1 | 51 |
| 11.1.2. Interview Question 2 | 51 |
| 11.1.3. Interview Question 3 | 51 |
| 11.1.4. Interview Question 4 | 51 |
| 11.1.5. Interview Question 5 | 51 |
| 11.2. af parts | 52 |
| 11.2.1. EAAL Model | 53 |
| 11.2.2. Antifragile Systems Design | 54 |
| 11.2.3. Residuarity Theory | 55 |
| 11.2.4. Systems of Systems | 56 |
| 11.2.5. Systems-in-Environment | 56 |
| 11.2.6. Complexity Theory | 56 |
| 11.3. methodologies | 57 |

| | |
|--|------------|
| References | 58 |
| List of Figures | 64 |
| List of Tables | 66 |
| Glossary of Terms | 68 |
| Abbreviations | 76 |
| Appendices | 79 |
| A. Properties of the Enterprise Architecture schools of thought | 80 |
| A.1. The properties of Enterprise IT Architecting | 80 |
| A.2. The properties of Enterprise Integrating | 81 |
| A.3. The properties of Enterprise Ecological Adaptation | 82 |
| B. Authors of the Enterprise Architecture schools of thought | 83 |
| C. Literature Selection | 84 |
| D. Interview summaries | 85 |
| D.1. Interview central government | 85 |
| D.2. Interview local government | 86 |
| D.3. Interview ISV | 89 |
| D.4. Interview with consultancy firm/service provider | 93 |
| E. Interview findings | 96 |
| F. Data preparation for interview analysis | 99 |
| F.1. Step 1: merge similar labels | 99 |
| F.2. Step 2: Filter cases on threshold | 100 |
| F.2.1. Outcome of filter cases on threshold | 100 |
| F.3. Step 3: | 100 |
| F.4. Step 4: Joining positives and negatives | 100 |
| G. Validation findings | 103 |
| G.1. Experience of validation group participants | 103 |
| G.2. Validation of antifragile attributes | 104 |
| G.2.1. Optionality | 105 |
| G.2.2. Mono-Monotonicity | 106 |
| G.2.3. Self-Organisation | 107 |
| G.2.4. Fail-Fast | 108 |
| G.2.5. Resources to invest | 109 |
| G.2.6. Seneca's Barbell | 110 |
| G.2.7. Safe working environment | 111 |

| | | |
|---------|--|-----|
| G.2.8. | Naar buiten kijken, samenwerking zoeken | 112 |
| G.2.9. | Data Governance Planes | 113 |
| G.3. | Validation of Enterprise Architecture schools of thought | 114 |
| G.3.1. | Enterprise IT Architecting | 114 |
| G.3.2. | Enterprise Integrating | 115 |
| G.3.3. | Enterprise Ecological Adaptation | 116 |
| G.4. | Validation of Enterprise Architecture attributes | 117 |
| G.4.1. | Systems-in-Environment thinking | 118 |
| G.4.2. | Holistic (systemic) stance | 119 |
| G.4.3. | Organisational learning | 120 |
| G.4.4. | Environmental learning | 121 |
| G.4.5. | Intra-organisational coherency | 122 |
| G.4.6. | System-in-Environment Co-Evolution learning | 123 |
| G.4.7. | Adapt to business language | 124 |
| G.4.8. | Agile Enterprise | 125 |
| G.4.9. | Real Time Trust | 126 |
| G.4.10. | Foster Dialogue | 127 |
| G.4.11. | Validation | 128 |
| G.4.12. | Always fitting Enterprise Architecture | 129 |
| G.5. | Closing Survey | 129 |
| G.6. | Follow-Up Survey | 130 |

| | |
|------------------------|------------|
| H. Research Log | 131 |
|------------------------|------------|

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 immemorial, 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. According to Mark (2010), the inability to change, progress, or grow can result in stagnation. Stagnation rejects realising ones full potential.

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, globalisation, market upheaval, disruption, and technological advance all combine to produce an effect that is difficult to mitigate, impossible to predict, and arduous to detect (O'Reilly, 2019, p. 885). Taleb (2008) his definition of a Black Swan event, Section 1.5, 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. According to Taleb (2012) 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 success factors that have a positive influence on Enterprise Architecture (EA) to contribute to achieving antifragility in the public sector.

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

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

architecture function of 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. I find the aspect of social responsibility important in my day to day work. Civilians and companies eventually pay every euro spent on a product or service based on taxes. If we can deliver our products and services more efficiently and more effectively, the better the public money is spent. Delivering products and services in the public sector is influenced by the changes the public sector is going through. These changes can be planned changes but also changes needed based on stressors, e.g. Figure 1.3. Antifragile can help us to get better and adapt to those changes more quickly, and by doing so, make changes more efficiently and more effective with a result of spending less public money.

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. ?? 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). ?? describes the found attributes from the literature that can be success factors. ?? ends with an overview of found attributes of EA and antifragile that could contribute to the public sector to become antifragile. This outcome is the first corner of the used triangulation approach. These attributes are the point of departure for further investigation. Chapter 5 gives a summary of the conducted interviews together with the findings from the interviews. The interviews are validated. The output of the interviews extends the list of attributes with new findings. Chapter 6 is about the outcome of the expert group. This chapter includes possible new findings and the validation of the output of the expert group. The Chapter 7 brings the outcomes from the interviews and expert group together for final analysis. The possible success factors are defined, weighted, and screened to determine a set of success factors by triangulation. Finally, the conclusion, discussion and recommendations are in Chapter 8. This thesis ends with Chapter 9 for a retrospective of the researcher, 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.

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

- **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.

For this research the lens is set to the public sector consisting out of the national governments, the local governments and the suppliers delivering services to these governmental agencies. The national governments because they are responsible for policy making while the local governments are responsible for executing most of those policies.

1.4. Introduction of the concept Enterprise Architecture

Lapalme et al. (2016, p. 104) says that Enterprise Architecture (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 (Lapalme et al., 2016).

1.5. Introduction of the concept of antifragility

Taleb (2008) describes a Black Swan event 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,
3. is explained in hindsight as if it were predictable.

For extremely rare events, Taleb (2008) argues that the standard tools of probability and prediction, such as the normal distribution, do not apply since they depend on a large population and past sample sizes that are never available for rare events by definition. Using statistics based on extrapolating observations of past events does not help predict 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. As seen in Figure 1.1, the exact opposite of something that is fragile is not only unbreakable, but it would benefit from shocks and a wide array of trauma (Taleb, 2012). It does not lose, but it gains. Taleb (2012) defines something that gains from shocks and a wide array of trauma as antifragile.



Figure 1.1.: The opposite of fragile

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 Section 1.4, with EA, an organisation can understand the complexity and manage change. One would expect that an organisation can use EA to get more towards the state of antifragility. The current Body of Knowledge (BoK) of EA and Complexity Science does contain some research on antifragility on application and information architectures but not on EA. The BoK is not containing 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 and antifragile that have a positive influence on EA to contribute in achieving antifragility in the public sector?

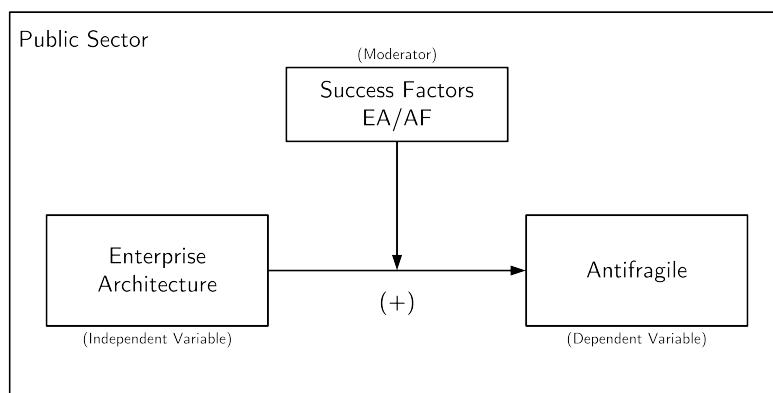


Figure 1.2.: Conceptual Research Model

1.8. Research question

Figure 1.2 shows the conceptual research model. The conceptual research model describes the hypotheses that, in the context of the public sector, there are success factors of EA and antifragile that have a positive influence on the contribution of Enterprise Architecture in achieving antifragility. Following the conceptual research model, the following research question is determined:

"What are the success factors that positively influence the contribution of Enterprise Architecture in achieving antifragility in the public sector?"

The following sub-questions support answering the research question:

1. What is literature saying about the public sector?
2. What is literature saying about antifragile?
3. What are possible success factors of antifragile?
4. What is literature saying about Enterprise Architecture?
5. What are possible success factors of Enterprise Architecture?
6. Which success factors can positively influence the contribution of Enterprise Architecture in achieving antifragility in the public sector?

1.9. Research relevance

EA has contributed to organisations in being more robust, and resilient. Using EA in pursuing antifragility will add value to companies by accelerating and growing when there is a stressor or a Black Swan event. For some examples of stressors which are relevant to the public sector see Figure 1.3. 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 achieving antifragility. Giving more insights on this subject will contribute to the BoK of EA and Complexity Science and help others get closer to antifragility by using EA.

<https://www.istockphoto.com/en/vector/506120634-84046799>

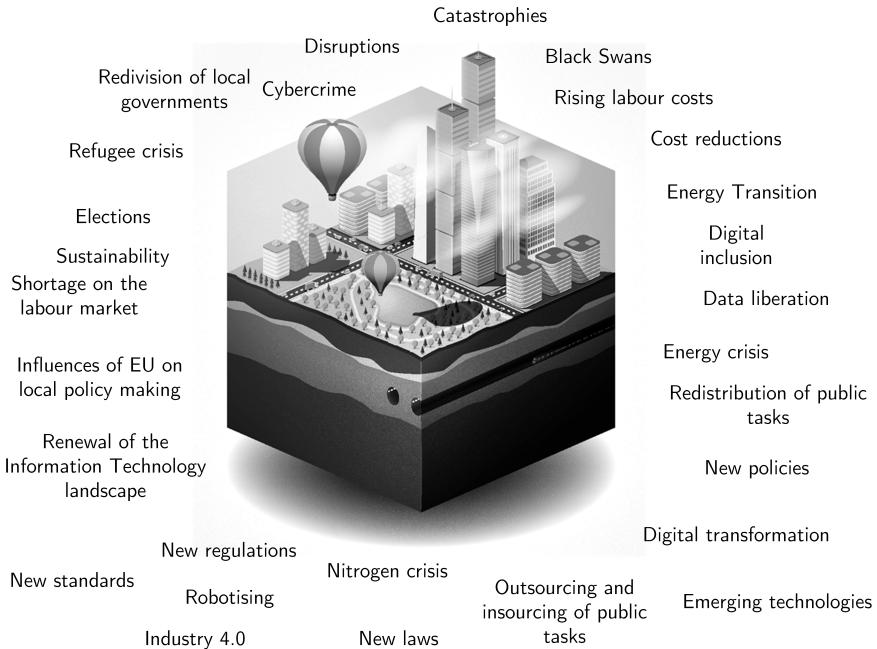


Figure 1.3.: Examples of stressors on the public sector

Because of the digital transformation, the pace of change is increasing rapidly. In a study by Eggers and Bellman (2015), 96% of respondents said digital technologies are significantly disrupting the public sector. According to Nurmi (2021), organisations in the public and private sectors alike face the need to manage themselves in an ever more interconnected and fast-paced world. Guggenberger et al. (2020) states that a paradigmatic change from a mechanistic toward a systemic worldview is ongoing, emphasizing the interconnectedness of participating organizations. 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 organisations and agencies in the Dutch public sector are searching for methods of dealing with this increased pace and the stressors. There are a lot of indications of this in the discussions and sessions held at "the iBestuur congress of 2021"¹. The relevance of this research is not only about adding to the BoK of EA and Complexity Science but also, in the context of social responsibility, to share the outcome with the public sector for further study and use.

¹https://magazine.ibestuur.nl/ibestuur_congres_2021_terugblik/cover

2. Background

This chapter describes the core concepts of the research. These concepts are the public sector, Enterprise Architecture, and antifragile. The concepts often make use, contain or refer to the concept system. This chapter will also describe the concept of system.

2.1. System

The used concepts public sector, EA, and antifragile are using the concept system. 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 behaviour is what Bertalanffy (1968, p. 32) calls an open system. An open system is a system that exchanges 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).

Ackoff et al. (1964, p. 51–69) criticised Bertalanffy (1951) and stated that a system is more than the sum of its parts. It is an indivisible whole (Ackoff, 1973, p. 664). It loses its essential properties when it is taken apart. Ackoff (1973, p. 664) also stresses that the elements of a system may themselves be systems, and every system may be a part of a larger system. The basic managerial idea introduced by systems thinking (Ackoff et al., 1964), is that to manage a system effectively, you might focus on the interactions of the parts rather than their behaviour separately. Gharajedaghi (2011, p. 182) defined the boundary of a system as that a system consists of all the variables that can be sufficiently influenced or controlled by participating actors. The variables that can not be influenced or controlled but impact the viability of the system are part of the context (Gharajedaghi, 2011, p. 183) or the environment (Mannaert et al., 2016, p. 13–14). Gharajedaghi (2011, p. 29) defined five principles to define the characteristics and assumptions about the behaviour of a system. These principles are building blocks of a mental model to understand systems.

The first principle *Openness*, states that the behaviour of living (open) systems can be understood only in the context of their environment (Gharajedaghi, 2011, p. 29). The second principle *Purposefulness* states that you need to understand the *Why they do* and *What they do* of the actors in the transactional environment to have the possibility to influence them (Gharajedaghi, 2011, p. 33). Gharajedaghi (2011, p. 38) defined the third

principle *Multidimensionality* as the ability to see complementary relations in opposing tendencies and to create feasible wholes with infeasible parts. The fourth principle is *Emergent Property* that states that properties of a system are properties of the whole and not the property of its parts (Ackoff, 1973; Gharajedaghi, 2011). *Counterintuitive behaviour* is the last principle. Gharajedaghi (2011, p. 48) describes the meaning of this principle as the means that actions intended to produce the desired outcome may generate opposite results.

The different concepts of the research are also using variations of the concept system. The three most used concepts are those of *System-of-Systems (SoS)*, *System-in-Environment (SiE)*, and *Ecosystem*.

2.1.1. System-of-Systems and System-in-Environment

International Council on Systems Engineering (2018) defines a SoS as a collection of independent systems integrated into a larger system that delivers unique capabilities. The independent constituent systems collaborate to produce global behaviour that they cannot produce alone. This definition is aligned with Ackoff (1973, p. 664) his definition of a system, see Section 2.1. When the definition of Ackoff (1973) and Gharajedaghi (2011) is used, you only use the term SoS to stress that the system is composed of multiple systems. The same also applies to SiE. Korhonen et al. (2016) and Lapalme (2012) use SiE as a term to stress that the system is part of and should be aware of its environment. Mannaert et al. (2016, p. 13–4) and Gharajedaghi (2011, p. 183) make similar statements, see Section 2.1. Lapalme (2012, p. 41) uses SiE as a means to enforce environmental learning to adapt the enterprise's desired goals to be more compatible with the environment.

2.1.2. Ecosystem

The concept of ecosystem relates to systems. The concept of ecosystem originated from the field of ecology. The Body of Knowledge (BoK) is in agreement that the concept of ecosystems in the field of ecology was defined by Tansley (1935). Tansley (1935, p. 299) defined an ecosystem as "But the more fundamental conception is, as it seems to me, the whole system (in the sense of physics), including not only the organism-complex but also the whole complex of physical factors in the widest sense" (Guggenberger et al., 2020, p. 3; Nurmi, 2021, p. 20). The concept of ecosystem is not only used in an ecological context but also in other contexts. Moore (1999, p. 76) suggested that a company must be viewed not as a member of a single industry but as part of a business ecosystem that crosses a variety of industries. A business ecosystem is the conceptualisation of various businesses that together form value creation networks (Guggenberger et al., 2020, p. 3). According to Guggenberger et al. (2020) there are five archetypes of an ecosystem. The first one is the *Business Ecosystem* as previously defined by Moore (1999, p. 76). Guggenberger et al. (2020, p. 5) defines the second archetype as that of a *Platform Ecosystem* which is novel in Information System (IS) research. Platform Ecosystems become apparent by the increasing amount of discussions and scientific interest in the field of digitally-

enabled ecosystems, such as app stores. The third ecosystem is defined by Guggenberger et al. (2020, p. 5) as *Service Ecosystem*. Accordingly, to Barros and Dumas (2006), Papazoglou and Heuvel (2006) and Huang et al. (2014), a Service Ecosystem is composed of service providers, consumers, and composition developers that collaboratively create new services, thereby adding value to the service ecosystem. The fourth ecosystem is a specialisation of that of the Business Ecosystem by Moore (1999). The fourth ecosystem is defined by Guggenberger et al. (2020, p. 5) as the *Innovation Ecosystem*. With an Innovation Ecosystem, various stakeholders, such as focal companies, suppliers, customers, policymakers, and additional innovators, share sets of knowledge and skills to jointly co-create innovative products and services (Iansiti & Levien, 2004; Gomes et al., 2018; Carayannis & Campbell, 2009). Guggenberger et al. (2020, p. 5) defined the last ecosystem as *Software Ecosystem*. Manikas and Hansen (2013) describes the Software Ecosystem as integrating combinations of interacting actors upon a shared technological platform that generates new software and services.

All the above ecosystem definitions do meet the general definition of a system previously defined by Ackoff (1973), Gharajedaghi (2011, p. 183) and Mannaert et al. (2016, p. 13–14).

2.2. Antifragile

"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 'Skin in the game'.
- **Diversity of cells and organisational learning.**
- **DNA - Shared purpose, values and culture.**

Accepting Complexity

2.2.1. The Extended Antifragile Attribute List

According to Botjes, Edzo A. et al. (2021) there are attributes that

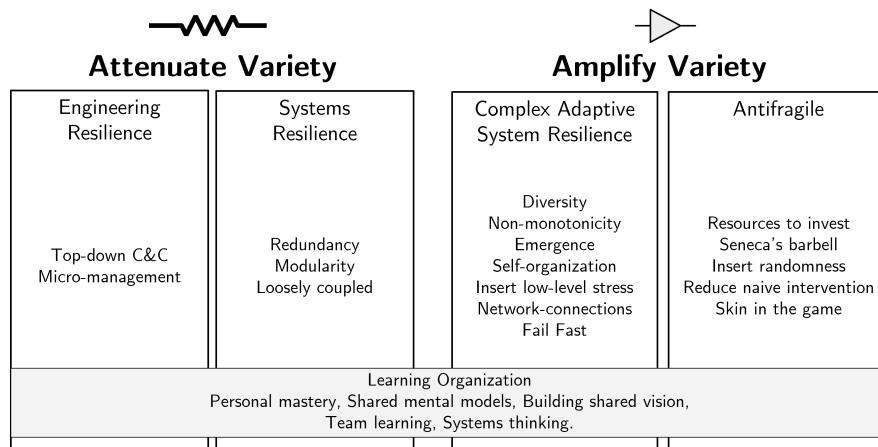


Figure 2.1.: The Extended Antifragile Attribute List (Botjes, Edzo A. et al., 2021)

According to Botjes (2020, p. 64) it is stated by Taleb (2008) that the following attributes are essential for an antifragile system: Optionality, Resources to invest, Seneca's barbell, Insert randomness, Reduce naive intervention, and Skin in the game. Botjes (2020, p. 64) states that optionality is excluded because of the overlap with diversity. It is understandable that Botjes (2020, p. 66) merges both attributes into one (diversity). They are both much alike. But Taleb (2012) and Gorgeon (2015) both use the term optionality. Optionality is the availability of options (Taleb, 2012, p. 176–177; Gorgeon, 2015, p. 9). Optionality is an idea advanced by Taleb (2012). At the most basic level, optionality just means having lots of options. E.g. if you develop a skill with many possible job opportunities, you have more optionality than someone who develops a skill that only has one or two job opportunities. For diversity Botjes (2020) used a definition of internally not being a mono-culture and externally having options. E.g. having two different coffee suppliers or having a diverse team. The difference between optionality and diversity is very subtle. Optionality is when you have the right to do something, but you do not have an obligation to do it, where diversity is something that is there or not. It is an option, "the right but not the obligation" for the buyer and, of course, "the obligation but not the right" for the other party, called the seller (Taleb, 2012, p. 174). Optionality allows the buyer to retain the upper bound and be unaffected by adverse outcomes which makes the buyer antifragile. In random, complex environments, convexity, as in optionality, is easier to attain than knowledge. Since this research is about possible success factors and optionality is slightly different than diversity, optionality will be reinstated for further research. With Figure 2.2 Extended Antifragile Attribute List is reinstated to the model for further use.

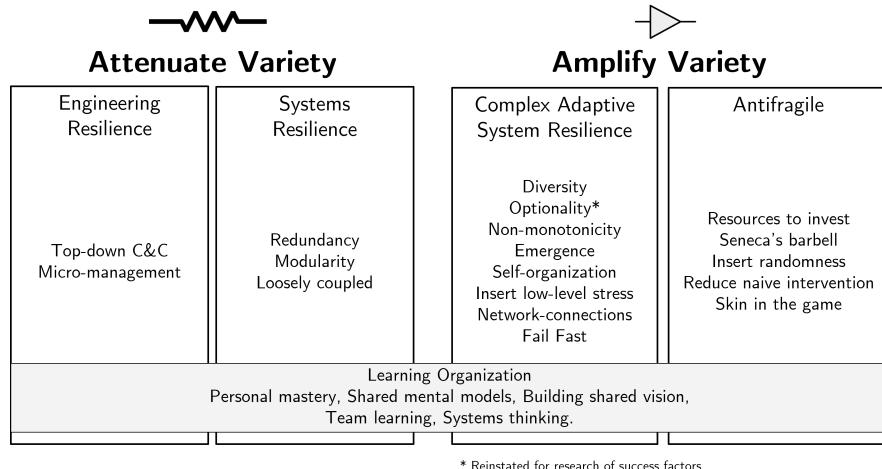


Figure 2.2.: The Extended Antifragile Attribute List (Botjes, Edzo A. et al., 2021) with optionality reinstated

2.2.2. Antifragility vs Agility

O'Reilly (2019, Abstract) states that rather than aiming to control or to remove control, we have to build systems, both technical and business, that aim to be antifragile to change. Following O'Reilly (2019, Abstract) this allows the production of business and technical architectures that enable agility through design rather than process or mindset. The cross-set of skills as defined by O'Reilly (2019, p. 889) can allow architecture to contribute by designing antifragile systems that enable agility and answers the business question of how to become resilient to the VUCA world. O'Reilly (2019, p. 885) proposes that by architecting for antifragility, businesses can gain agility and deliver systems with a higher level of quality.

Aghina et al. (2018, p. 7) defined five trademarks and twenty-three practices for organisational agility. When you combine these trademarks and practices with Extended Antifragile Attribute List (EAAL) of Botjes (2020, p. 69) it is clear that the result is the same as that of O'Reilly (2019, Abstract) who states *Agility through Antifragility*. By using the attributes from EAAL it is possible to achieve agility in a system, System-of-Systems, System-in-Environment, and an ecosystem. Agility can be the result of applying antifragile attributes.

2.3. Public sector

As described in Section 1.3 Introduction of the public sector the governments are generally divided into three levels (PrivacySense, 2016).

- **The national government**, such as the military, the tax authority, and homeland affairs.

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

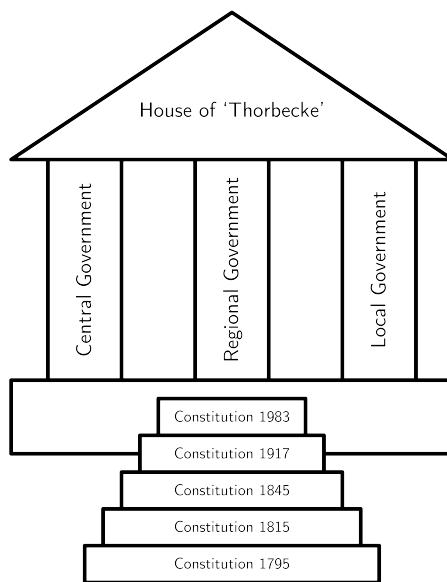


Figure 2.3.: The House of 'Thorbecke'

I will focus this research on the public sector level local government of the Netherlands. In Section 8.2 I will discuss the applicability on non Dutch public sectors.

subsidiarity principle - the principle that a central authority should have a subsidiary function, performing only those tasks which cannot be performed at a more local level

2.3.1. Collaboration between public and private sector

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

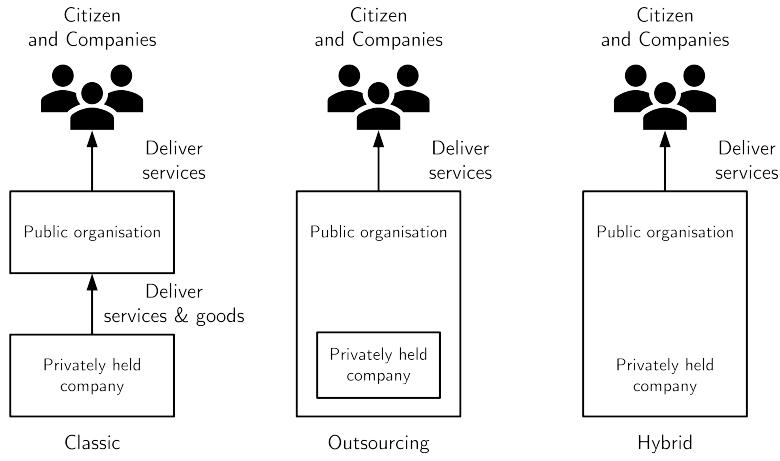


Figure 2.4.: Public sector collaboration models

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

2.3.2. Differences with the Private Sector Market

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

2.3.3. The public sector as a System of Systems

2.4. Enterprise Architecture

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

White (2018) states that the organisations business requirements guide EA. EA helps layout how information, business and technology flow together. While Gartner (n.d.) states that Enterprise Architecture is a discipline for proactively and holistically leading enterprise responses to disruptive forces by identifying and analysing the execution of change toward desired business vision and outcomes. EA delivers value by presenting

business and IT leaders with signature-ready recommendations for adjusting policies and projects to achieve targeted business outcomes that capitalise on relevant business disruptions. Ross et al. (2014, p. 9) defines EA as the organising logic for business processes and IT infrastructure, reflecting the integration and standardisation requirements of the company's operating model. The EA provides a long-term view of a company's processes, systems, and technologies so that individual projects can build capabilities and not just fulfil immediate needs. Following Graves (2009, p. 4) EA is the discipline through which an enterprise can identify, develop and manage its knowledge of its purpose, its structure and itself. Some of that knowledge will be about IT. However, it will also need to include many other concerns like (e.g.): "Business, Process, Security, Data, Application, and technology-infrastructure architecture as well as organisational structures, performance management, and business continuity & resilience planning (Graves, 2009, p. 4)."

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

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

When I consider, following Section 2.3.3, the public sector as a System-of-Systems (SoS) the definitions of EA of Gartner (n.d.) and Graves (2009) do align with SoS. If I take into account that Graves (2009) is one of the authors of the third school of thought, see for more details Section 2.4.1, I will use the definition of Graves for this research.

2.4.1. Approaches of Enterprise Architecture

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

Kotusev et al. (2015) distinguished three approaches. These three approaches are the traditional, the Massachusetts Institute of Technology (MIT), and the DYnamic Architecture (DYA) approach. The traditional approach, initially presented by Spewak (1993), to Enterprise Architecture Management (EAM), can be generally described as a four-step sequential process (Kotusev et al., 2015, p. 4071):

1. document the current (as-is, baseline) state,

2. develop the desired future (to-be, target) state,
3. develop the transition plan to migrate from the current to the future state,
4. implement the plan and then repeat the whole process all over again.

The MIT, developed by Ross et al. (2014), approach advocates the development of a core diagram reflecting a long-term enterprise-level architectural vision. This abstract architectural vision should be later translated into concrete project-level decisions through IT governance mechanisms involving business and IT managers on different organisational levels (Kotusev et al., 2015, p. 4072). DYnamic Architecture (DYA), initially presented by van den Berg et al. (2005), advocates "just enough, just in time" architecture, no EA is designed until there is a need for it. EAM activities in the DYA approach are triggered by concrete business initiatives appearing in the process of strategic dialogue. As a response to a new business initiative, architectural services update EA if necessary and prepare a project-start architecture for a new project in order to ensure that this new project fits nicely into existing EA and larger picture (Kotusev et al., 2015, p. 4072).

Lapalme (2012) is using a different approach. He defined three schools of thought on EA. The first school is about Enterprise IT Architecting. The first school is about aligning an enterprise's IT assets to execute business strategy effectively and various operations using the proper IT capabilities (Lapalme, 2012, p. 38). With the first school of thought, EA is the glue between business and IT. The second school of thought is Enterprise Integrating. This school is about designing all facets of the enterprise. The goal is to execute the enterprise's strategy by maximising the overall coherency between all of its facets. This school is grounded in systems thinking. This school approaches enterprise design holistically or systemically (Lapalme, 2012, p. 40). For the second school, EA is the link between strategy and execution. The last school of thought is Enterprise Ecological Adaptation (EEA). This school, EA is about fostering organisational learning by designing all facets of the enterprise, including its relationship to its environment, to enable innovation and system-in-environment adaptation. Creating the enterprise strategy and designing the organisation are top priorities. Like the enterprise integration school, this school is concerned with contradictions, not just within the organisation. The third school looks for incoherence in the bidirectional relationship between the enterprise and its environment (Lapalme, 2012, p. 40–41). The third school of thought, EA is the means for organisational innovation and sustainability. For detailed properties of the schools of thought, see Appendix 'Properties of the Enterprise Architecture schools of thought'. Lapalme (2012) defined the scope of EEA the enterprise in its environment. The scope includes the enterprise and its environment, the bidirectional relationships, and the transactions between the enterprise and its environment. The purpose is to help the organisation innovate and adapt by designing the various enterprise facets to maximise organisational learning.

As Botjes (2020) concluded with his EAAL model the attribute learning organisation is of importance for being resilient or antifragile. If the learning organisation is one of the conditions to be antifragile the practice of EA should be of the school of EEA.

3. Methodology

3.1. Research Model

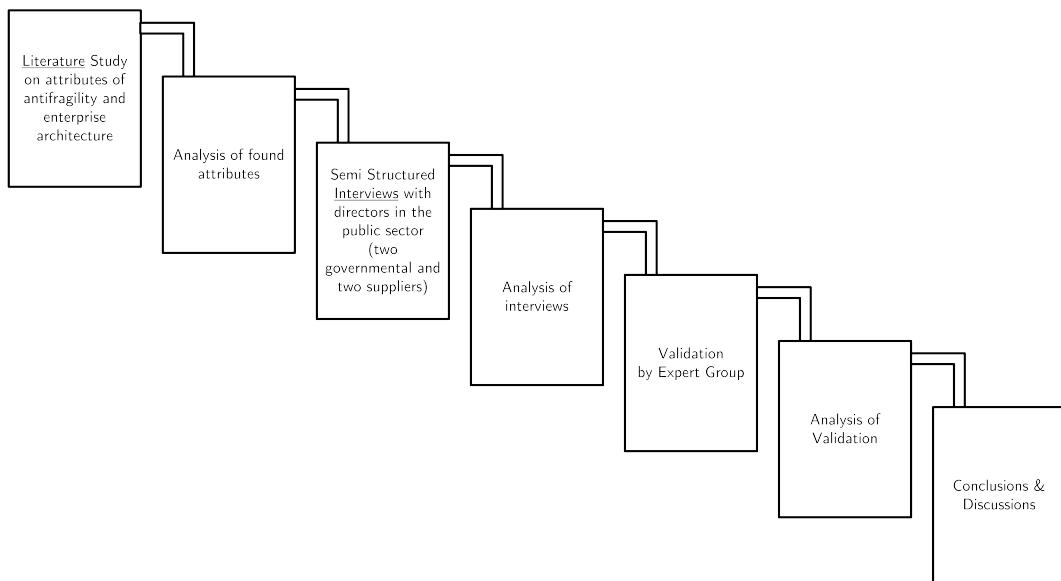


Figure 3.1.: Research Model

3.2. Research quality

The quality attributes of Recker (2013, p. 15–17) are used to increase the rigorousness of the research. The quality attributes of Recker (2013, p. 15–17) are supported by the *Open Science Framework (OSF)* of Foster and Deardorff (2017), the *FAIR Guiding Principles* of Wilkinson et al. (2016, Box 2), and the application of *Triangulation*, Section 3.2.4.

3.2.1. Quality attributes

Recker (2013, p. 15–17) suggests using four attributes to increase the quality of research. The first attribute that is defined by Recker (2013, p. 15) is *Replicability*. Recker (2013, p. 15) characterises *Replicability* as the extend to which research procedures are repeatable. The attribute 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 (Recker, 2013, p. 15). The second attribute stated by Recker (2013, p. 16) is *Independence* which is closely related to reliability. *Independence* 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 (Recker, 2013, p. 16). *Precision* is the third attribute defined by Recker (2013, p. 16). According to Recker (2013, p. 16) *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. The last attribute that Recker (2013, p. 16) mentions is *Falsification*. *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 (Recker, 2013, p. 16). The quality attributes are operationalised in this research as described in Table 3.1.

| Quality attribute | Operationalisation |
|-------------------|--------------------|
| Replicability | |
| Independence | |
| Precision | |
| Falsification | |

Table 3.1.: Operationalisation of the quality attributes

3.2.2. The FAIR Guiding Principles

In 2016 ‘The FAIR Guiding Principles for scientific data management and stewardship’ was published in *Scientific Data*¹ by Wilkinson et al. Wilkinson et al. (2016, p. 3) emphasised *FAIRness* being applied to both human-driven and machine-driven activities. Wilkinson et al. (2016, Box 2) intended to provide guidelines to improve the Findability, Accessibility, Interoperability, and Reuse of digital assets. These principles are also called the FAIR Guiding Principles. The FAIR Guiding Principles describe distinct considerations for contemporary data publishing environments concerning supporting both manual and automated deposition, exploration, sharing, and reuse Wilkinson et al. (2016, p. 4). The first step in (re)using data is to find it (GO FAIR, 2017, p. 1). According to GO FAIR (2017, p. 1) metadata and data should be easy to find for both humans and computers. Machine-readable metadata is essential for the automatic discovery of datasets and services (GO FAIR, 2017, p. 1). *Accessible* means that once the user finds the required data, it needs to know how it can be accessed (GO FAIR, 2017, p. 1). Accordingly to GO FAIR (2017, p. 2) *Interoperable* means that 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 (GO FAIR, 2017, p. 2). The last guiding principle is stated by GO FAIR (2017, p. 2) as *Reusable*. Following GO FAIR (2017, p. 2) the ultimate goal of the FAIR Guiding Principles is to optimise the reuse of data. Metadata and data should be well described so that they can be replicated and

¹<https://www.nature.com/sdata/>

combined in different settings (GO FAIR, 2017, p. 2). The FAIR Guiding Principles are operationalised in the research as described in Table 3.2.

| Guiding Principle | Operationalisation |
|--------------------------|--|
| Findable | The thesis, research, and data sets contain keywords, links, structures, and meta data that can be indexed. |
| Accessible | The thesis, research and data sets are published on GitHub, Zenodo, and Researchgate based on Open Access. Objects are created containing a location where the data can be acquired if it cannot be published because of author rights. |
| Interoperable | This principle is least relevant for this research. The data sets are qualitative based on literature, interviews, Expert Group feedback, and surveys. The created data sets are available for analysis and are stored in structured Microsoft Excel files. The files are easy to import or reuse in other environments. |
| Reusable | The publication of the thesis, research and data sets are licensed under a CC-BY-SA 4.0 license. The thesis, research, and data sets are allowed to be shared and adapted (commercially) as long as the original author is attributed and the possible derivate is published under the same license. |

Table 3.2.: Operationalisation of the FAIR Guiding Principles

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.

3.2.4. Triangulation

Triangulation has its origins in geography. To know the position of a distant object, two checkpoints are needed. The mutual distance between the calibration points and the angles relative to the object make it possible to calculate the correct distance via triangulation² (Mortelmans, 2018, p. 88). Following Recker (2013, p. 88) triangulation literally

¹<https://www.cos.io/>

²<https://www.britannica.com/science/triangulation-trigonometry>

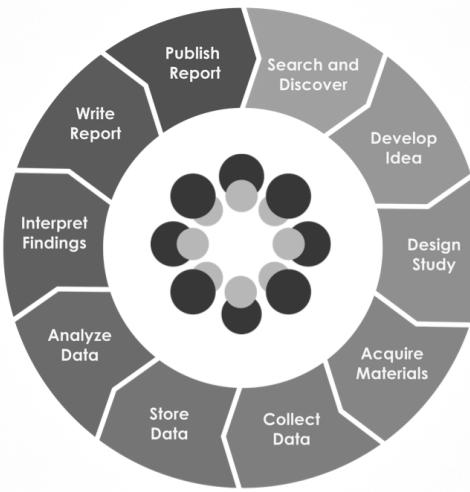


Figure 3.2.: Open Science Framework

means doing more than just one thing (Recker, 2013, p. 88). According to Recker (2013, p. 110) triangulation means you are seeking convergence and corroboration of results from different methods and designs studying the same phenomenon. Through triangulation, the researcher can gain a more nuanced picture of the situation and increase the reliability and validity of their findings (Recker, 2013, p. 88). Recker (2013, p. 88) states that the use of triangulation assists researchers in increasing the robustness of results. Findings can be strengthened through the cross-validation achieved when different kinds and sources of data converge and are found to be congruent (Recker, 2013, p. 88). Saunders et al. (2015, p. 207) states that triangulation involves using more than one source of data and method of collection to confirm the validity, credibility, and authenticity of research data, analysis and interpretation. Saunders et al. (2015, p. 207) also stresses that it is a necessity to use *triangulation* for a multi-method quantitative study, multi-method qualitative study or a mixed-methods study.

Mortelmans (2018, p. 481) explains that in the qualitative research tradition, triangulation has become the method of choice for increasing the credibility of results. It is stated by Mortelmans (2018, p. 481) that there are four types of triangulation. According to Mortelmans (2018, p. 88) the first type is that of *Data Triangulation*. Mortelmans (2018, p. 481) states that with *Data Triangulation*, different types of data are collected. The condition here is that the researcher stays within the qualitative paradigm (Mortelmans, 2018, p. 481). Mortelmans (2018, p. 481) defines the second type *Researcher Triangulation*. To avoid case contamination, multiple researchers analyse the same data (Mortelmans, 2018, p. 482). Afterwards, the results are compared with each other, and it is examined where any differences come from (Mortelmans, 2018, p. 482). The third case is defined by Mortelmans (2018, p. 481) as *Theory Triangulation*. Mortelmans (2018, p. 482) explains that *Theoretical Triangulation* means triangulating the results from different theoretical angles. Looking at data from a different perspective often yields

compelling (Mortelmans, 2018, p. 482). The last type of triangulation is defined by Mortelmans (2018, p. 481) as *Methodological Triangulation*. According to Mortelmans (2018, p. 483) explains *Methodological Triangulation* as the combination of data collected by qualitative technique with data collected by quantitative means. However, Mortelmans (2018, p. 483) *Methodological Triangulation* explains it does not necessarily mean that quantitative methods are applied in research.

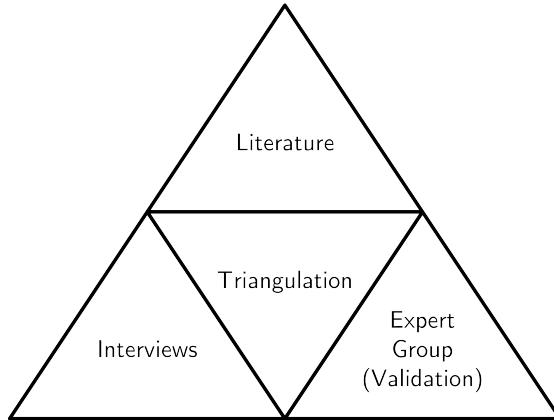


Figure 3.3.: Operationalisation of Triangulation

Triangulation is operationalised as Methodological Triangulation by using, as visualised by Figure 3.3, literature study to abstract attributes, interviews with data analysis to validate attributes and an expert group with data analysis to validate attributes.

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.

| 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 3.3.: 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 3.4.: 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 3.5.: 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.

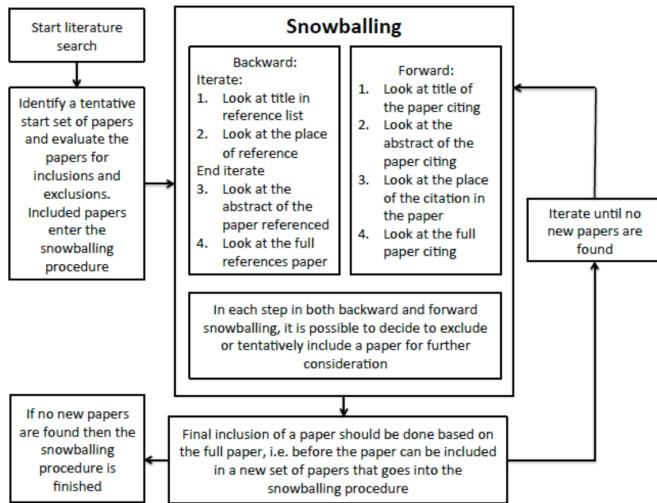


Figure 3.4.: Snowballing literature (Wohlin, 2014)

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 3.6.: Antifragile keywords

Enterprise Architecture

As described earlier in the subsection 10.2.1 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 3.7.: 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 3.8.: 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 3.9.: 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 sucess factors are incorrect. This method is the principle of falsification (subsection ??). 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.

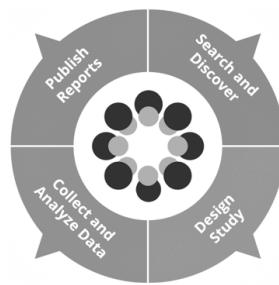


Figure 3.5.: Open Science Framework

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 LATEX³. 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/spp/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 bibLATEX file for future reference. For traceability the entries in the bibLATEX 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 | LATEX |
| ResearchGate | | | TeXstudio |
| Google Scholar | 2 | PaperPanda | ORCID |
| Z | 0 | bibLATEX | ResearchGate |
| Z | x | Meetingwizard | Zenodo |
| Z | x | Microsoft Excel | Grammarly |
| Y | 2 | GitHub | Microsoft Visio |
| Y | 2 | Cloud Berry Explorer for S3 | |
| Y | | QDA Miner Lite | |

Table 3.10.: 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. Attributes

4.1. Attributes of antifragile

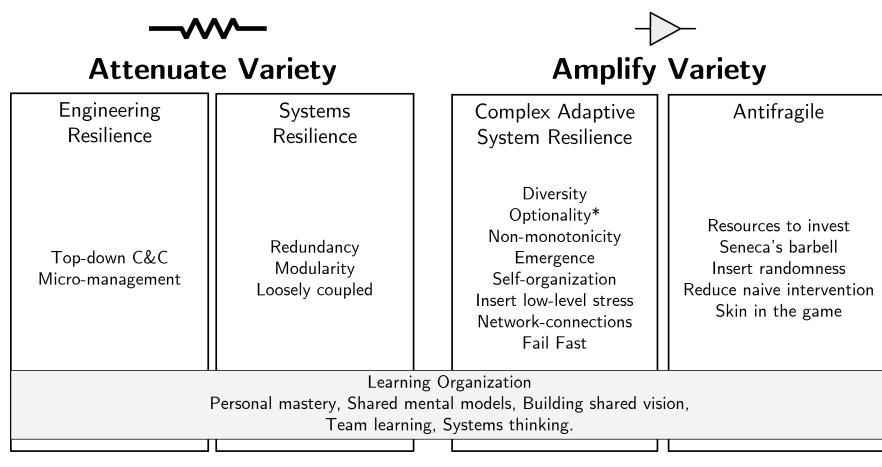


Figure 4.1.: Extended Antifragile Attribute List (Botjes, Edzo A. et al., 2021) with Optionality

4.2. Attributes of Enterprise Architecture

- 4.2.1. Enterprise Architecture schools of thought
- 4.2.2. Enterprise IT Architecting
- 4.2.3. Enterprise Integrating
- 4.2.4. Enterprise Ecological Adaptation
- 4.2.5. Summary of EA/AF

4.3. EA

- 4.3.1. Summary of EA/AF

4.4. Systems Theory

| Attribute | Variety | Behaviour | Sources |
|---------------------------|------------------------|------------------------|------------------------------|
| Top Down C&C | Attenuated | Engineering Resilience | (Botjes, 2020) |
| Micro-Management | Attenuated | Engineering Resilience | (Botjes, 2020) |
| Redundancy | Attenuated | Systems Resilience | (Botjes, 2020) |
| Modularity | Attenuated | Systems Resilience | (Botjes, 2020) |
| Loosely coupled | Attenuated | Systems Resilience | (Botjes, 2020) |
| Diversity | Amplified | CAS Resilience | (Botjes, 2020) |
| Optionality | Amplified | CAS Resilience | (Taleb, 2012; Gorgeon, 2015) |
| Non-Monotonicity | Amplified | CAS Resilience | (Botjes, 2020) |
| Emergence | Amplified | CAS Resilience | (Botjes, 2020) |
| Self-Organisation | Amplified | CAS Resilience | (Botjes, 2020) |
| Insert low-level stress | Amplified | CAS Resilience | (Botjes, 2020) |
| Network-connections | Amplified | CAS Resilience | (Botjes, 2020) |
| Fail Fast | Amplified | CAS Resilience | (Botjes, 2020) |
| Resources to invest | Amplified | Antifragile | (Botjes, 2020; Taleb, 2012) |
| Seneca's barbell | Amplified | Antifragile | (Taleb, 2012; Botjes, 2020) |
| Insert randomness | Amplified | Antifragile | (Taleb, 2012; Botjes, 2020) |
| Reduce naive intervention | Amplified | Antifragile | (Taleb, 2012; Botjes, 2020) |
| Skin in the game | Amplified | Antifragile | (Taleb, 2012; Botjes, 2020) |
| Personal Mastery | Attenuated & Amplified | Learning Organisation | (Botjes, 2020) |
| Shared mental models | Attenuated & Amplified | Learning Organisation | (Botjes, 2020) |
| Building shared vision | Attenuated & Amplified | Learning Organisation | (Botjes, 2020) |
| Team learning | Attenuated & Amplified | Learning Organisation | (Botjes, 2020) |
| Systems thinking | Attenuated & Amplified | Learning Organisation | (Botjes, 2020) |

Table 4.1.: Selected attributes of Antifragile

5. Validation by interviews

5.1. Interviews

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

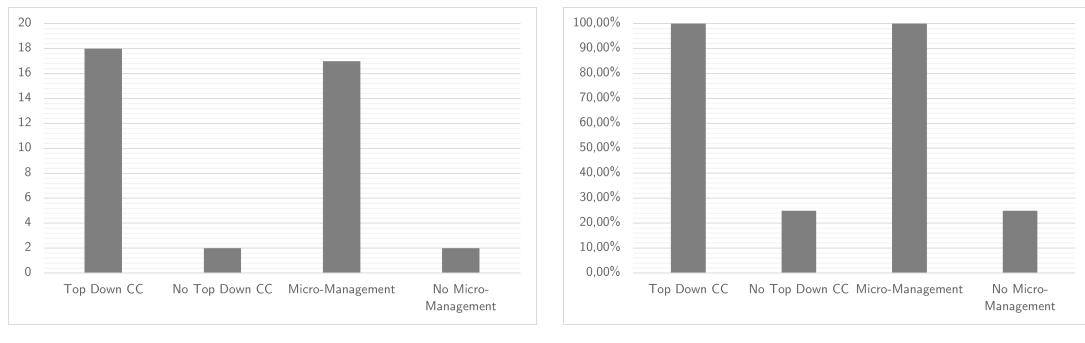
| Number | Question | Concept |
|---------|---|--------------|
| 1a. | How is your organisation applying EA? | EA |
| 1b. | Who is accountable for EA in your organisation? | EA |
| 1c. | How is EA enabling your organisation to quickly adapt to changes (external influences)? | EA |
| 2a. | Does the operational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

Table 5.1.: Interview questions

5.2. Summary of interviews

5.3. interview results

5.3.1. Engineering Resilience

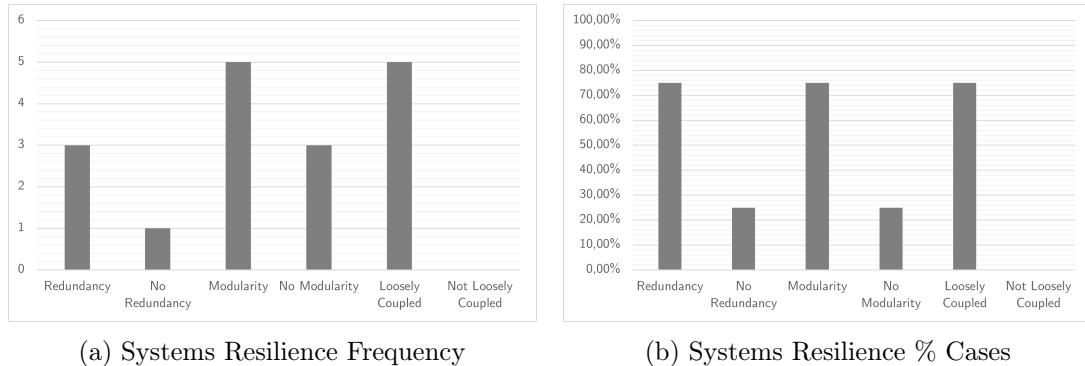


(a) Engineering Resilience Frequency

(b) Engineering Resilience % Cases

Figure 5.1.: Interview results Engineering Resilience

5.3.2. Systems Resilience



(a) Systems Resilience Frequency

(b) Systems Resilience % Cases

Figure 5.2.: Interview results Systems Resilience

5.3.3. Complex Adaptive System Resilience

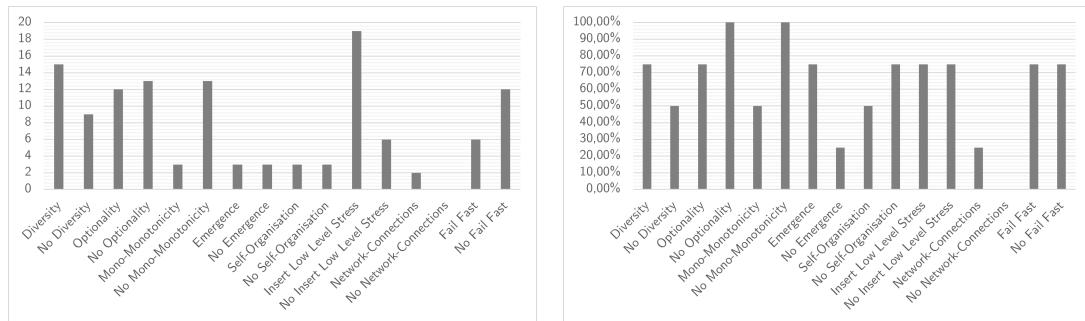


Figure 5.3.: Interview results CAS Resilience

5.3.4. Antifragile

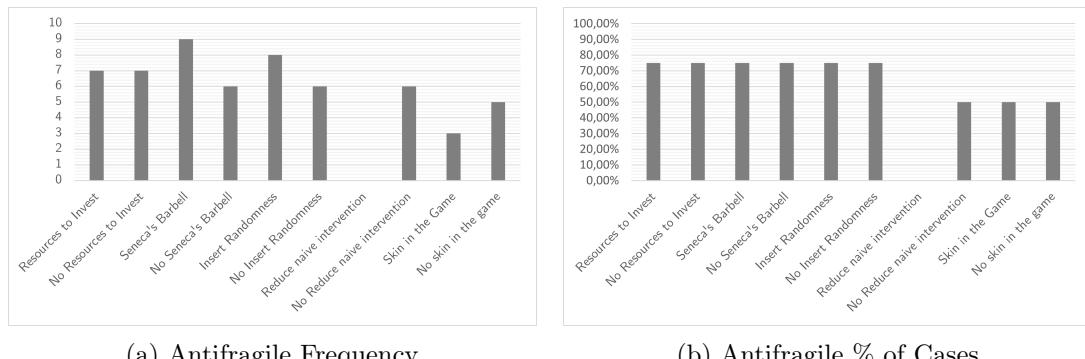


Figure 5.4.: Interview results Antifragile

5.3.5. Learning organisation

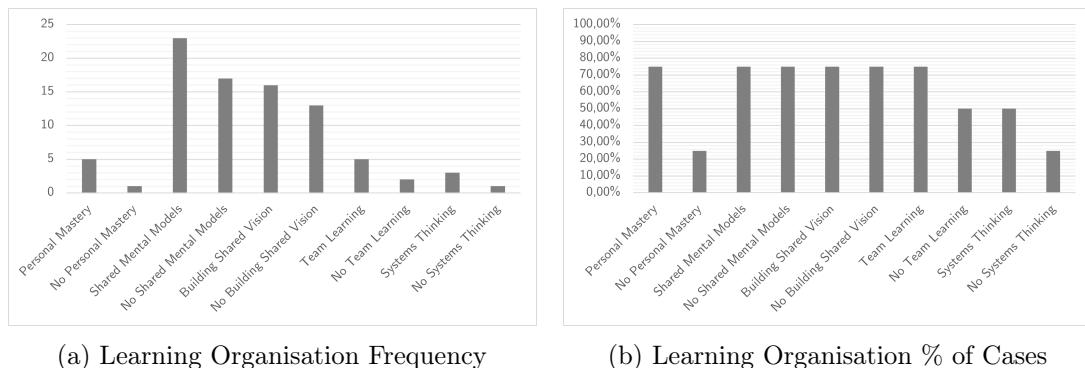


Figure 5.5.: Interview results Learning Organisation

5.3.6. Enterprise Architecture schools of thought

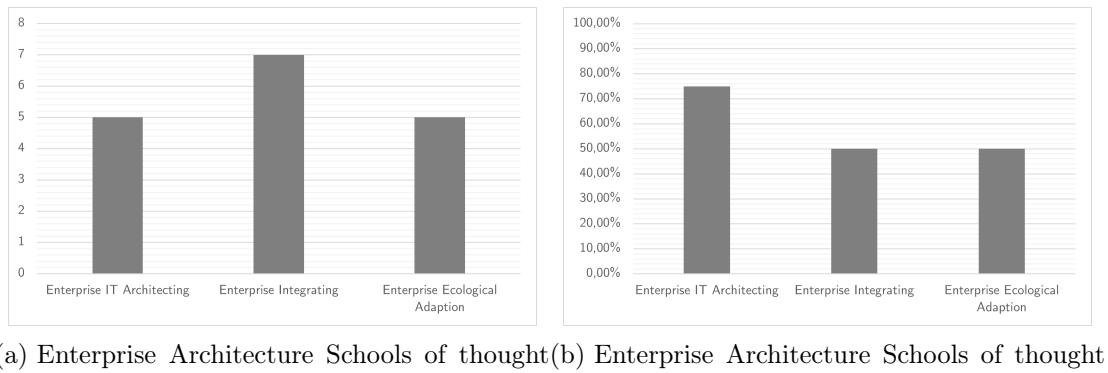


Figure 5.6.: Interview results Enterprise Architecture Schools of thought

5.3.7. Findings

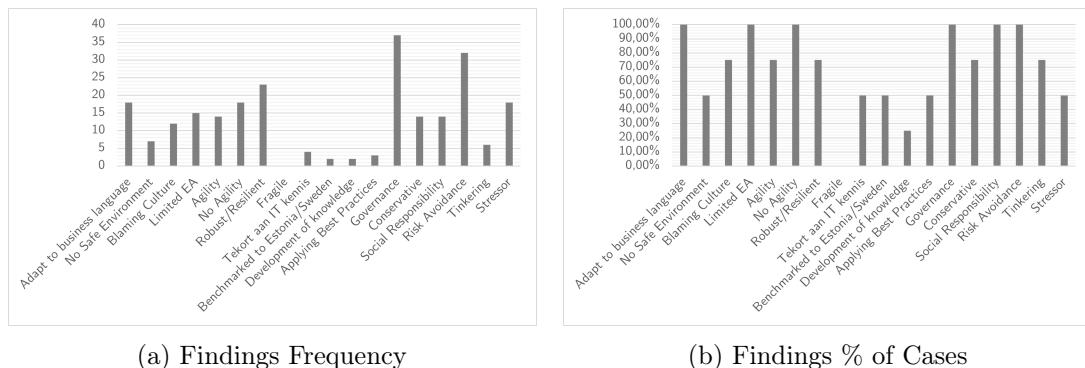


Figure 5.7.: Interview results Findings

5.4. Identified success factors

5.5. Findings

The central government is mostly robust and has a high risk aversion. With the administrative bodies of the local government the risk aversion is less and there is more insert low level stress. Because of this the local government is used to all the stressors and more antifragile.

Remark. Needs better description

| Attribute | Behaviour | Central Government | Local Government | Independent Software Vendor | Service Provider |
|---------------------------|------------------------|---------------------------|-------------------------|------------------------------------|-------------------------|
| Top Down C&C | Engineering Resilience | ✓ | ✓ | ✓ | ✓ |
| Micro-Management | Engineering Resilience | | | | |
| Redundancy | Systems Resilience | | | | |
| Modularity | Systems Resilience | | | | |
| Loosely coupled | Systems Resilience | | | | |
| Diversity | CAS Resilience | | | | |
| Optionality | CAS Resilience | | | | |
| Non-Monotonicity | CAS Resilience | | | | |
| Emergence | CAS Resilience | | | | |
| Self-Organisation | CAS Resilience | | | | |
| Insert low-level stress | CAS Resilience | | | | |
| Network-connections | CAS Resilience | | | | |
| Fail Fast | CAS Resilience | | | | |
| Resources to invest | Antifragile | | | | |
| Seneca's barbell | Antifragile | | | | |
| Insert randomness | Antifragile | | | | |
| Reduce naive intervention | Antifragile | | | | |
| Skin in the game | Antifragile | | | | |
| Personal Mastery | Learning Organisation | | | | |
| Shared mental models | Learning Organisation | | | | |
| Building shared vision | Learning Organisation | | | | |
| Team learning | Learning Organisation | | | | |
| Systems thinking | Learning Organisation | | | | |

Table 5.2.: Identified success factors from interviews

6. Validation by Expert Group

7. Final analysis

7.1. Identified success factors

7.2. Scoring of Success Factors

7.3. Possible success factors

Based on the dataset used, it can be stated with some degree of certainty that the following attributes can be a success factor

| Attribute | Literature | Interviews | Validation group | Score (n out of 3) |
|-----------------------------------|------------|------------|------------------|--------------------|
| Top-Down Command & Control | ✓ | | | 1 |
| Micro-Management | ✓ | | | 1 |
| Redundancy | ✓ | | | 1 |
| Modularity | ✓ | | | 1 |
| Loosely coupled | ✓ | | | 1 |
| Diversity | ✓ | | | 1 |
| Optionality | ✓ | ✓ | ✓ | 3 |
| Non-monotonicity | ✓ | ✓ | ✓ | 3 |
| Emergence | ✓ | | | 1 |
| Self organisation | ✓ | ✓ | ✓ | 3 |
| Insert low-level stress | ✓ | | | 1 |
| Network-connections | ✓ | | | 1 |
| Fail-Fast | ✓ | ✓ | ✓ | 3 |
| Resources to invest | ✓ | ✓ | ✓ | 3 |
| Seneca's barbell | ✓ | ✓ | ✓ | 3 |
| Insert randomness | ✓ | | ✓ | 2 |
| Reduce naive intervention | ✓ | | ✓ | 2 |
| Skin in the game | ✓ | | | 1 |
| Personal Mastery | ✓ | | | 1 |
| Shared mental models | ✓ | | | 1 |
| Building shared vision | ✓ | | | 1 |
| Team learning | ✓ | | | 1 |
| Systems thinking | ✓ | | | 1 |
| Safe working environment* | | ✓ | ✓ | 2 |
| Naar buiten kijken, Samenwerken** | | ✓ | ✓ | 2 |
| Data Governance Planes** | | | ✓ | 1 |

* Result of the used interviews data set.

** Results of the used validation data set.

Table 7.1.: Identified success factors of antifragile

| Attribute | <i>Literature</i> | <i>Interviews</i> | <i>Validation group</i> | <i>Score</i> |
|----------------------------------|-------------------|-------------------|-------------------------|--------------|
| Enterprise IT Architecting | ✓ | ✓ | | 2 |
| Enterprise Integrating | | ✓ | | 1 |
| Enterprise Ecological Adaptation | ✓ | ✓ | ✓ | 3 |

Table 7.2.: Identified the relevant Enterprise Architecture school of thought

| Attribute | <i>Literature</i> | <i>Interviews</i> | <i>Validation group</i> | <i>Score</i> |
|--|-------------------|-------------------|-------------------------|--------------|
| Systems-in-Environment thinking | ✓ | ✓ | | 2 |
| Holistic (systemic) stance | ✓ | ✓ | | 2 |
| Organisational learning | ✓ | ✓ | | 2 |
| Environmental learning | ✓ | ✓ | | 2 |
| Intra-organisational coherency | ✓ | ✓ | | 2 |
| System-in-environment coevolution learning | ✓ | ✓ | | 2 |
| Adapt to business language* | ✓ | ✓ | | 2 |
| Agile Enterprise ** | | ✓ | | 2 |
| Real Time Trust ** | | ✓ | | 1 |
| Foster Dialogue** | | ✓ | | 1 |
| Validation** | | ✓ | | 1 |
| Always fitting Architecture** | | ✓ | | 1 |

* Result of the used data set from interviews.

** Results of the used data set from the validation.

Table 7.3.: Identified success factors of Enterprise Architecture

| Attribute | Literature | Interviews | Validation group | Score |
|---------------------------|------------|------------|------------------|-------|
| Top Down C&C | 1 | 1 | 1 | 3 |
| Micro-Management | 1 | 0 | 1 | 2 |
| Redundancy | 1 | 1 | 0 | 2 |
| Modularity | 1 | 0 | 0 | 1 |
| Loosely coupled | 0 | 1 | 0 | 1 |
| Diversity | 0 | 0 | 1 | 1 |
| Optionality | | | | |
| Non-Monotonicity | | | | |
| Emergence | | | | |
| Self-Organisation | | | | |
| Insert low-level stress | | | | |
| Network-connections | | | | |
| Fail Fast | | | | |
| Resources to invest | | | | |
| Seneca's barbell | | | | |
| Insert randomness | | | | |
| Reduce naive intervention | | | | |
| Skin in the game | | | | |
| Personal Mastery | | | | |
| Shared mental models | | | | |
| Building shared vision | | | | |
| Team learning | | | | |
| Systems thinking | | | | |

Table 7.4.: Identified success factors

| Attribute | <i>Type</i> |
|----------------------------------|--|
| Optionality | Antifragile |
| Non-monotonicity | Antifragile |
| Self organisation | Antifragile |
| Fail-Fast | Antifragile |
| Resources to invest | Antifragile |
| Seneca's barbell | Antifragile |
| Enterprise Ecological Adaptation | Enterprise Architecture schools of thought |

Table 7.5.: Identified the relevant Enterprise Architecture school of thought

8. Conclusion and discussions

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

8.1. Conclusion

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

8.2. Discussions

- Discuss the definition of System Thinking vs Emergence
- Discuss Blaming Culture Public Sector
- Discuss Speaking the language of the Business with EA

8.3. Recommendations

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque.

Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

9. Retrospective

"I have found out how little I actually know"

- The added value of a Co-Promotor

10. Theoretical background2

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

10.1. Antifragile

Antifragile loves both randomness and uncertainty.

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

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).

10.1.1. What is a stressor?

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

10.1.2. Volatile, uncertain, complex, and ambiguous

Volatile, uncertain, complex, and ambiguous.

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

antifragile with fragile, robust, resilient, and agile.

10.1.4. 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.

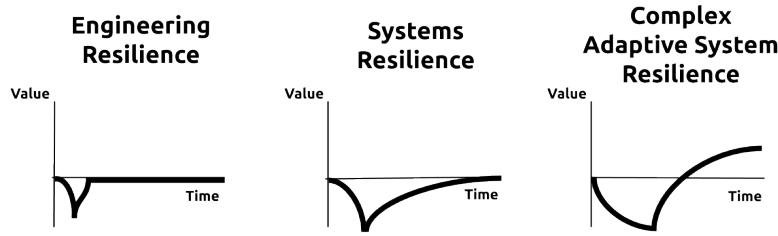


Figure 10.1.: Three types of resilience (Botjes, 2020)

10.1.5. Antifragile Systems Design

10.1.6. Residuality Theory

10.2. 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.

10.2.1. 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

10.2.2. Steering mechanisms

10.3. 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.

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.

10.3.1. 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.

10.4. What is a system?

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

10.4.1. 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)

10.4.2. Summary of the concept system

10.4.3. 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.

11. Concepts

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.

11.1. 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).

11.1.1. Interview Question 1

11.1.2. Interview Question 2

11.1.3. Interview Question 3

11.1.4. Interview Question 4

11.1.5. Interview Question 5

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 Halattunen (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.

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.

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.

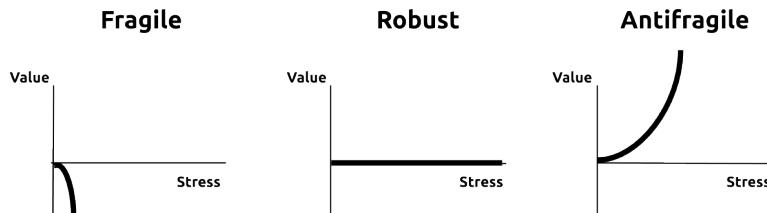


Figure 11.1.: Extended Antifragile Attribute List (EAAL) Triad (Botjes, 2020)

Remark. 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.

11.2. af parts

"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 'Skin in 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 Mithridatium (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.

11.2.1. 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.

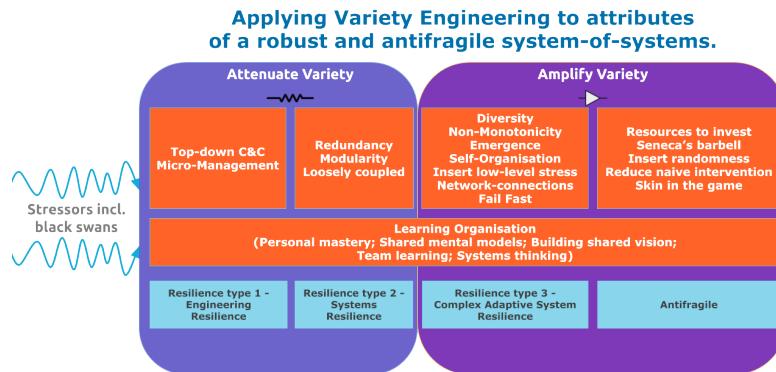


Figure 11.2.: EAAL (Botjes, 2020)

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.

11.2.2. 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 consists 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.

11.2.3. Resiliency 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). Resiliency 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 resiliency theory.

barry@blacktulip.se

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

11.2.4. 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.

11.2.5. Systems-in-Environment

(Lapalme, 2012, p. 41)

11.2.6. 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.

11.3. methodologies

References

- Ackoff, R. L. (1973). Science in the systems age: Beyond ie, or, and MS. *Oper. Res.*, 21(3), 661–671. <https://doi.org/10.1287/opre.21.3.661>
- Ackoff, R. L., Ashby, W. R., Boulding, K. E., Charnes, A., Churchman, C. W., Cooper, W. W., Drenick, R. F., Gerard, R. W., Kalaba, R., Linvill, W. K., & Mesarovié, M. D. (1964). *Views on general systems theory: Proceedings*. J. Wiley. http://documents.irevues.inist.fr/bitstream/handle/2042/30196/XX_CNE-Perspective_000742.pdf?sequence=1&isAllowed=y#page=71
- Aghina, W., Ahlback, K., Smet, A. D., Lackey, G., Lurie, M., Murarka, M., & Hand-scomb, C. (2018, January). *The five trademarks of agile organizations* (research rep.). McKinsey & Company. <https://www.mckinsey.com/business-functions/people-and-organizational-performance/our-insights/the-five-trademarks-of-agile-organizations#>
- Barros, A., & Dumas, M. (2006). The Rise of Web Service Ecosystems. *IT Professional*, 8(5), 31–37. <https://doi.org/10.1109/MITP.2006.123>
- 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. (1951). Problems of general systems theory. *Human Biology*, 23(4), 302–312. <https://doi.org/10.2307/41448003>
- 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>
- Botjes, Edzo A., van den Berg, Martin, van Gils, Bas & Mulder, Hans. (2021, August). *Attributes relevant to antifragile organizations*.
- Brafman, O., & Beckstrom, R. A. (2007). *The starfish and the spider: The unstoppable power of leaderless organizations*. Turnaround.
- Carayannis, E. G., & Campbell, D. F. (2009). 'mode 3' and 'quadruple helix': Toward a 21st century fractal innovation ecosystem. *International Journal of Technology Management*, 46(3/4), 201. <https://doi.org/10.1504/ijtm.2009.023374>
- 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>
- Eggers, W. D., & Bellman, J. (2015). The journey to government's digital transformation. https://www2.deloitte.com/content/dam/insights/us/articles/digital-transformation-in-government/DUP_1081_Journey-to-govt-digital-future_MASTER.pdf
- Foster, E. D., & Deardorff, A. (2017). Open science framework (OSF). *Journal of the Medical Library Association*, 105(2). <https://doi.org/10.5195/jmla.2017.88>
- 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>
- Gharajedaghi, J. (2011). *Systems thinking: Managing chaos and complexity: A platform for designing business architecture* (3rd ed) [OCLC: ocn705351973]. Morgan Kaufmann.
- GO FAIR. (2017). *Fair principles* (tech. rep.). <https://www.go-fair.org/fair-principles/>
- Gomes, L., Facin, A., Salerno, M. S., & Ikenami, R. K. (2018). Unpacking the innovation ecosystem construct: Evolution, gaps and trends. *Technological Forecasting and Social Change*, 136, 30–48. <https://doi.org/10.1016/j.techfore.2016.11.009>
- Gorgeon, A. (2015, December 14). *Antifragile information systems* (research rep.). International Conference on Information Systems. https://www.researchgate.net/publication/285288834_Antifragile_Information_Systems
- Graves, T. (2009, June 16). *Enterprise architecture: A pocket guide*. IT Governance Publishing (ITGP).
- Grefhorst, D., & Proper, E. (2011). *Architecture principles: The cornerstones of enterprise architecture* [OCLC: ocn729345210]. Springer.
- Guggenberger, T., Möller, F., Haarhaus, T., Gür, I., & Otto, B. (2020). ECOSYSTEM TYPES IN INFORMATION SYSTEMS. https://www.researchgate.net/publication/341188637_ECOSYSTEM_TYPES_IN_INFORMATION_SYSTEMS
- 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>
- Huang, K., Fan, Y., & Tan, W. (2014). Recommendation in an evolving service ecosystem based on network prediction. *IEEE Transactions on Automation Science and Engineering*, 11(3), 906–920. <https://doi.org/10.1109/tase.2013.2297026>
- Iansiti, M., & Levien, R. (2004). Strategy as Ecology. *Harvard business review*, 82, 68–78, 126.

- International Council on Systems Engineering. (2018). *Systems of Systems primer*. [https://www.incose.org/products-and-publications/sos-primer#:~:text=A%20System%20of%20Systems%20\(SoS,a%20topic%20of%20increasing%20interest](https://www.incose.org/products-and-publications/sos-primer#:~:text=A%20System%20of%20Systems%20(SoS,a%20topic%20of%20increasing%20interest).
- 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>
- Korhonen, J. J., Lapalme, J., McDavid, D., & Gill, A. Q. (2016). Adaptive enterprise architecture for the future: Towards a reconceptualization of EA. *2016 IEEE 18th Conference on Business Informatics (CBI)*. <https://doi.org/10.1109/cbi.2016.38>
- Kotusev, S., Singh, M., & Storey, I. (2015). Consolidating enterprise architecture management research. *2015 48th Hawaii International Conference on System Sciences*. <https://doi.org/10.1109/hicss.2015.489>
- 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>
- Manikas, K., & Hansen, K. M. (2013). Software ecosystems – a systematic literature review. *Journal of Systems and Software*, 86(5), 1294–1306. <https://doi.org/10.1016/j.jss.2012.12.026>
- 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>
- Moore, J. (1999). Predators and Prey: A New Ecology of Competition. *Harvard business review*, 71, 75–86.
- Mortelmans, D. (2018). *Handboek kwalitatieve onderzoeksmethoden* [OCLC: 1281878372]. Acco.

- 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>
- Papazoglou, M. P., & Heuvel, W.-J. V. D. (2006). Service-oriented design and development methodology. *International Journal of Web Engineering and Technology*, 2(4), 412. <https://doi.org/10.1504/ijwet.2006.010423>
- 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>
- Saunders, M. N. K., Lewis, P., & Thornhill, A. (2015). *Research methods for business students* (Seventh edition). Pearson Education.
- 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/>

- Spewak, S. (1993). *Enterprise architecture planning: Developing a blueprint for data, applications, and technology*. Wiley.
- 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>
- Tansley, A. G. (1935). The use and abuse of vegetational concepts and terms. *Ecology*, 16(3), 284–307. <https://doi.org/10.2307/1930070>
- 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 den Berg, M., Luijpers, J., van Steenbergen, M., & Wagter, R. (2005, January 18). *Dynamic enterprise architecture*. John Wiley & Sons. https://www.ebook.de/de/product/6972176/wagter_van_den_berg_van_steenberg_dynamic_enterprise_architecture.html
- 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>
- 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>
- Wilkinson, M. D., Dumontier, M., Aalbersberg, I. J., Appleton, G., Axton, M., Baak, A., Blomberg, N., Boiten, J.-W., da Silva Santos, L. B., Bourne, P. E., Bouwman, J., Brookes, A. J., Clark, T., Crosas, M., Dillo, I., Dumon, O., Edmunds, S., Evelo, C. T., Finkers, R., ... Mons, B. (2016). The FAIR guiding principles for scientific data management and stewardship. *Scientific Data*, 3(1), 160018. BriefCommunication. <https://doi.org/10.1038/sdata.2016.18>
- 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., & Halattunen, 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.
- Ylinen, M., & Pekkola, S. (2018). Enterprise Architecture as a Scapegoat for Difficulties in Public Sector Organizational Transformation. *International Conference on Information Systems (ICIS'2018)*. Retrieved March 23, 2022, from <https://researchportal.tuni.fi/en/publications/enterprise-architecture-as-a-scapegoat-for-difficulties-in-public>
- Ylinen, M., & Pekkola, S. (2020). Jack-of-all-trades torn apart: Skills and competences of an enterprise architect. *Proceedings of the 28th European Conference on Information Systems (ECIS): An Online AIS Conference, June 15-17, 2020*, 13. Retrieved

March 23, 2022, from <https://researchportal.tuni.fi/fi/publications/jack-of-all-trades-torn-apart-skills-and-competences-of-an-enterp>

List of Figures

| | |
|--|-----|
| 1.1. The opposite of fragile | 4 |
| 1.2. Conceptual Research Model | 4 |
| 1.3. Examples of stressors on the public sector | 6 |
| 2.1. The Extended Antifragile Attribute List (Botjes, Edzo A. et al., 2021) . . | 10 |
| 2.2. The Extended Antifragile Attribute List (Botjes, Edzo A. et al., 2021) with optionality reinstated | 11 |
| 2.3. The House of 'Thorbecke' | 12 |
| 2.4. Public sector collaboration models | 13 |
| 3.1. Research Model | 16 |
| 3.2. Open Science Framework | 19 |
| 3.3. Operationalisation of Triangulation | 20 |
| 3.4. Snowballing literature | 22 |
| 3.5. Open Science Framework | 26 |
| 4.1. Extended Antifragile Attribute List (Botjes, Edzo A. et al., 2021) with Optionality | 29 |
| 5.1. Interview results Engineering Resilience | 32 |
| 5.2. Interview results Systems Resilience | 32 |
| 5.3. Interview results CAS Resilience | 33 |
| 5.4. Interview results Antifragile | 33 |
| 5.5. Interview results Learning Organisation | 34 |
| 5.6. Interview results Enterprise Architecture Schools of thought | 34 |
| 5.7. Interview results Findings | 35 |
| 10.1. Three types of resilience | 47 |
| 11.1. EAAL Triad | 52 |
| 11.2. EAAL | 54 |
| G.1. Scoring of antifragile attribute Optionality | 105 |
| G.2. Scoring of antifragile attribute Mono-Monotonicity | 106 |
| G.3. Scoring of antifragile attribute Self-Organisation | 107 |
| G.4. Scoring of antifragile attribute Fail-Fast | 108 |
| G.5. Scoring of antifragile attribute Resources to Invest | 109 |
| G.6. Scoring of antifragile attribute Seneca's Barbell | 110 |

| | |
|--|-----|
| G.7. Scoring of antifragile attribute Safe working environment | 111 |
| G.8. Scoring of antifragile attribute Naar buiten kijken | 112 |
| G.9. Scoring of antifragile attribute Data Governance Planes | 113 |
| G.10.Scoring of school of thought Enterprise IT Architecting | 114 |
| G.11.Scoring of school of thought Enterprise Integrating | 115 |
| G.12.Scoring of school of thought Enterprise Ecological Adaptation | 116 |
| G.13.Scoring of EA attribute Systems-in-Environment thinking | 118 |
| G.14.Scoring of EA attribute Holistic (systemic) stance | 119 |
| G.15.Scoring of EA attribute Organisational learning | 120 |
| G.16.Scoring of EA attribute Environmental learning | 121 |
| G.17.Scoring of EA attribute Intra-Organisational coherency | 122 |
| G.18.Scoring of EA attribute System-in-Environment Co-Evolution learning . | 123 |
| G.19.Scoring of EA attribute adapt to business language | 124 |
| G.20.Scoring of EA attribute Agile Enterprise | 125 |
| G.21.Scoring of EA attribute Real Time Trust | 126 |
| G.22.Scoring of EA attribute Foster Dialogue | 127 |
| G.23.Scoring of EA attribute Validation | 128 |
| G.24.Scoring of EA attribute Always fitting EA | 129 |

List of Tables

| | | |
|-------|---|-----|
| 3.1. | Operationalisation of the quality attributes | 17 |
| 3.2. | Operationalisation of the FAIR Guiding Principles | 18 |
| 3.3. | Example score triangulation | 20 |
| 3.4. | Meaning of the score of triangulation | 21 |
| 3.5. | Meaning of the score of triangulation | 21 |
| 3.6. | Antifragile keywords | 23 |
| 3.7. | EEA authors | 23 |
| 3.8. | Enterprise Architecture keywords | 24 |
| 3.9. | Public sector keywords | 24 |
| 3.10. | Used infrastructure & tooling | 28 |
| 4.1. | Selected attributes of Antifragile | 30 |
| 5.1. | Interview questions | 31 |
| 5.2. | Identified success factors from interviews | 36 |
| 7.1. | Identified success factors of antifragile | 39 |
| 7.2. | Identified the relevant Enterprise Architecture school of thought | 40 |
| 7.3. | Identified success factors of Enterprise Architecture | 40 |
| 7.4. | Identified success factors | 41 |
| 7.5. | Identified the relevant Enterprise Architecture school of thought | 42 |
| A.1. | Properties of Enterprise IT Architecting | 80 |
| A.2. | Properties of Enterprise Integrating | 81 |
| A.3. | Properties of Enterprise Ecological Adaptation | 82 |
| B.1. | Authors of the Enterprise Architecture schools of thought | 83 |
| E.1. | Interview results Engineering Resilience | 96 |
| E.2. | Interview results Systems Resilience | 96 |
| E.3. | Interview results Complex Adaptive Systems Resilience | 97 |
| E.4. | Interview results Antifragile | 97 |
| E.5. | Interview results Learning Organisation | 98 |
| E.6. | Interview results Enterprise Architecture schools of thought | 98 |
| E.7. | Interview results Findings | 98 |
| F.1. | Data preparation 1 - Merging similar labels | 99 |
| F.2. | Data preparation 2 - Select cases based on a threshold of 75% or more . . | 100 |

| | |
|--|-----|
| F.3. Results of filtering cases Engineering Resilience on threshold | 100 |
| F.4. Results of filtering cases Systems Resilience on threshold | 100 |
| F.5. Results of filtering cases Complex Adaptive Systems Resilience on threshold | 101 |
| F.6. Results of filtering cases Antifragile on threshold | 101 |
| F.7. Results of filtering cases Learning Organisation on threshold | 101 |
| F.8. Results of filtering cases other findings on threshold | 102 |
| F.9. Results of filtering cases Enterprise Architecture schools of thought on threshold | 102 |
| F.10. Data preparation 4 - Joining positives with negatives | 102 |
| | |
| G.1. Experience of validation group participants | 103 |
| G.2. Validation of antifragile attributes | 104 |
| G.3. Scoring of antifragile attribute Optionality | 105 |
| G.4. Scoring of antifragile attribute Mono-Monotonicity | 106 |
| G.5. Scoring of antifragile attribute Self-Organisation | 107 |
| G.6. Scoring of antifragile attribute Fail-Fast | 108 |
| G.7. Scoring of antifragile attribute Resources to Invest | 109 |
| G.8. Scoring of antifragile attribute Seneca's Barbell | 110 |
| G.9. Scoring of antifragile attribute Safe working environment | 111 |
| G.10. Scoring of antifragile attribute Naar buiten | 112 |
| G.11. Scoring of antifragile attribute Data Governance Planes | 113 |
| G.12. Validation of Enterprise Architecture schools of thought | 114 |
| G.13. Scoring of school of thought Enterprise IT Architecting | 114 |
| G.14. Scoring of school of thought Enterprise Integrating | 115 |
| G.15. Scoring of school of thought Enterprise Ecological Adaptation | 116 |
| G.16. Validation of Enterprise Architecture attributes | 117 |
| G.17. Scoring of EA attribute Systems-in-Environment thinking | 118 |
| G.18. Scoring of EA attribute Holistic (systemic) stance | 119 |
| G.19. Scoring of EA attribute Organisational learning | 120 |
| G.20. Scoring of EA attribute Environmental learning | 121 |
| G.21. Scoring of EA attribute Intra-Organisational coherency | 122 |
| G.22. Scoring of EA attribute System-in-Environment Co-Evolution learning . . | 123 |
| G.23. Scoring of EA attribute adapt to business language | 124 |
| G.24. Scoring of EA attribute Agile Enterprise | 125 |
| G.25. Scoring of EA attribute Real Time Trust | 126 |
| G.26. Scoring of EA attribute Foster Dialogue | 127 |
| G.27. Scoring of EA attribute Validation | 128 |
| G.28. Scoring of EA attribute Always fitting EA | 129 |
| G.29. Closing Survey | 129 |
| G.30. Follow-up Survey | 130 |

Glossary of Terms

A | B | C | D | E | F | H | I | J | L | M | N | O | P | R | S | T | U | V

A

adapt to business language

Speak the language of your stakeholders such as Directors, Politicians, Public Administrators, and others.

agile

The ability to adjust before failure happens.

agility

The state of being agile.

ambiguous

Not expressed or understood clearly.

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.

antifragile

The ability to strive for and evolve under stress.

antifragility

The state of being antifragile.

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..

arduous

Hard to accomplish or achieve.

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.

B

Black Swan event

A black swan is an unpredictable event that is beyond what is normally expected of a situation and has potentially severe consequences. Black swan events are characterized by their extreme rarity, severe impact, and the widespread insistence they were obvious in hindsight.

building shared vision

A practice of unearthing shared pictures of the future that foster genuine commitment and enrollment rather than compliance.

C

Chief Architect

In information technology, a Chief Architect is a c-level executive whose job is to look closely at how IT functions can be centralized so that departments across the company can work together seamlessly. The chief architect may also be called the Enterprise Architect.

complex

A whole made up of complicated or interrelated parts.

Complexity Science

Complexity science is concerned with complex systems and problems that are dynamic, unpredictable and multi-dimensional, consisting of a collection of interconnected relationships and parts. Unlike traditional "cause and effect" or linear thinking, complexity science is characterized by non-linearity.

D

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..

disintermediation

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

diversity

Diversity is internally not being a mono-culture and externally having options. For example having two different coffee suppliers. Or having a diverse team.

E

emergence

Emergence refers to the existence or formation of collective behaviors, what parts of a system do together that they would not do alone.

Enterprise Ecological Adaptation

Enterprise Architecture is the means for organizational innovation and sustainability.

Enterprise Integrating

Enterprise Architecture is the link between strategy and execution.

Enterprise IT Architecting

Enterprise Architecture is the glue between business and IT.

environmental learning

Use environmental learning to adapt the enterprise desired goals to be more compatible with the environment.

F

Fail-Fast

The attributes "diversity", "non-monotonicity", "emergence", "self-organisation", "insert low-level stress", and "network-connections" combined enables the possibility to execute the strategy to embrace the adagium "Fail Fast"..

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.

foster

To promote the growth or development of.

fragile

The quality of being easily broken or destroyed.

fragility

The state of being fragile.

H

Holistic (systemic) stance

The EA process must not only think of a single domain but about the combination of domains (IT domains and business domains) together. Addressing any IT and business architecture sub-domains separately and trying to adapt the other sub-domains accordingly will probably produce an ineffective and unsustainable outcome.

I

immemorial

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

insert low-level stress

Continuous Improvement is achieved by inserting low-level of stress continuously into a learning system. This will keep the system sharp all the time.

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.

intra-organisational coherency

Its possible to make the organisation conducive to ecological learning, environmental influencing, and coherent strategy execution by reinforce wanted intra-dynamics and attenuate unwanted ones.

J

joint venture

A joint venture is a business entity created by two or more parties, generally characterized by shared ownership, shared returns and risks, and shared governance.

L

loosely coupled

Loosely coupled is the degree of dependency on the exact working of another module. For example when the color-schema of a website is changed it is preferred that this does not impact the functioning of the website. Another example is that when there are new employees introduced at the finance department the taste of the coffee changes. It is important to understand that there is always some degree of coupling.

M

Micro-Management

Micro-management is about the freedom in the use of the product. When there are minituous working instructions available in a business process the employee has no freedom in the execution of the job. Another great example is a lego building block. It is engineered and fabricated into the greatest detail creating a building block that is almost completely robust. Lego has a very small resilience behaviour through engineering.

modularity

Modularity is the degree that components may be separated and recombined, often with the benefit of flexibility. For example the finance team and the marketing team. Another example is the user-interface module and the data storage module.

N

network-connections

A network is created by connections to other nodes. More connections increases potential for optionality for new constructions and also new functionalities.

non-monotonicity

Non-monotonicity is about not only learning from the good but also from the bad. For example the lessons learned during a retrospective session.

O

optionality

Optionality is an idea advanced by Nassim Taleb in his book Antifragile. At the most basic level, optionality just means having lots of options. If you develop a skill with many possible job opportunities, you have more optionality than someone who develops a skill that only has one or two job opportunities.

organisational learning

To enable innovation and system-in-environment adaptation, Enterprise Architecture is about organisational learning. Designing all facets of the enterprise, including its relationship to the environment, will foster organisational learning.

P

parliamentary inquiry

The parliamentary committee of inquiry is a particular type of temporary committee of the House. The parliamentary inquiry is the most powerful instrument the Dutch parliament has at its disposal to carry out its duty to scrutinize the work of the government.

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.

public sector

The Public Sector is comprised of organisations that are owned and operated by the government and exist to provide services for its citizens..

R

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.

redundancy

Redundancy is about having not a single point of failure by making use of duplication. An example is a backup electricity generators. Another example is local government as backup system of the central government.

resiliency

The state of being resilient.

resilient

The ability to recover from failure.

resources to invest

Oportunities 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.

robust

The ability to resist failure.

S

safe working environment

When you create a safe work environment for employees, you set yourself up for business success, by reducing problem avoidance, accelerating trouble shooting, and increasing innovation. Taking this approach to errors demonstrates a leader's acceptance that people need to make mistakes in order to improve so that your business can achieve ever-greater goals.

self organisation

Self-Organisation is a process where some form of overall order arises from local interactions between parts of an initially disordered system. For example students sitting together in the school cafeteria.

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.

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.

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 good 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.

stressor

When systems are performing effectively, they are in a predetermined condition and conversely when they are not functioning correctly, they are in an unintended state. An unintended condition can be known or unknown. Stressors are forces that threaten to transfer a system from an intended to an unintended condition. In short you can also say that a stressor is an event from outside the system that causes stress.

system-in-environment coevolution learning

System-in-environment coevolution is the combination of environmental learning, intra-organisational coherency and attenuating unwanted forces.

systems thinking

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

Systems-in-Environment thinking

A system (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.

T

team learning

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

the House of Thorbecke

In 1848, as minister, Thorbecke laid the foundations for the current administrative division and task demarcation. In 1850 and 1851 he established the Provinces Act and the Municipalities Act. We therefore also speak of 'the House of Thorbecke'.

Top-Down Command & Control

Top-Down command and control is in an organisation that an employee is not free to decide to go left or right but has to follow orders. The careful design of an iPhone or a good pen is also an example of limited freedom of movement in the product itself.

U

uncertain

Not known beyond doubt.

uncertainty

the state of being uncertain.

V

volatile

Likely to change in a very sudden or extreme way.

Abbreviations

A | B | C | D | E | F | I | K | M | S | V

A

API

Application Programming Interface.

ASD

Antifragile Systems Design.

B

BIT

”Bureau ICT-toetsing”.

BoK

Body of Knowledge.

C

CAS

Complex Adaptive System.

CCO

Chief Commercial Officer.

CEO

Chief Executive Officer.

COO

Chief Operations Officer.

CTO

Chief Technology Officer.

D

DY**A**

DYnamic Architecture.

E**EA**

Enterprise Architecture.

EAAL

Extended Antifragile Attribute List.

EAM

Enterprise Architecture Management.

EEA

Enterprise Ecological Adaptation.

F**FMEA**

Failure Mode Effects Analysis.

I**idEA**

Interactive Dynamic Enterprise Architecture.

IS

Information System.

ISV

Independent Software Vendor.

K**KPI**

Key Performance Indicator.

M**MIT**

Massachusetts Institute of Technology.

S

SaaS

Software-as-a-Service.

SiE

System-in-Environment.

SoS

System-of-Systems.

V**VNG-R**

"Vereniging Nederlandse Gemeenten - Realisatie".

VSM

Viable Systems Model.

VUCA

Volatility, Uncertainty, Complexity and Ambiguity.

Appendices

A. Properties of the Enterprise Architecture schools of thought

This appendix describes the Enterprise Architecture school of thoughts in more details. It will help the reader with detailed understanding of the three schools of thought.

A.1. The properties of Enterprise IT Architecting

The school of thought Enterprise IT Architecting (Lapalme, 2012, p. 39) is summarised in the following table.

| 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

A.2. The properties of Enterprise Integrating

The school of thought Enterprise Integrating is summarised in the following table.

| Enterprise Integrating school of thought | |
|--|--|
| Motto | Enterprise Architecture is the link between strategy and execution |
| Objectives and concerns | Effectively implement the enterprise strategy Support organizational coherence |
| Principles and assumptions | Apply a holist (systemic) stance Don't question business strategies and objectives Manage the environment Jointly design all organisational dimensions |
| Skills | Facilitate small-group collaboration Apply systems thinking |
| Challenges | Understand organizational systemic dynamics Collaborate across the organization |
| Insights | Encourage systems thinking and paradigm shifts 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

A.3. The properties of Enterprise Ecological Adaptation

The school of thought Enterprise Ecological Adaptation is summarised in the following table.

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

Table A.3.: Properties of Enterprise Ecological Adaptation

B. Authors of the Enterprise Architecture schools of thought

This appendix indicates which authors in the Body of Knowledge are related to which school of thought. Lapalme (2012, p. 42) mapped enterprise architecture authors from the Body of Knowledge according to the three schools of thought.

| Enterprise IT Architecting | Enterprise Integrating | Enterprise Ecological Adaptation |
|---|--|------------------------------------|
| Clive Finkelstein | Peter Bernus and Colleagues (editors) | Jamshid Ghara Jedaghi |
| 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 Steenbergen | | James Lapalme and Donald de Guerre |

Table B.1.: Authors of the Enterprise Architecture schools of thought

C. Literature Selection

D. Interview summaries

This appendix contains summaries per interview. This appendix gives the reader of this thesis more details on the answers given by the interviewees. These summaries are created from the recorded interviews and transcriptions belonging to these recordings.

D.1. Interview central government

Question 1 / Enterprise Architecture

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

Question 2 / Agility of the public sector

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

Question 3 / Dealing with uncertainty and unexpected events

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

Question 5 / The risk appetite of the public sector

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

Question 6 / The use of diversity and optionality in the public sector

It would be nice to work with optionality and smaller units within the public sector and EA to make it easier to adapt. Think about in EA disposable microservices. Nevertheless,

it remains that EA is not important. It is at the end of the chain and is not used in administrative decision-making. Enterprise architecture is confronted with decision-making.

Closing statements

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

D.2. Interview local government

Question 1 / Enterprise Architecture

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

Question 2 / Agility of the public sector

The public sector is more about risk aversion. Legality is about holding on to what is known. So, it is exactly known what the municipalities do, and we know precisely what the Land Registry does. All the subsystems of the public sector have a defined assignment. Moreover, it would be best if it stayed between the lines. Think, for example, about purpose limitation. Purpose Limitation will hold it back when public sector wants to be agile. The public sector cannot experiment that easily with rules like these. It will

put experimentation at the edge. The operating model of the public sector does not offer the freedom to do so that easily. The public sector can not experiment, discover and then say this was a nice experiment; let us go further. It is impossible to take decisions on the whole, such as within the social domain. If you have the right to confiscate a car, you cannot decide that there need to be a taxi to drive kids to school. It is a responsibility of a different part of the public sector. This all has to do with the House of Thorbecke¹ together with the current legislation and regulations. It does not mean that the public sector does not want to be more agile. It is not about separate parts of the government anymore. There is more and more collaboration based on federation. The public sector wants to be more agile. It is often a subject of conversation. Nevertheless, it gets stuck in the administrative decision-making processes.

Question 3 / Dealing with uncertainty

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

Question 4 / Dealing with unexpected events

We, fortunately, live in a country where the public sector is staffed with good people who understand what citizens need or what is needed in a disaster area. So help is available pretty quickly. For example the fires at Moerdijk³, near Rotterdam. Or the plane crash of Turkish Airlines⁴ at Schiphol. Before we knew it, the fires were already

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

²<https://commonground.nl/>

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

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

distinguished. However, the public sector is not able to ascertain if it is an incident or a structural problem. If the problem takes too long, we see the reflex to control it again, so we fall back to our past habits. Adopting newly learned patterns is hard with the current legislation and regulations. Maybe we must be in a continuous crisis, so we have the freedom to do what we have to do. It is easier to be more agile in a crisis. With the local governments, there is only one who can decide what to do in a crisis, and this is the mayor as part of the triangle¹. It seems that the local governments have two organisation & operational models. A model for running the municipality in a normal state and one in a state of crisis. (note: Seneca's Barbell?)

Question 5 / The risk appetite of the public sector

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

Question 6 / The use of diversity and optionality in the public sector

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

Closing statements

The government will not disappear, but that trust in the government will. Some government organizations or parts of them can undoubtedly disappear. (note: does not fit with

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

the questions but find it an important statement). The public sector needs a cross-sector EA. It's no longer just about your organization. You have to work together more and more. The EA can then be further tailored to your own organization.

D.3. Interview ISV

Question 1 / Enterprise Architecture

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

stuck.

Question 2 / Agility of the public sector

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

Question 3 / Dealing with uncertainty

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

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

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

Question 4 / Dealing with unexpected events

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

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

than changes initiated by chaos. The feedback from unexpected events is not fed into the system so that it can be changed (note: learning organisation not in place).

Question 5 / The risk appetite of the public sector

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

Question 6 / The use of diversity and optionality in the public sector

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

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

to switch suppliers. This has a positive influence on executing optionality. But this way of working is not sustained in, for example, the EA.

Closing statements

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

D.4. Interview with consultancy firm/service provider

Question 1 / Enterprise Architecture

We have, to an extent, an EA with the necessary elements for the products and services we develop ourselves. We do not have a dedicated enterprise architect. Other types of architects maintain the current EA. The CTO is accountable for the EA. In the end, everything rolls up to the CEO.

Our EA is, at this moment, mostly about our products and services and addresses our primary concerns. The concerns are the connections between data, how they should communicate, and the impact on our products and services. With the EA, we can determine our solution gaps and steer towards procurement of applications and integrations. The integrations are with the sales, finance, HR, and delivery capabilities. We still have two separate worlds in our organisation. These two worlds are the supporting and delivery capabilities of our organisation. Bringing these two worlds together will be on the roadmap for next year so we can work with an integrated EA. Both worlds come together when we think about our customers. We will realise that when we develop features for our platform, we can connect to the propositions that we offer to our customers. The lack of an EA slows us down from achieving this. We do not have a business architecture, but we advise our customers on business architecture. We have to close this gap.

With the current EA we can make adjustments to our products and services very fast and flexible. Our EA supports it because it contains the architecture of our products and services and our infrastructure down to the data models that we use for our customers. However, we do not have control over our supporting applications, such as Salesforce. Our products and services are robust & resilient and support us to be agile. Sometimes we disconnect a server to see what happens (note: insert randomness / SRE / Chaos Engineering). We continuously improve ourselves to get better (note: learning organisation).

Question 2 / Agility of the public sector

There is a low degree of agility in the public sector. This low agility is possible because of the lack of IT knowledge and skills in politics and policymakers. If we look at the

electoral lists of the central and local elections, we can state that there is a shortage of knowledge, skills and fundamental IT knowledge. There are exceptions, but not that much.

If we compare this to, for example, the Estonian model, we see a world of difference. We are not there (yet). We have to invest more in this. If we think of the public sector as an aggregate and you go lower in the aggregation, you already see that it is going better. We see that the public sector has been taking significant steps in the last ten years. Administrative governmental agencies have more responsibilities to operationalise, develop and maintain systems. We have been able to leave a mark in the on the technical quality of systems. It is a good development that the BIT exists. The operating model of the public sector is extending. Compared to the private sector, the government is at a good average. Maybe this is already a good position for the government. We will see more and more connections and integrations with specific ministries and administrative agencies. The digital transformation is progressing. More and more is shared online and is easy to access. We see this as a positive effect. We can help the public sector further because of this by bringing in best practices. How should we unlock our data, what can we do with this data, and what is the effect on IT and Governance. EA can support us in this.

Question 3 / Dealing with uncertainty

We see the desire for robustness & resilience. The public sector tries to push it back to how it was. As an example, the regulations on electric steps. It is a new development, and it falls outside the scope of current regulations. It is not a scooter or a bicycle, and it does not fit in any other regulations. The reaction of the policymakers is to rule it out. It is not allowed until there is an agreement on new regulations. The Dutch model is to push it back to how it was. The electric steps are allowed if there is an agreement on how to allow them. We see the same behaviour with the IT capability. Policymaking takes time. It slows down new developments. The choices are made based on robustness, certainty and clarity. The behaviour has everything to do with the risk aversion of the public sector.

The basic attitude of the public sector is to avoid mistakes. When a choice has a risk, they do not decide until everything is clear. There is an implicit postponement in this behaviour. The risk of this behaviour is that the public sector is missing great opportunities. The founding of BIT is an excellent thing to have some certainty, but it is concerning that the whole public sector is moving towards control and risk mitigation. It removes agility from the system while the government plays a facilitating role in our society. All risks should be avoided, and everything needs to be traceable, making no mistakes. By this approach, the public sector is probably missing out on options that can make a difference, and it inhibits realising potentials. The public sector is using EA as a way to attenuate.

Question 4 / Dealing with unexpected events

If something happens, there is the will to act by setting up something new, reworking systems, and other things. Nevertheless, there still is a considerable delay after the unexpected event happened. After achieving the goal is directly followed up by attenuation. The public sector does not want to make mistakes, so the public sector will do as minimal as possible to achieve the goal because of risk mitigation.

If something happens, the public sector deals with that. However, because of the aversion to risks, the public sector is not getting the most out of it. If the public sector exploits the situation, instead of familiar ways, with more radical approaches, the result will be a significant progression, even when there is uncertainty. It is another way of doing so with the risk that something will go wrong. If it goes wrong, there is a risk that the press will magnify it because it is about spending public money. Unfortunately, successes do not get attention.

Question 5 / The risk appetite of the public sector

We want to play a role in this world by being more innovative. We allow some governmental bodies to go a little further in experimentation and development, but this is mainly on a project-by-project basis. For these projects, we accepted that it would cost us public money and that making mistakes is allowed. However, generically, the trajectories we see do not have a risk appetite and are even risk-averse. Most of the time, this is good for a reliable government. Use, for risk-taking cases, specific demarcated parts of the public sector.

Question 6 / The use of diversity and optionality in the public sector

We see an improvement on this topic over the past years in the public sector. We see a growth in knowledge, from an IT perspective, in multiple areas in the public sector. E.g. architecture, implementation, development, code quality and other qualitative aspects of IT. We see, at this moment, this contribution mainly from the central government and not so much from the local governments. We think that this improvement will continue. We do hope that this improvement will reach the electoral lists. If we look at the systems, we do not see any uniformity. We do see differences in designs and the ways of looking at things.

E. Interview findings

This appendix describes the interview findings in more details. This appendix can be used by the reader of the thesis with more detailed information.

| Code | Count | % Codes | Cases | % Cases |
|---------------------|--------------|----------------|--------------|----------------|
| Top Down CC | 18 | 3,10% | 4 | 100,00% |
| No Top Down CC | 2 | 0,30% | 1 | 25,00% |
| Micro-Management | 17 | 2,90% | 4 | 100,00% |
| No Micro-Management | 2 | 0,30% | 1 | 25,00% |

Table E.1.: Interview results Engineering Resilience

| Code | Count | % Codes | Cases | % Cases |
|---------------------|--------------|----------------|--------------|----------------|
| Redundancy | 3 | 0,50% | 3 | 75,00% |
| No Redundancy | 1 | 0,20% | 1 | 25,00% |
| Modularity | 5 | 0,90% | 3 | 75,00% |
| No Modularity | 3 | 0,50% | 1 | 25,00% |
| Loosely Coupled | 5 | 0,90% | 3 | 75,00% |
| Not Loosely Coupled | | | | |

Table E.2.: Interview results Systems Resilience

| Code | Count | % Codes | Cases | % Cases |
|----------------------------|--------------|----------------|--------------|----------------|
| Diversity | 15 | 2,60% | 3 | 75,00% |
| No Diversity | 9 | 1,60% | 2 | 50,00% |
| Optionality | 12 | 2,10% | 3 | 75,00% |
| No Optionality | 13 | 2,30% | 4 | 100,00% |
| Mono-Monotonicity | 3 | 0,50% | 2 | 50,00% |
| No Mono-Monotonicity | 13 | 2,30% | 4 | 100,00% |
| Emergence | 3 | 0,50% | 3 | 75,00% |
| No Emergence | 3 | 0,50% | 1 | 25,00% |
| Self-Organisation | 3 | 0,50% | 2 | 50,00% |
| No Self-Organisation | 3 | 0,50% | 3 | 75,00% |
| Insert Low Level Stress | 19 | 3,30% | 3 | 75,00% |
| No Insert Low Level Stress | 6 | 1,00% | 3 | 75,00% |
| Network-Connections | 2 | 0,30% | 1 | 25,00% |
| No Network-Connections | | | | |
| Fail Fast | 6 | 1,00% | 3 | 75,00% |
| No Fail Fast | 12 | 2,10% | 3 | 75,00% |

Table E.3.: Interview results Complex Adaptive Systems Resilience

| Code | Count | % Codes | Cases | % Cases |
|---------------------------|--------------|----------------|--------------|----------------|
| Resources to Invest | 7 | 1,20% | 3 | 75,00% |
| No Resources to Invest | 7 | 1,20% | 3 | 75,00% |
| Seneca's Barbell | 9 | 1,60% | 3 | 75,00% |
| No Seneca's Barbell | 6 | 1,00% | 3 | 75,00% |
| Insert Randomness | 8 | 1,40% | 3 | 75,00% |
| No Insert Randomness | 6 | 1,00% | 3 | 75,00% |
| Reduce naive intervention | 6 | 1,00% | 2 | 50,00% |
| Skin in the Game | 3 | 0,50% | 2 | 50,00% |
| No skin in the game | 5 | 0,90% | 2 | 50,00% |

Table E.4.: Interview results Antifragile

| Code | Count | % Codes | Cases | % Cases |
|---------------------------|--------------|----------------|--------------|----------------|
| Personal Mastery | 5 | 0,90% | 3 | 75,00% |
| No Personal Mastery | 1 | 0,20% | 1 | 25,00% |
| Shared Mental Models | 23 | 4,00% | 3 | 75,00% |
| No Shared Mental Models | 17 | 2,90% | 3 | 75,00% |
| Building Shared Vision | 16 | 2,80% | 3 | 75,00% |
| No Building Shared Vision | 13 | 2,30% | 3 | 75,00% |
| Team Learning | 5 | 0,90% | 3 | 75,00% |
| No Team Learning | 2 | 0,30% | 2 | 50,00% |
| Systems Thinking | 3 | 0,50% | 2 | 50,00% |
| No Systems Thinking | 1 | 0,20% | 1 | 25,00% |

Table E.5.: Interview results Learning Organisation

| Code | Count | % Codes | Cases | % Cases |
|--------------------------------|--------------|----------------|--------------|----------------|
| Enterprise IT Architecting | 5 | 0,90% | 3 | 75,00% |
| Enterprise Integrating | 7 | 1,20% | 2 | 50,00% |
| Enterprise Ecological Adaption | 5 | 0,90% | 2 | 50,00% |

Table E.6.: Interview results Enterprise Architecture schools of thought

| Code Description | Count | % Codes | Cases | % Cases |
|-------------------------------|--------------|----------------|--------------|----------------|
| Adapt to business language | 18 | 3,10% | 4 | 100,00% |
| No Safe Environment | 7 | 1,20% | 2 | 50,00% |
| Blaming Culture | 12 | 2,10% | 3 | 75,00% |
| Limited EA | 15 | 2,60% | 4 | 100,00% |
| Agility | 14 | 2,40% | 3 | 75,00% |
| No Agility | 18 | 3,10% | 4 | 100,00% |
| Robust/Resilient | 23 | 4,00% | 3 | 75,00% |
| Fragile | | | | |
| Tekort aan IT kennis | 4 | 0,70% | 2 | 50,00% |
| Benchmarked to Estonia/Sweden | 2 | 0,30% | 2 | 50,00% |
| Development of knowledge | 2 | 0,30% | 1 | 25,00% |
| Applying Best Practices | 3 | 0,50% | 2 | 50,00% |
| Governance | 37 | 6,40% | 4 | 100,00% |
| Conservative | 14 | 2,40% | 3 | 75,00% |
| Social Responsibility | 14 | 2,40% | 4 | 100,00% |
| Risk Avoidance | 32 | 5,50% | 4 | 100,00% |
| Tinkering | 6 | 1,00% | 3 | 75,00% |
| Stressor | 18 | 3,10% | 2 | 50,00% |

Table E.7.: Interview results Findings

F. Data preparation for interview analysis

F.1. Step 1: merge similar labels

| Step | Description | Rationale |
|------|--|--|
| 1 | Create, positive and negative, Main Categories of Engineering, Systems, CAS, Antifragile, and Learning Organisation) | Need extra categories to merge overarching subjects |
| 2 | Merge Agility into CAS | How Agility is interpreted is the same as CAS |
| 3 | Merge tinkering into Learning Organisation | How tinkering is interpreted it is the same as Learning Organisation |
| 4 | Merge Robust/Resilience into Engineering Resilience | How Robust/Resilience is interpreted it is the same as Engineering Resilience |
| 5 | Merge Governance into Engineering Resilience | How Governance is interpreted is the same as Top Down Command Control and Micro Management so Engineering Resilience |
| 6 | Merge Shortage on IT Knowledge into No Resources to invest | Shortage on IT Knowledge can be interpreted as a resource that is not there (No Resources to invest) |
| 7 | Merge Applying Best practices into Mono-Monotonicity | Applying Best practices is learning from the past |
| 8 | Merge Development of Knowledge into Learning Organisation | Development of Knowledge within an organisation can be seen as the learning capability of an organisation |
| 9 | Merge Blaming Culture into No Safe Environment | No Safe Environment is a result of a Blaming Culture |
| 10 | Merge Limited EA into Enterprise IT Architecting | Limited EA is interpreted as the school of thought Enterprise IT Architecting |
| 11 | Merge conservative into Risk Avoidance | Risk Avoidance is a result of Conservative |

Table F.1.: Data preparation 1 - Merging similar labels

F.2. Step 2: Filter cases on threshold

| Step | Description | Rationale |
|------|---|---|
| 1 | Select labels where % case is 75% or more | When three interviewees mentioned the label it could be a label of significance (Triangulation) |

Table F.2.: Data preparation 2 - Select cases based on a threshold of 75% or more

F.2.1. Outcome of filter cases on threshold

| Code | Count | % Codes | Cases | % Cases |
|------------------------|-------|---------|-------|---------|
| Engineering Resilience | 60 | 10,40% | 4 | 100,00% |
| Top Down CC | 18 | 3,10% | 4 | 100,00% |
| Micro-Management | 17 | 2,90% | 4 | 100,00% |

Table F.3.: Results of filtering cases Engineering Resilience on threshold

| Code | Count | % Codes | Cases | % Cases |
|-----------------|-------|---------|-------|---------|
| Redundancy | 3 | 0,50% | 3 | 75,00% |
| Modularity | 5 | 0,90% | 3 | 75,00% |
| Loosely Coupled | 5 | 0,90% | 3 | 75,00% |

Table F.4.: Results of filtering cases Systems Resilience on threshold

F.3. Step 3:

F.4. Step 4: Joining positives and negatives

| Code | Count | % Codes | Cases | % Cases |
|---------------------------------------|--------------|----------------|--------------|----------------|
| Complex Adaptive System Resilience | 14 | 2,40% | 3 | 75,00% |
| No Complex Adaptive System Resilience | 18 | 3,10% | 4 | 100,00% |
| Diversity | 15 | 2,60% | 3 | 75,00% |
| Optionality | 12 | 2,10% | 3 | 75,00% |
| No Optionality | 13 | 2,20% | 4 | 100,00% |
| No Mono-Monotonicity | 13 | 2,20% | 4 | 100,00% |
| Emergence | 3 | 0,50% | 3 | 75,00% |
| No Self-Organisation | 3 | 0,50% | 3 | 75,00% |
| Insert Low Level Stress | 19 | 3,30% | 3 | 75,00% |
| No Insert Low Level Stress | 6 | 1,00% | 3 | 75,00% |
| Fail Fast | 6 | 1,00% | 3 | 75,00% |
| No Fail Fast | 12 | 2,10% | 3 | 75,00% |

Table F.5.: Results of filtering cases Complex Adaptive Systems Resilience on threshold

| Code | Count | % Codes | Cases | % Cases |
|------------------------|--------------|----------------|--------------|----------------|
| Resources to Invest | 7 | 1,20% | 3 | 75,00% |
| No Resources to Invest | 11 | 1,90% | 3 | 75,00% |
| Seneca's Barbell | 9 | 1,60% | 3 | 75,00% |
| No Seneca's Barbell | 6 | 1,00% | 3 | 75,00% |
| Insert Randomness | 8 | 1,40% | 3 | 75,00% |
| No Insert Randomness | 6 | 1,00% | 3 | 75,00% |

Table F.6.: Results of filtering cases Antifragile on threshold

| Code | Count | % Codes | Cases | % Cases |
|---------------------------|--------------|----------------|--------------|----------------|
| Learning Organisation | 8 | 1,40% | 4 | 100,00% |
| Personal Mastery | 5 | 0,90% | 3 | 75,00% |
| Shared Mental Models | 23 | 4,00% | 3 | 75,00% |
| No Shared Mental Models | 17 | 2,90% | 3 | 75,00% |
| Building Shared Vision | 16 | 2,80% | 3 | 75,00% |
| No Building Shared Vision | 13 | 2,20% | 3 | 75,00% |
| Team Learning | 5 | 0,90% | 3 | 75,00% |

Table F.7.: Results of filtering cases Learning Organisation on threshold

| Code | Count | % Codes | Cases | % Cases |
|----------------------------|--------------|----------------|--------------|----------------|
| Adapt to business language | 18 | 3,10% | 4 | 100,00% |
| No Safe Environment | 19 | 3,30% | 3 | 75,00% |
| Social Responsibility | 14 | 2,40% | 4 | 100,00% |
| Risk Avoidance | 46 | 8,00% | 4 | 100,00% |

Table F.8.: Results of filtering cases other findings on threshold

| Code | Count | % Codes | Cases | % Cases |
|----------------------------|--------------|----------------|--------------|----------------|
| Enterprise IT Architecting | 21 | 3,60% | 4 | 100,00% |

Table F.9.: Results of filtering cases Enterprise Architecture schools of thought on threshold

| Step | Description | Rationale |
|-------------|--|--|
| 1 | Rationalize Positives and negatives by add/substract | Bringing the values back to the found success factors/attributes |

Table F.10.: Data preparation 4 - Joining positives with negatives

G. Validation findings

G.1. Experience of validation group participants

| Question | Rating | Variability | Abstains |
|--|--------|-------------|----------|
| How many years of experience do you have in the field of enterprise architecture? | 9,8 | 8% | 0 |
| How many years have you worked as an (enterprise) architect? | 10,6 | 12% | 0 |
| How many years of experience do you have in the field of complexity sciences (like antifragile)? | 7,4 | 16% | 0 |
| How many years of experience do you have with the public sector? | 12,2 | 17% | 0 |
| How many years of experience do you have with working in publicly-held organisations? | 10 | 16% | 0 |
| How many years of experience do you have with working in privately-held organisations? | 17,2 | 21% | 0 |

Table G.1.: Experience of validation group participants

G.2. Validation of antifragile attributes

| Attribute | Rating | Variability | Abstains |
|---|--------|-------------|----------|
| Optionality | 6,9 | 32% | 0 |
| Mono-Monotonicity | 7 | 51% | 0 |
| Self-Organisation | 8,2 | 23% | 0 |
| Fail-Fast | 7,8 | 35% | 0 |
| Resources to Invest | 6,7 | 36% | 1 |
| Seneca's Barbell | 5,8 | 37% | 1 |
| Safe working environment | 7,4 | 31% | 0 |
| Naar buiten kijken, samenwerking zoeken | 6,2 | 55% | 0 |
| Data Governance planes (tbv infrastructure-as-code / Software Defined Anything) | 4,4 | 56% | 1 |

Table G.2.: Validation of antifragile attributes

G.2.1. Optionality

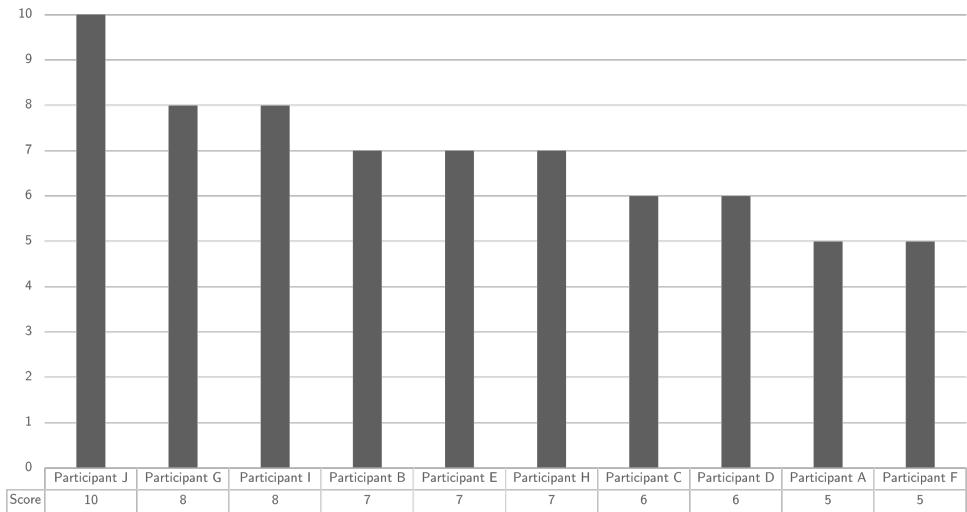


Figure G.1.: Scoring of antifragile attribute Optionality

| Attribute | Rating | Variability | Abstains |
|-------------|--------|-------------|----------|
| Optionality | 6,9 | 32% | 0 |

Table G.3.: Scoring of antifragile attribute Optionality

G.2.2. Mono-Monotonicity

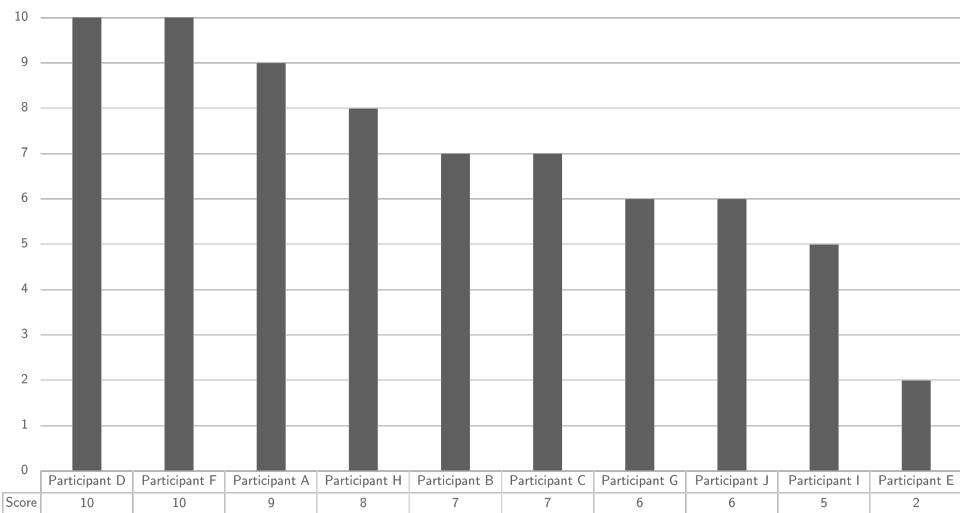


Figure G.2.: Scoring of antifragile attribute Mono-Monotonicity

| Attribute | Rating | Variability | Abstains |
|-------------------|--------|-------------|----------|
| Mono-Monotonicity | 7 | 51% | 0 |

Table G.4.: Scoring of antifragile attribute Mono-Monotonicity

G.2.3. Self-Organisation

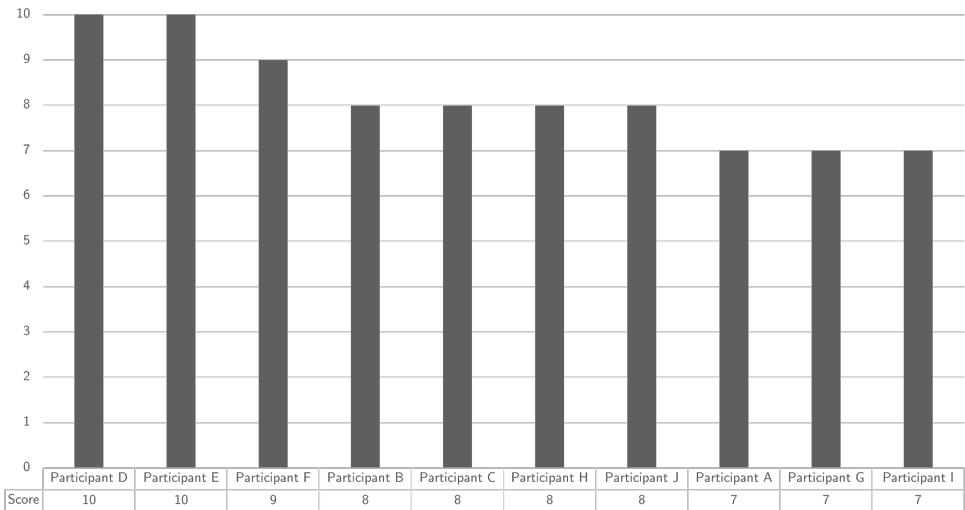


Figure G.3.: Scoring of antifragile attribute Self-Organisation

| Attribute | Rating | Variability | Abstains |
|-------------------|--------|-------------|----------|
| Self-Organisation | 8,2 | 23% | 0 |

Table G.5.: Scoring of antifragile attribute Self-Organisation

G.2.4. Fail-Fast

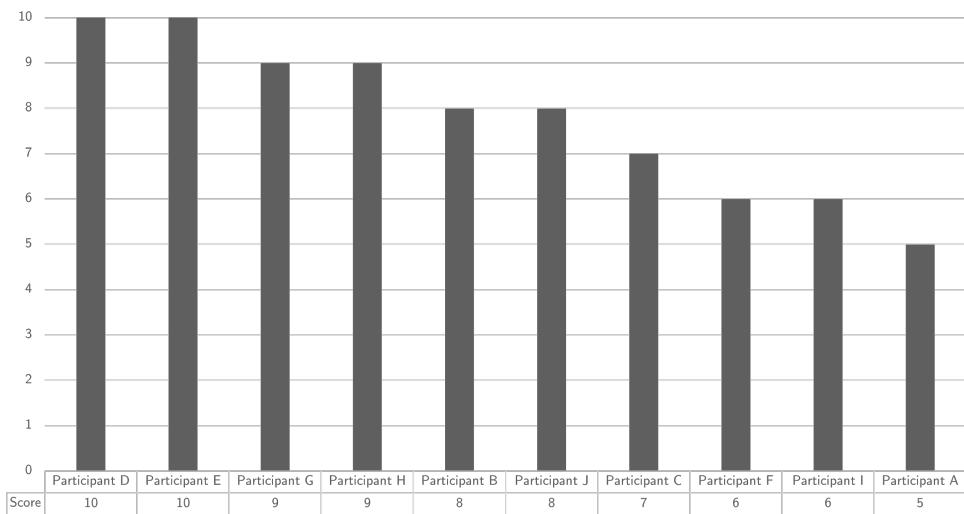


Figure G.4.: Scoring of antifragile attribute Fail-Fast

| Attribute | Rating | Variability | Abstains |
|-----------|--------|-------------|----------|
| Fail-Fast | 7,8 | 35% | 0 |

Table G.6.: Scoring of antifragile attribute Fail-Fast

G.2.5. Resources to invest

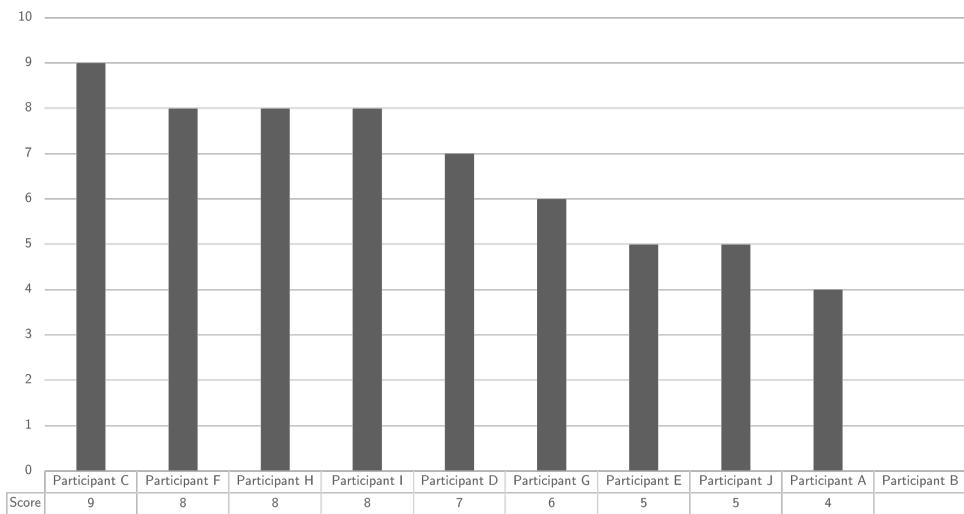


Figure G.5.: Scoring of antifragile attribute Resources to Invest

| Attribute | Rating | Variability | Abstains |
|---------------------|--------|-------------|----------|
| Resources to Invest | 6,7 | 36% | 1 |

Table G.7.: Scoring of antifragile attribute Resources to Invest

G.2.6. Senenca's Barbell

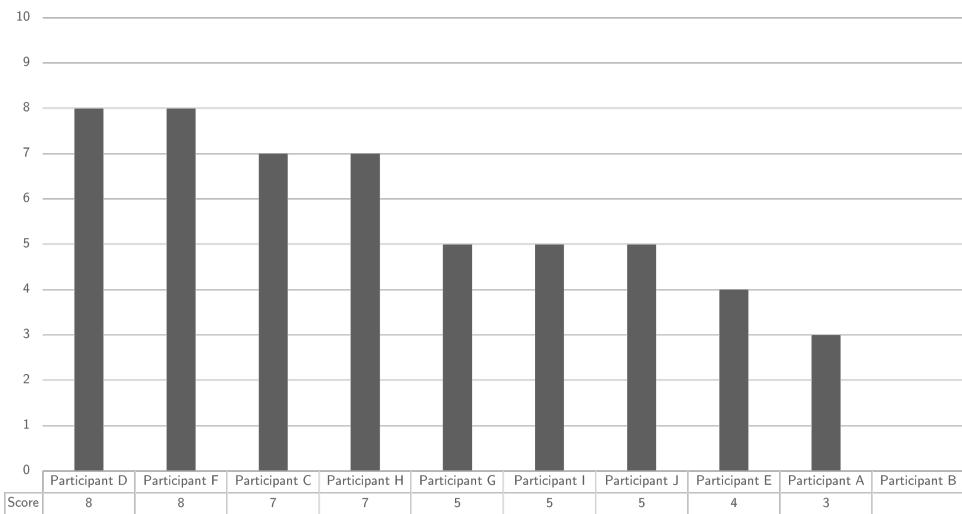


Figure G.6.: Scoring of antifragile attribute Seneca's Barbell

| Attribute | Rating | Variability | Abstains |
|------------------|--------|-------------|----------|
| Seneca's Barbell | 5,8 | 37% | 1 |

Table G.8.: Scoring of antifragile attribute Seneca's Barbell

G.2.7. Safe working environment

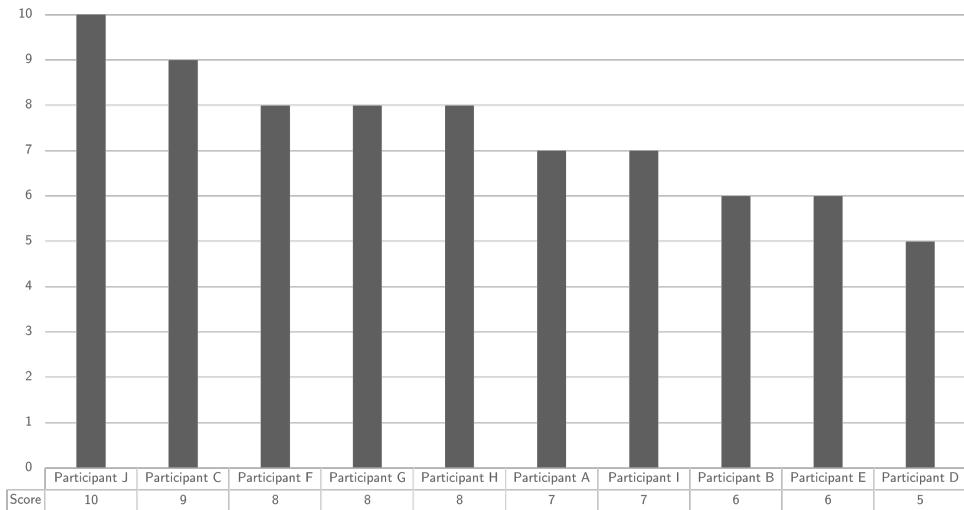


Figure G.7.: Scoring of antifragile attribute Safe working environment

| Attribute | Rating | Variability | Abstains |
|--------------------------|--------|-------------|----------|
| Safe working environment | 7,4 | 31% | 0 |

Table G.9.: Scoring of antifragile attribute Safe working environment

G.2.8. Naar buiten kijken, samenwerking zoeken

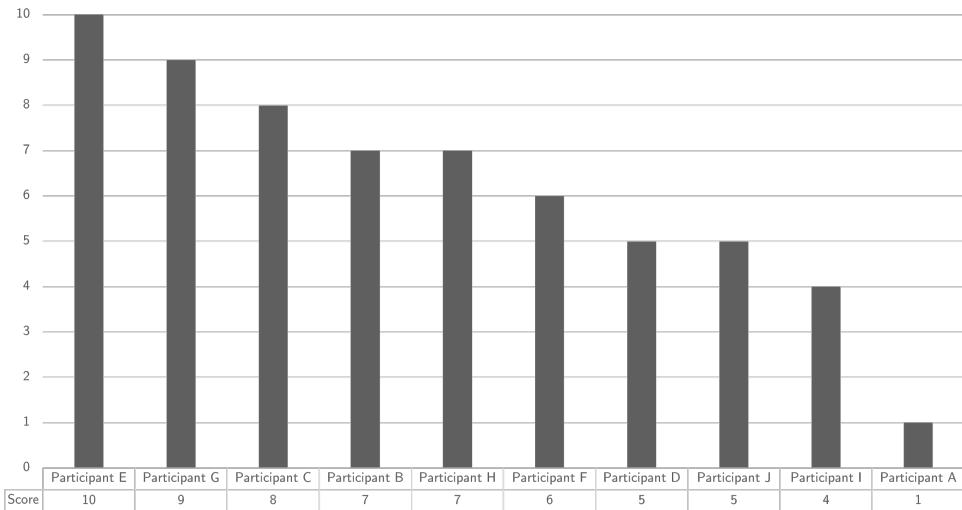


Figure G.8.: Scoring of antifragile attribute Naar buiten kijken

| Attribute | Rating | Variability | Abstains |
|---|--------|-------------|----------|
| Naar buiten kijken, samenwerking zoeken | 6,2 | 55% | 0 |

Table G.10.: Scoring of antifragile attribute Naar buiten

G.2.9. Data Governance Planes

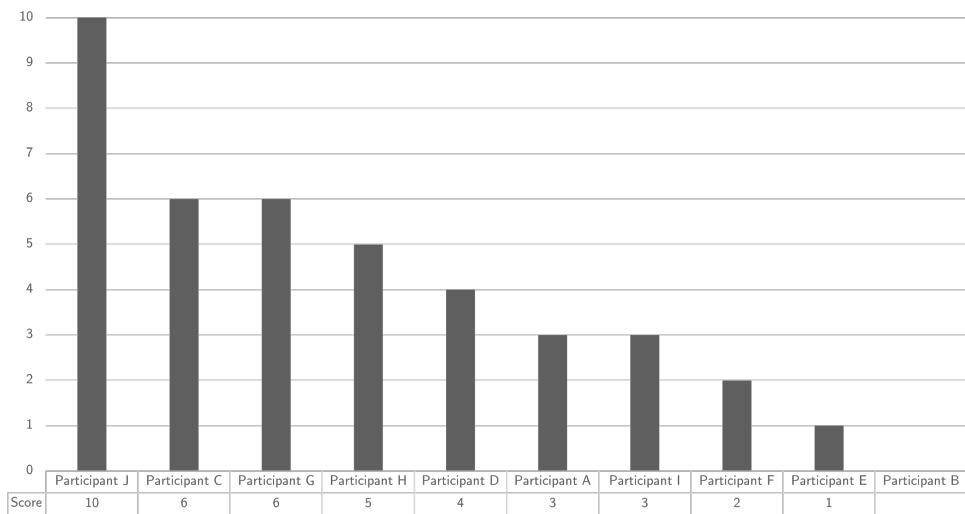


Figure G.9.: Scoring of antifragile attribute Data Governance Planes

| Rating | Variability | Abstains |
|--------|-------------|----------|
| 4,4 | 56% | 1 |

Table G.11.: Scoring of antifragile attribute Data Governance Planes

G.3. Validation of Enterprise Architecture schools of thought

| School | Rating | Variability | Abstains |
|----------------------------------|--------|-------------|----------|
| Enterprise IT Architecting | 5,6 | 34% | 0 |
| Enterprise Integrating | 7,2 | 16% | 0 |
| Enterprise Ecological Adaptation | 8,8 | 27% | 0 |

Table G.12.: Validation of Enterprise Architecture schools of thought

G.3.1. Enterprise IT Architecting

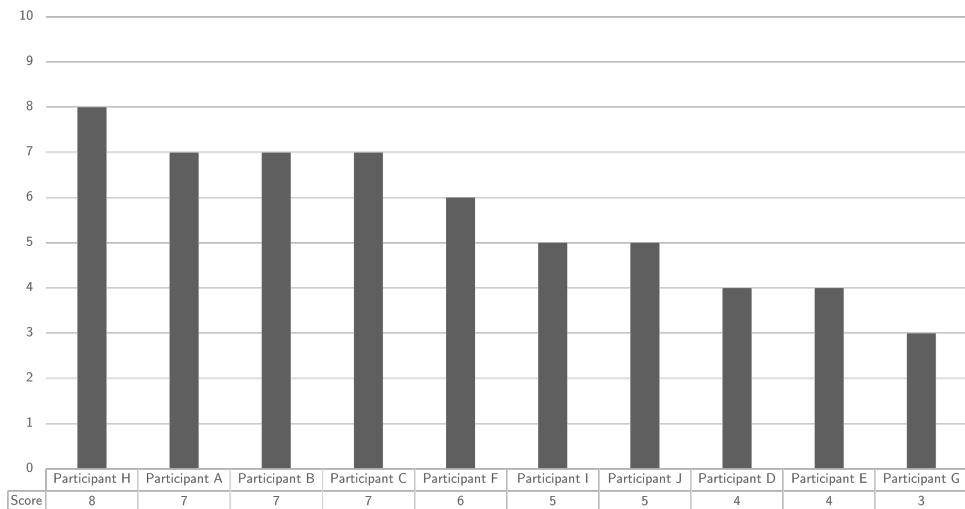


Figure G.10.: Scoring of school of thought Enterprise IT Architecting

| Attribute | Rating | Variability | Abstains |
|----------------------------|--------|-------------|----------|
| Enterprise IT Architecting | 5,6 | 34% | 0 |

Table G.13.: Scoring of school of thought Enterprise IT Architecting

G.3.2. Enterprise Integrating

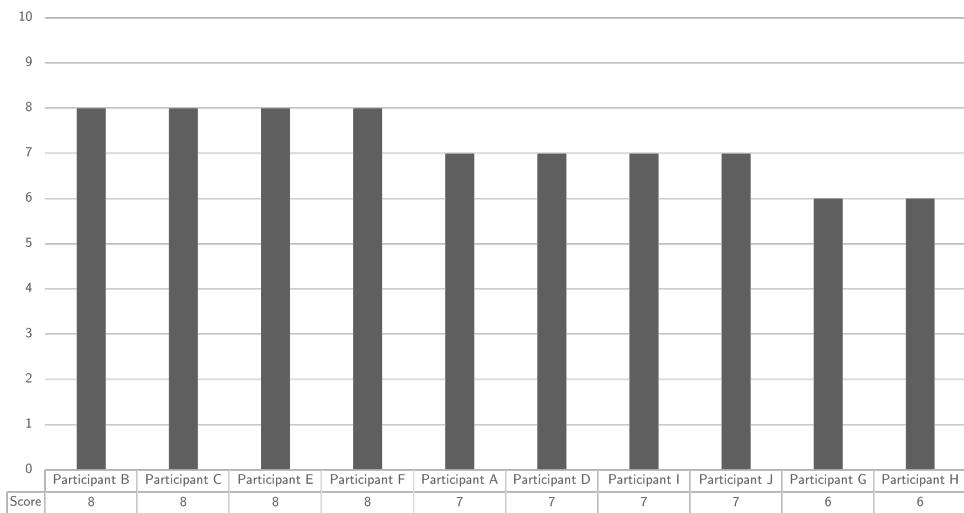


Figure G.11.: Scoring of school of thought Enterprise Integrating

| Attribute | Rating | Variability | Abstains |
|------------------------|--------|-------------|----------|
| Enterprise Integrating | 7,2 | 16% | 0 |

Table G.14.: Scoring of school of thought Enterprise Integrating

G.3.3. Enterprise Ecological Adaptation

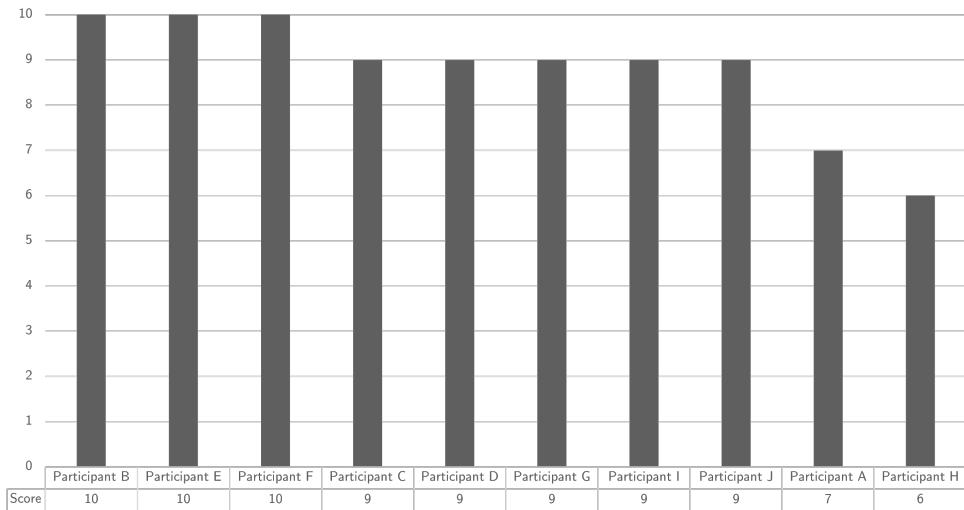


Figure G.12.: Scoring of school of thought Enterprise Ecological Adaptation

| Attribute | Rating | Variability | Abstains |
|----------------------------------|--------|-------------|----------|
| Enterprise Ecological Adaptation | 8,8 | 27% | 0 |

Table G.15.: Scoring of school of thought Enterprise Ecological Adaptation

G.4. Validation of Enterprise Architecture attributes

| Attribute | Rating | Variability | Abstains |
|--|--------|-------------|----------|
| Systems-in-environment thinking | 7,7 | 28% | 0 |
| Holist (systemic) stance | 7 | 47% | 0 |
| Organisational learning | 7,3 | 44% | 0 |
| Environmental learning | 7,7 | 29% | 0 |
| Intra-organisational coherency | 6,4 | 31% | 0 |
| System-in-environment coevolution learning | 6,6 | 36% | 0 |
| Adapt to business language | 7,1 | 35% | 0 |
| Agile Enterprise | 6,4 | 50% | 0 |
| Real Time Trust (Policy & Attribute based) | 5,6 | 54% | 1 |
| Foster Dialogue | 6,9 | 32% | 0 |
| Validation | 7,4 | 24% | 0 |
| Altijd goed architectuur | 5,8 | 46% | 1 |

Table G.16.: Validation of Enterprise Architecture attributes

G.4.1. Systems-in-Environment thinking

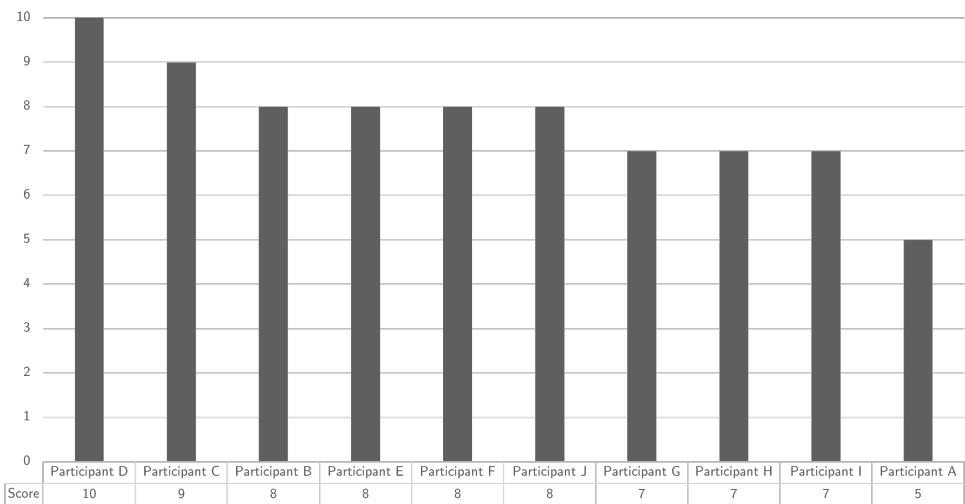


Figure G.13.: Scoring of EA attribute Systems-in-Environment thinking

| Attribute | Rating | Variability | Abstains |
|---------------------------------|--------|-------------|----------|
| Systems-in-environment thinking | 7,7 | 28% | 0 |

Table G.17.: Scoring of EA attribute Systems-in-Environment thinking

G.4.2. Holistic (systemic) stance

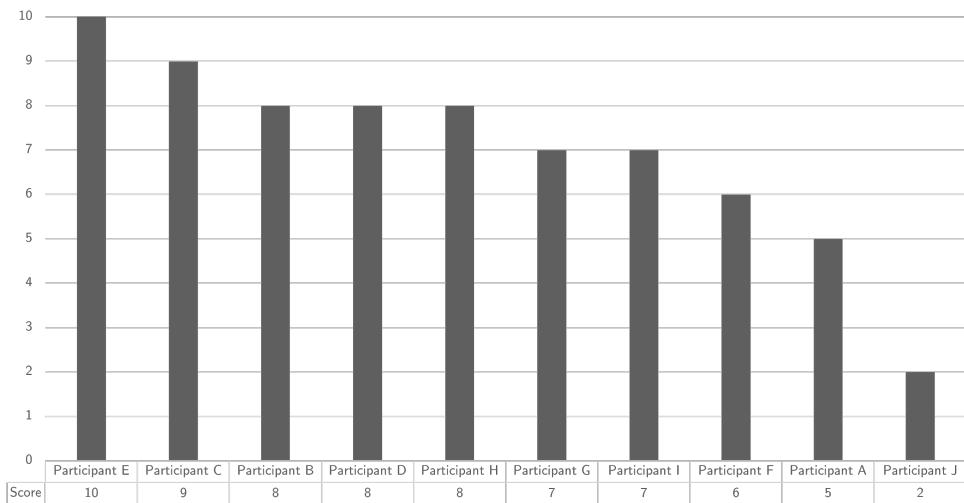


Figure G.14.: Scoring of EA attribute Holistic (systemic) stance

| Attribute | Rating | Variability | Abstains |
|--------------------------|--------|-------------|----------|
| Holist (systemic) stance | 7 | 47% | 0 |

Table G.18.: Scoring of EA attribute Holistic (systemic) stance

G.4.3. Organisational learning

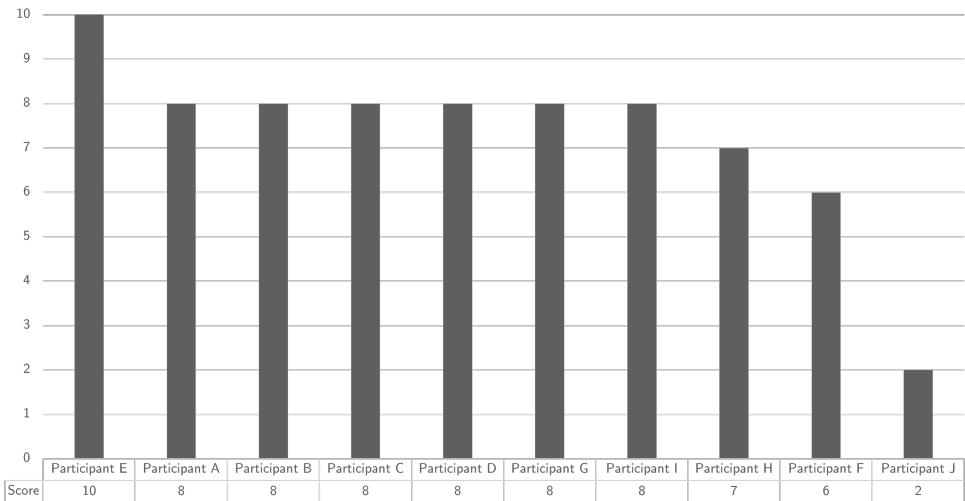


Figure G.15.: Scoring of EA attribute Organisational learning

| Attribute | Rating | Variability | Abstains |
|-------------------------|--------|-------------|----------|
| Organisational learning | 7,3 | 44% | 0 |

Table G.19.: Scoring of EA attribute Organisational learning

G.4.4. Environmental learning

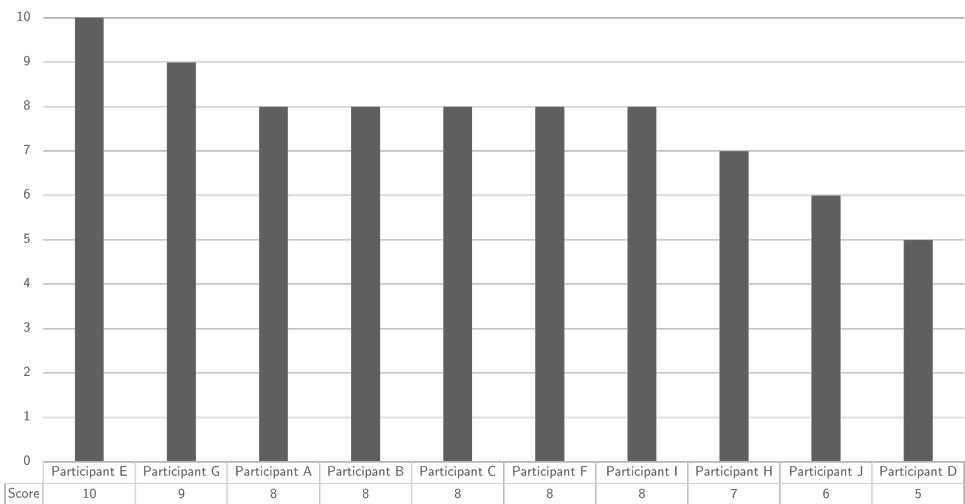


Figure G.16.: Scoring of EA attribute Environmental learning

| Attribute | Rating | Variability | Abstains |
|------------------------|--------|-------------|----------|
| Environmental learning | 7,7 | 29% | 0 |

Table G.20.: Scoring of EA attribute Environmental learning

G.4.5. Intra-organisational coherency

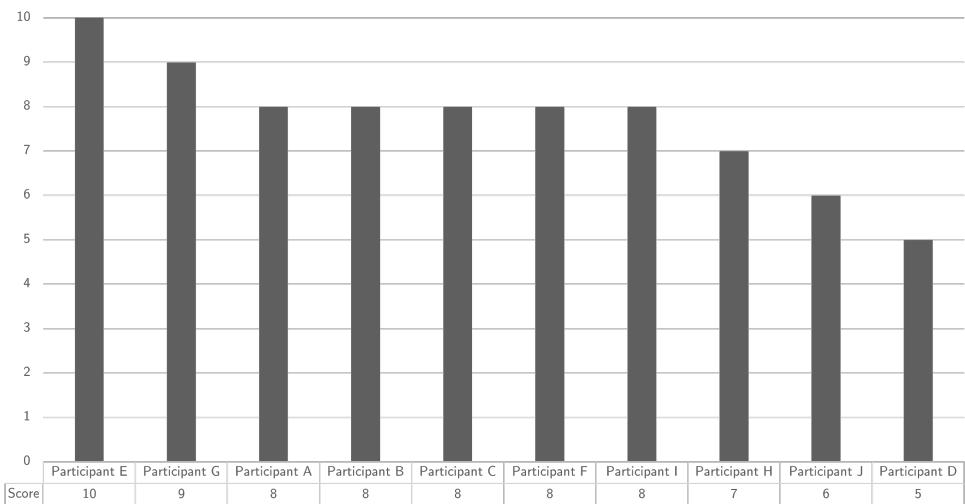


Figure G.17.: Scoring of EA attribute Intra-Organisational coherency

| Attribute | Rating | Variability | Abstains |
|--------------------------------|--------|-------------|----------|
| Intra-organisational coherency | 6,4 | 31% | 0 |

Table G.21.: Scoring of EA attribute Intra-Organisational coherency

G.4.6. System-in-Environment Co-Evolution learning

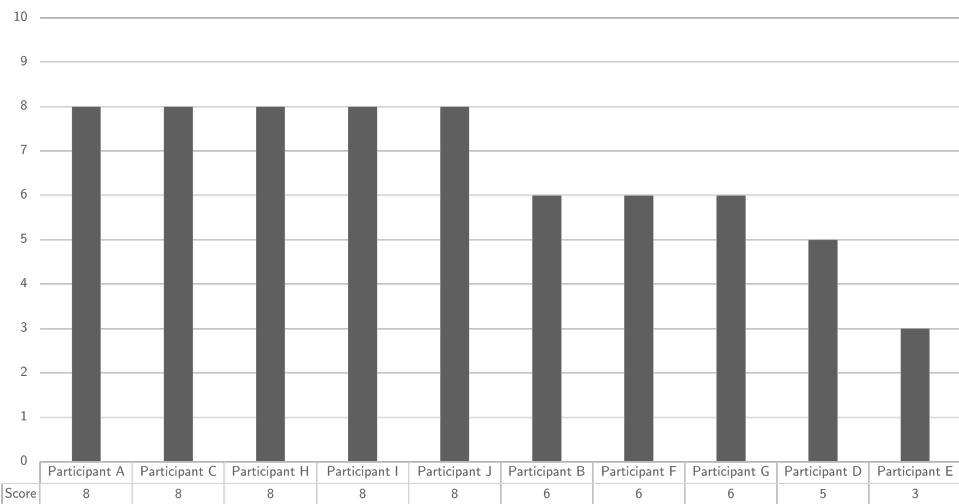


Figure G.18.: Scoring of EA attribute System-in-Environment Co-Evolution learning

| Attribute | Rating | Variability | Abstains |
|--|--------|-------------|----------|
| System-in-environment coevolution learning | 6,6 | 36% | 0 |

Table G.22.: Scoring of EA attribute System-in-Environment Co-Evolution learning

G.4.7. Adapt to business language

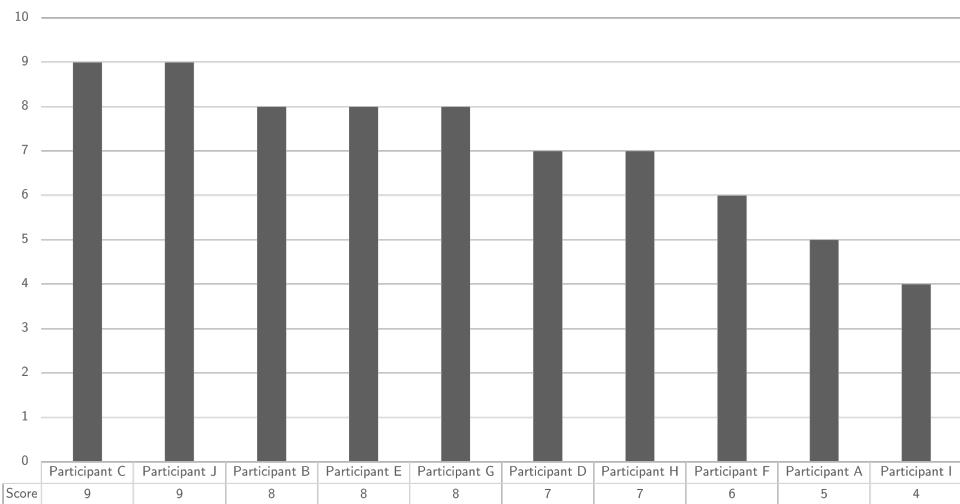


Figure G.19.: Scoring of EA attribute adapt to business language

| Attribute | Rating | Variability | Abstains |
|----------------------------|--------|-------------|----------|
| Adapt to business language | 7,1 | 35% | 0 |

Table G.23.: Scoring of EA attribute adapt to business language

G.4.8. Agile Enterprise

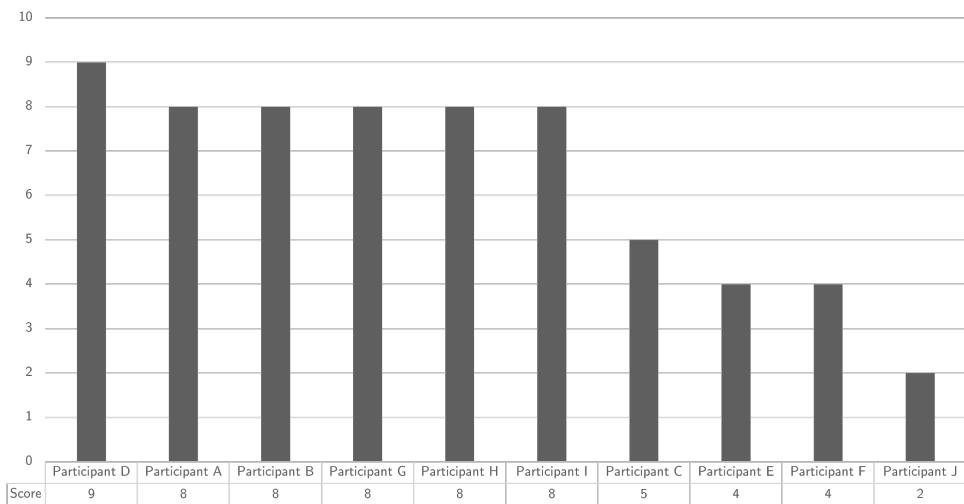


Figure G.20.: Scoring of EA attribute Agile Enterprise

| Attribute | Rating | Variability | Abstains |
|------------------|--------|-------------|----------|
| Agile Enterprise | 6,4 | 50% | 0 |

Table G.24.: Scoring of EA attribute Agile Enterprise

G.4.9. Real Time Trust

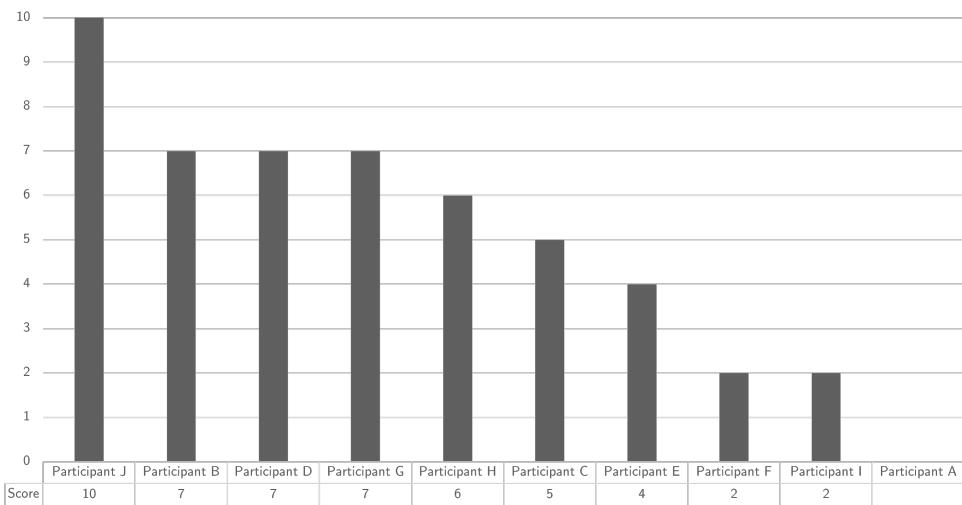


Figure G.21.: Scoring of EA attribute Real Time Trust

| Attribute | Rating | Variability | Abstains |
|--|--------|-------------|----------|
| Real Time Trust (Policy & Attribute based) | 5,6 | 54% | 1 |

Table G.25.: Scoring of EA attribute Real Time Trust

G.4.10. Foster Dialogue

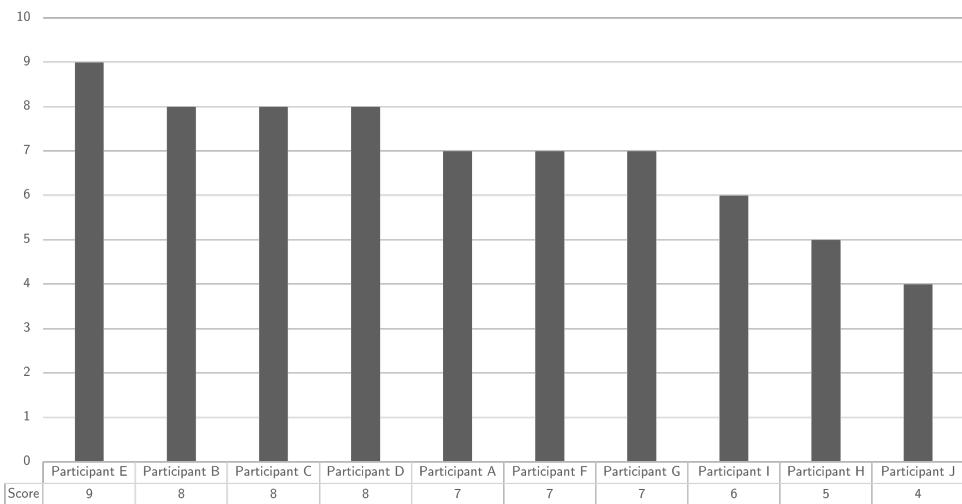


Figure G.22.: Scoring of EA attribute Foster Dialogue

| Attribute | Rating | Variability | Abstains |
|-----------------|--------|-------------|----------|
| Foster Dialogue | 6,9 | 32% | 0 |

Table G.26.: Scoring of EA attribute Foster Dialogue

G.4.11. Validation

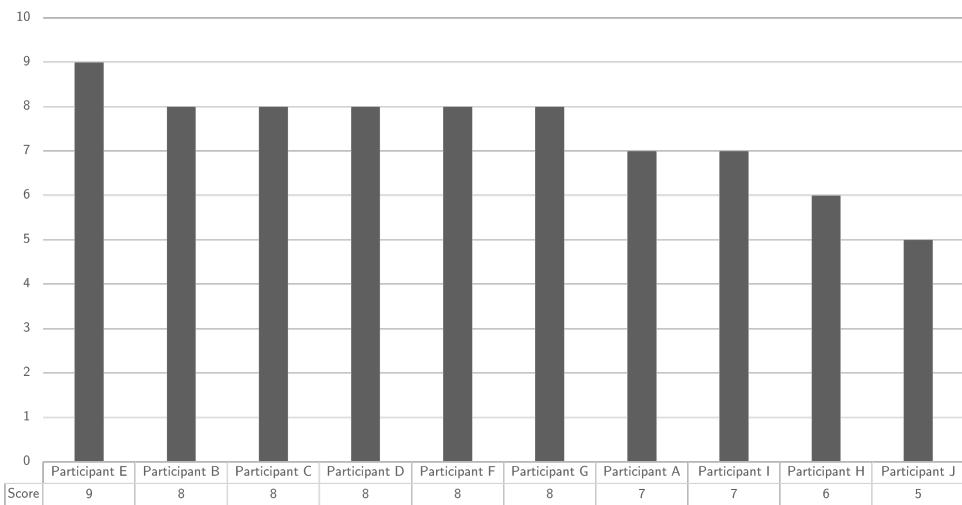


Figure G.23.: Scoring of EA attribute Validation

| Attribute | Rating | Variability | Abstains |
|------------|--------|-------------|----------|
| Validation | 7,4 | 24% | 0 |

Table G.27.: Scoring of EA attribute Validation

G.4.12. Always fitting Enterprise Architecture

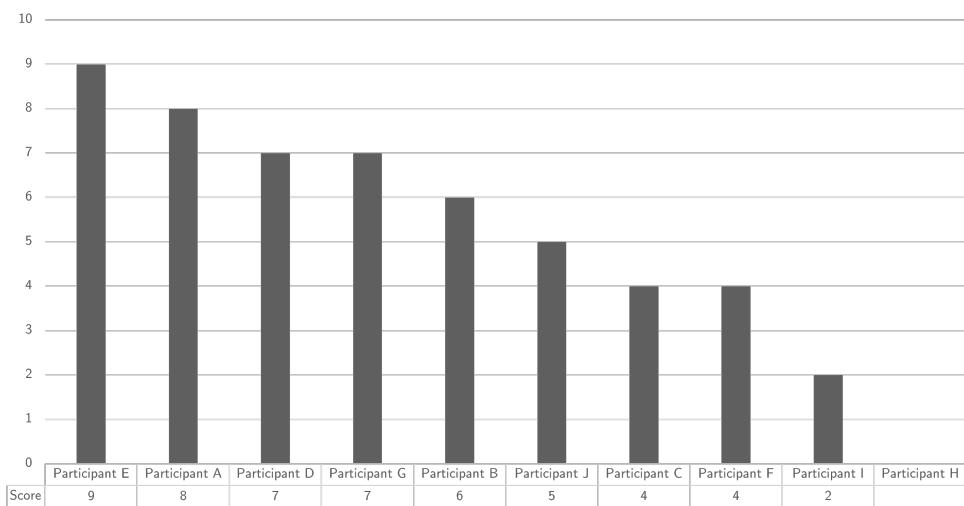


Figure G.24.: Scoring of EA attribute Always fitting EA

| Attribute | Rating | Variability | Abstains |
|-------------------|--------|-------------|----------|
| Always fitting EA | 5,8 | 46% | 1 |

Table G.28.: Scoring of EA attribute Always fitting EA

G.5. Closing Survey

| Question | Rating | Variability | Abstains |
|---|--------|-------------|----------|
| To what extent do you find the research relevant? | 8,2 | 23% | 0 |
| To what extent did this session fulfil your expectations? | 8 | 24% | 0 |
| To what extent do you think that the research can be used by yourself? | 7,7 | 10% | 0 |
| To what extent do you think that the research can be used in the public sector? | 7,2 | 32% | 1 |
| To what extent do you think that the research can be used by your organisation? | 6,6 | 33% | 0 |

Table G.29.: Closing Survey

G.6. Follow-Up Survey

| Question | Rating | Variability | Abstains |
|--|--------|-------------|----------|
| I want to receive possible updates on this research. | 9 | 0% | 1 |
| I want to know when the thesis is published. | 9 | 0% | 1 |

Table G.30.: Follow-up Survey

H. Research Log

| Date | What |
|----------|---|
| 24/11/21 | Initial research subject proposal to AMS. |
| 25/11/21 | Initial research subject proposal sent to Hans Mulder & Yuri Bobbert. |
| 30/11/21 | First meeting with Hans Mulder to explore the subject. |
| 12/02/21 | AMS Master Project Coaching. |
| 10/03/21 | Second meeting with Hans Mulder. Definitive Area of Research selected. The success factors of EA for Business Agility/Resilience/antifragility. |
| 11/03/21 | Elaborated with COO Centric Public Sector Solutions on antifragility. |
| 14/03/21 | Started research on the concept of antifragility. |
| 03/04/21 | One Pager on the concepts Enterprise Architecture, Public Sector, Independant 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, Dieneke Schouten, and Maarten Hillenaar. Promotor suggestion Roland Ettema, Martin Op 't Land, Bas van Gils or Hans Mulder. Sugested Hans Mulder as promotor with Edzo Botjes as co-promotor. |
| 21/06/21 | Requested Maarten Hillenaar as Sponsor, Dieneke 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, bibLATEXcitation 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 Xtemplate 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. |
