

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
Antwerp, Belgium
25th 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

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. Author	1
1.2. Structure	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. Research subject	4
1.8. Research question	5
1.9. Research relevance	5
2. Background	8
2.1. System	8
2.1.1. System-of-Systems and System-in-Environment	9
2.1.2. Ecosystem	9
2.2. Antifragile	10
2.2.1. Antifragile and Resilience	13
2.2.2. Antifragility vs Agility	14
2.2.3. Attenuate variety vs Amplified variety	14
2.2.4. Literature on antifragile after 2020	14
2.3. Public sector	15
2.3.1. Public accountability	15
2.3.2. Collaboration between public and private sector	16
2.3.3. Differences with the Private Sector Market	17
2.3.4. The public sector as a System of Systems	18
2.4. Enterprise Architecture	18
2.4.1. Approaches of Enterprise Architecture	19
3. Methodology	21
3.1. Research Model	21

3.2.	Research approach	22
3.2.1.	Literature study	22
3.2.2.	Interviews	25
3.2.3.	Expert Group	25
3.2.4.	Analysis	26
3.2.5.	Conclusion and discussions	26
3.3.	Research methods	26
3.3.1.	Quantitive methods	27
3.3.2.	Qualitative methods	27
3.3.3.	Mixed-methods	28
3.3.4.	Design Science research	28
3.3.5.	Applied research method	28
3.4.	Research quality	29
3.4.1.	Quality attributes	29
3.4.2.	FAIR Guiding Principles	30
3.4.3.	Open Science Framework	31
3.4.4.	Triangulation	32
3.5.	Research infrastructure and tooling	33
3.5.1.	Research execution	33
3.5.2.	Research administration	34
3.5.3.	Thesis creation	35
3.5.4.	Summary of used infrastructure and tooling	35
4.	Attributes	37
4.1.	Attributes of antifragile	37
4.1.1.	Antifragile attributes	39
4.2.	Attributes of Enterprise Architecture	40
5.	Interviews	42
5.1.	Interview results	43
5.1.1.	Interview results on attenuate variety	44
5.1.2.	Interview results on amplify variety	45
5.1.3.	Interview results on learning organisation	46
5.1.4.	Interview results on Enterprise Architecture schools of thought	47
5.1.5.	Interview results on possible new attributes	48
5.2.	Qualitative Data Analysis	49
5.3.	Results of Qualitative Data Analysis	50
5.4.	Attributes most likely to be a success factor	51
6.	Expert group	53
6.1.	Validation of attributes	54
6.1.1.	Validation of antifragile attributes	55
6.1.2.	Validation of Enterprise Architecture schools of thought	55
6.1.3.	Validation of Enterprise Architecture attributes	56

6.2. Relevance of the research	56
7. Analysis	58
7.1. Identified success factors	59
7.2. Scoring of Success Factors	60
7.3. Possible success factors	60
8. Conclusion and discussions	64
8.1. Conclusion	64
8.2. Discussions	65
8.2.1. Is the public sector in The Netherlands unique?	65
8.2.2. Is the public sector different than the private sector?	65
8.2.3. Size of Expert Group	65
8.2.4. The composition of the Expert Group	65
8.2.5. Causal Loop Diagram	65
8.3. Recommendations	65
9. Retrospective	66
9.1. Quality of Research	66
9.2. Process of Research	66
9.3. Researcher	66
References	67
List of Figures	73
List of Tables	75
Glossary of Terms	76
Abbreviations	85
Appendix A. Properties of the Enterprise Architecture schools of thought	88
A.1. The properties of Enterprise IT Architecting	88
A.2. The properties of Enterprise Integrating	89
A.3. The properties of Enterprise Ecological Adaptation	90
Appendix B. Authors of the Enterprise Architecture schools of thought	91
Appendix C. Conceptmap of interview questions mapped to attributes	92
Appendix D. Literature catch-up	94
Appendix E. Interview summaries	97
E.1. Interview central government	97
E.2. Interview local government	98

E.3. Interview Independent Software Vendor	101
E.4. Interview with consultancy firm/service provider	105
Appendix F. Interview findings	108
F.1. Interview results Engineering Resilience attributes	108
F.2. Interview results Systems Resilience attributes	108
F.3. Interview results Complex Adaptive Systems Resilience attributes	109
F.4. Interview results Antifragile attributes	109
F.5. Interview results learning organisation attributes	110
F.6. Interview results Enterprise Architecture schools of thought	110
F.7. Interview results new attributes	111
Appendix G. Validation findings	112
G.1. Validation of antifragile attributes	112
G.1.1. Validation of optionality	113
G.1.2. Validation of non-monotonicity	114
G.1.3. Self-Organisation	115
G.1.4. Fail-Fast	116
G.1.5. Resources to invest	117
G.1.6. Senenca's Barbell	118
G.1.7. Safe working environment	119
G.1.8. Naar buiten kijken, samenwerking zoeken	120
G.1.9. Data Governance Planes	121
G.2. Validation of Enterprise Architecture schools of thought	122
G.2.1. Enterprise IT Architecting	122
G.2.2. Enterprise Integrating	123
G.2.3. Enterprise Ecological Adaptation	124
G.3. Validation of Enterprise Architecture attributes	125
G.3.1. Systems-in-Environment thinking	126
G.3.2. Holistic (systemic) stance	127
G.3.3. Organisational learning	128
G.3.4. Environmental learning	129
G.3.5. Intra-organisational coherency	130
G.3.6. System-in-Environment Co-Evolution learning	131
G.3.7. Adapt to business language	132
G.3.8. Agile Enterprise	133
G.3.9. Real Time Trust	134
G.3.10. Foster Dialogue	135
G.3.11. Validation	136
G.3.12. Always fitting Enterprise Architecture	137
G.4. Closing Survey	137
G.5. Follow-Up Survey	137

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 change²[\[https://plato.stanford.edu/entries/process-philosophy/\]](https://plato.stanford.edu/entries/process-philosophy/). 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 (2016) 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 (2021) claims that by being more robust, or resilient, the company can only withstand the change but does not gain from it.

Taleb (2021) defines the opposite state of fragile, antifragile as an answer to what Taleb (2016) calls Black Swan events. According to Taleb (2021) resilient, robust (and company) are states that neither breaks nor improves. Taleb (2021) 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. 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

² [

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 public 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. Structure

In chapter 1, the context of the research is set, the core concepts of EA and antifragility are introduced together with the the public sector. The chapter states the problem statement, the research questions, and the substantiation of the relevance of the research. In chapter 2, the background on the concepts is given. The lens of the public sector is defined. chapter 3 explains the used research methodology and the approach for the research. chapter 4 describes the found attributes from the literature that can be success factors. chapter 4 ends with an overview of found attributes of EA and antifragile that could contribute to the public sector to become antifragile. 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 literature study, interviews and expert group together for 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. To support the reader of this thesis with mutual understanding on definitions this thesis contains a glossary of terms.

1.3. Introduction of the public sector

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

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

- **The regional government**, such as the provinces, the police, and water management.
- **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 (2016) 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 (2016) 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 (2021) 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, 2021). It does not lose, but it gains. Taleb (2021) 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. 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?

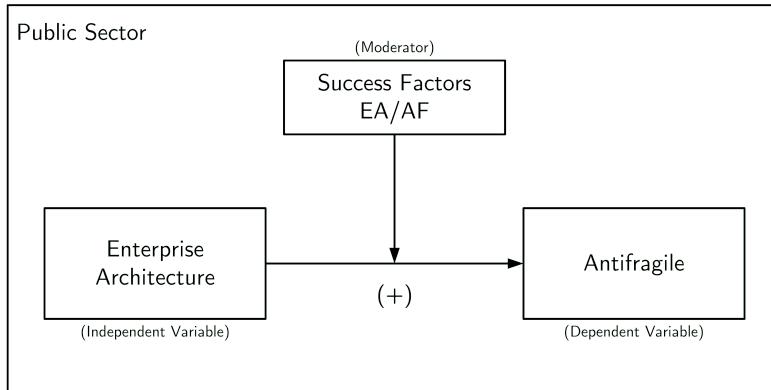


Figure 1.2.: Conceptual Research Model

1.8. Research question

figure 1.2 shows the conceptual research model. The conceptual research model describes the hypothesises 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 the literature saying about the public sector?
2. What is the literature saying about antifragile?
3. What are the possible success factors of antifragile?
4. What is the 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 2021. 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.

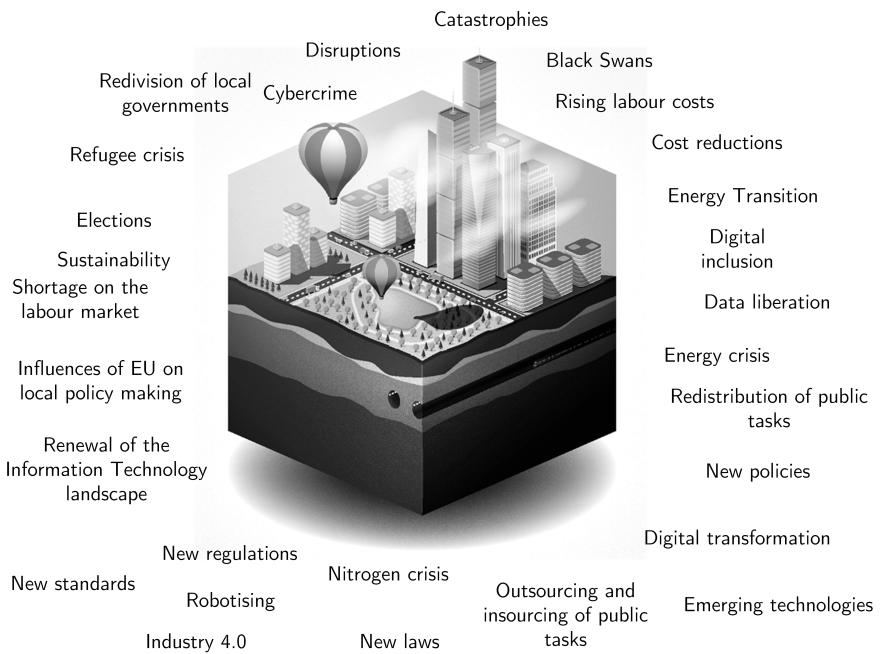


Figure 1.3.: Examples of stressors on the public sector

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. 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

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

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 public responsibility, to share the outcome with the public sector for further study and use.

¹ https://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 von Bertalanffy (1968, p. 32) calls an open system. An open system is a system that exchanges matter with its environment (von Bertalanffy, 1968, p. 32), as where a closed system is considered to be isolated from its environment (von Bertalanffy, 1968, p. 39).

Ackoff et al. (1964, p. 51–69) criticised von 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 (1993, 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 (1993, 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 van den 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 (1993). 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

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.

As Taleb (2021, p. 54) points out "Stress is knowledge (and knowledge is stress)."

O'Reilly (2019, p. 886) mentions that it is important to realise that the degree of fragility of a system is often a function of its internal structure. O'Reilly (2019, p. 886) states that 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 a system.

"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, 2006).
- **Ownership.** Result based and 'Skin in the game'.
- **Diversity of cells and organisational learning.**
- **DNA - Shared purpose, values and culture.**

"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, 2006).
- **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, 2006). The only real difference with Complex Adaptive System and antifragile of Taleb (2021) 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.

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.

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

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). 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.

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.

Accepting Complexity

2.2.1. Antifragile and Resilience

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).

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.

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.

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.

2.2.3. Attenuate variety vs Amplified variety

Botjes et al. (2021, p. 4) uses the concepts of attenuate variety and amplify variety. Botjes et al. (2021, p. 4) used the work of Ashby (1979) and Beer (1994) to define attenuate variety and amplify variety. Botjes et al. (2021, p. 4) explains that attenuate variety is reducing the variety in a system and that the absorption of change in the context of systems reduces variety. On the other hand Botjes et al. (2021, p. 4) explains amplify variety is increasing the variety in a system and that amplify internal variety is about increasing the chance of a higher entropy and therefore being more capable to absorb increasing external variety caused by change.

The more amplified variety a SoS has the more antifragile the SoS is (**NEEDS REF**).

2.2.4. Literature on antifragile after 2020

Before selecting possible attributes a new search for literature was conducted with the terms as defined in section 3.2.1 for the concepts antifragile and EA. The search was conducted in a specific time frame. The time frame was set from 2020 to March 2022. This time frame was chosen to only search for literature that is released after the research period of Botjes (2020). Thirty-one new articles, books and in-proceedings were found that could be of interest. For more information see Appendix D. Of those thirty-three new sources, three were already in the current set of literature, eight were not found or were not publicly available, thirteen were not relevant. Seven possible new sources were selected. From those seven some were not relevant or just partially.

From the seven that were left the following literature is selected for further study:

Title	Author	Year
blah	blah	2020

Table 2.1.: Literature of interest (2020–March 2022)

2.3. Public sector

2.3.1. Public accountability

Public accountability is a form of accountability that relates specifically to the public sector. Public accountability as such should be distinguished from public responsibilities, which involves a substantive discussion about tasks, obligations and liabilities in the public sector.

Elements:

Accountability relates to the expenditure of public funds Accountability relates to the exercise of public duties and powers Accountability is placed in the perspective of the public good

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.

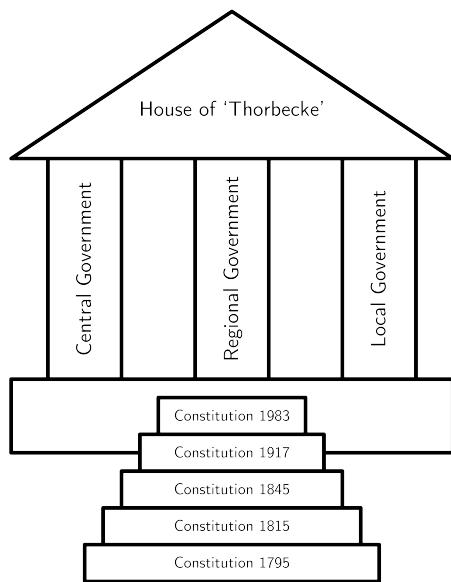


Figure 2.1.: The House of 'Thorbecke'

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

2.3.2. Collaboration between public and private sector

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

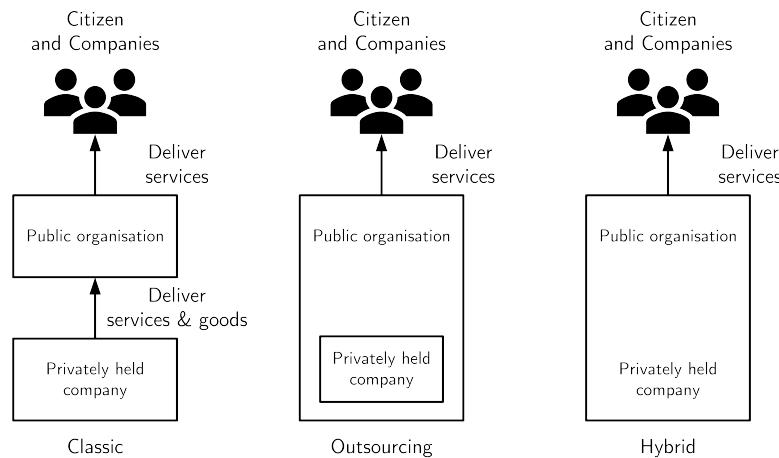


Figure 2.2.: Public sector collaboration models

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

Themes relevant for the government for 2021 until 2025 (i-Strategy) (Digitaleoverheid, 2021).

1. I in het hart
2. Digitale weerbaarheid
3. ICT-landschap
4. Generieke voorzieningen
5. Informatiehuishouding
6. Data en Algoritmen
7. I-vakmanschap
8. Transparantie en inzicht
9. I-besturing
10. Markt en innovatie

2.3.3. 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.

2.3.4. The public sector as a System of Systems

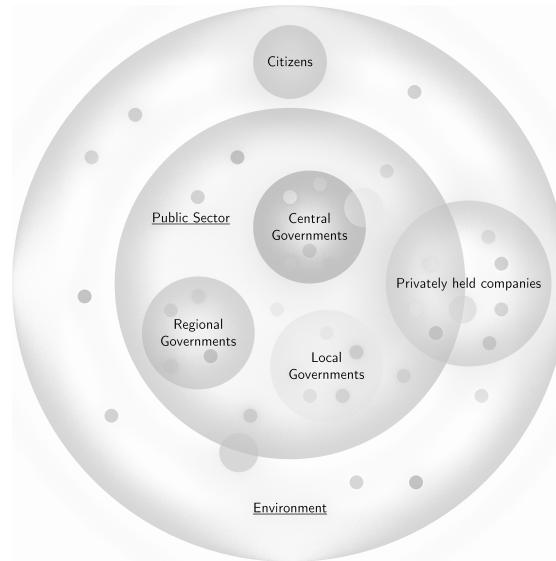


Figure 2.3.: Public Sector as a System-of-Systems

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; 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 2.3.4, 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 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

This chapter contains the overarching research strategy and defines the methods used in the research.

3.1. Research Model

This section describes the research steps. The detailed information on how these steps are operationalised are part of, section 3.2. figure 3.1 gives an overview on the steps that are taken to answer the main research question, section 1.8.

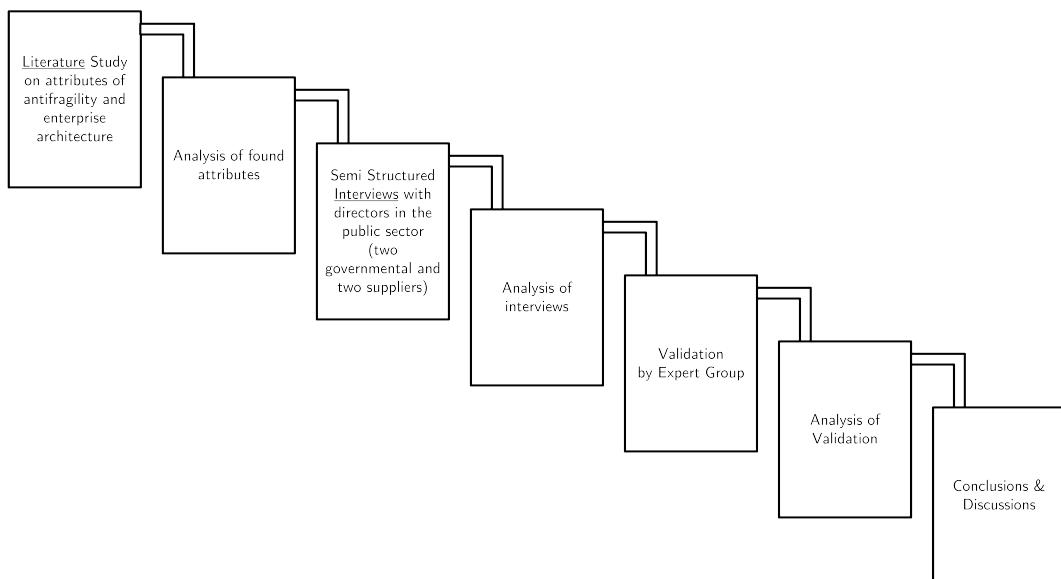


Figure 3.1.: Research Model

To answer the sub-questions and the main research question literature research has a central part in the approach. The research starts with a literature study on the concepts of systems, the public sector, antifragile, and Enterprise Architecture (EA). The goal of this step is to define the concepts and search for attributes that can possibly be a success factor. The output will be analysed and possible success factors are determined. The outcome of this analysis will be validated by interviews. The interviews are analysed to validate the possible success factors and possible new success factors. The outcome will be validated by an Expert Group. After the validation by the expert group the final

analysis will take place before conclusions are taken and a discussion on the outcome will take place.

3.2. Research approach

This section elaborates on the detailed approach of the research.

3.2.1. Literature study

The literature study will answer most of the sub-questions as stated in section 1.8. The questions "What is the literature saying about the public sector?", "What is the literature saying about antifragile?", "What are the possible success factors of antifragile?", "What is the literature saying about Enterprise Architecture?" and "What are possible success factors of Enterprise Architecture?" will be answered. The answers will be split up into two chapters. These chapters are chapter 2 and chapter 4. For the literature research, two primary methods are used. The first method is (forward and backwards) snowballing of already acquired and found literature. In the literature administration, it is easy to recognize snowballing by using the column *Found at*, see section 3.5.1. The second method is the use of online scientific libraries.

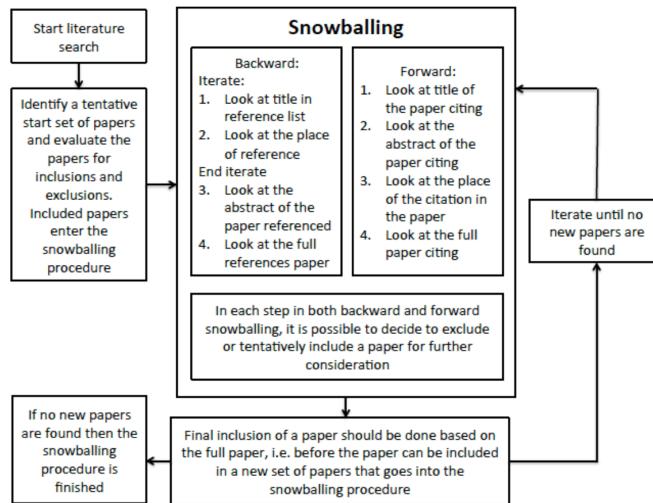


Figure 3.2.: Snowballing literature (Wohlin, 2014)

For finding relevant literature online scientific libraries are used. The online scientific libraries are Web of Science, Research Gate, Google Scholar, and Semantic Scholar. The full concept name is used and the known abbreviations of the concept (e.g. Enterprise Architecture and EA). Literature is only accepted if the literature complies with quality attributes. These attributes are accuracy, authority, objectivity, currency, and coverage¹.

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

All found literature is administrated for replicability, independence, precision, accessibility, and reusability. Section 3.5.1 describes how literature registration and administration is executed.

System

For the literature study on system two primary sources are used. The first is that of Ackoff (1973) with the title ‘Science in the Systems Age: Beyond IE, OR, and MS’ and the second is that of Gharajedaghi (2011) with the title of *Systems thinking: managing chaos and complexity a platform for designing business architecture*. Ackoff is one of the original researchers on the subject of systems while Gharajedaghi is and a follower of Ackoff and is one of the authors that is noticed by Lapalme (2012, p. 42) to be one of the authors following the EA school of thought of EEA, see table 3.3. The first method for literature study is snowballing. Snowballing of these sources is used to determine other important literature on the concept of system. 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.

system	System-of-Systems
System-in-Environment	ecosystem
antifragile system	Enterprise Architecture system

Table 3.1.: System keywords

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* from Taleb. Taleb is the progenitor of the antifragile theory. The second primary source is the book *The Black Swan: the impact of the highly improbable* from Taleb. *Antifragile: things that gain from disorder* is the answer to *The Black Swan: the impact of the highly improbable*. The third primary source is the master thesis ‘Defining Antifragility and the application on Organisation Design’ by Botjes. Botjes (2020) contains an extensive study of literature in the field of antifragile and the context of an organisation. By using the thesis of Botjes the literature study of this research can concentrate on the literature that was released after 2020. Botjes et al. published a paper on the same subject named ‘Attributes relevant to antifragile organizations’. This paper is the fourth primary resource. The last primary resource is that of the article ‘No More Snake Oil: Architecting Agility through Antifragility’ by O'Reilly (2019). Botjes (2020) did not use the articles of O'Reilly. The articles of O'Reilly were less of interest for the subject of Botjes. While for the current research O'Reilly (2019) has added value since it targets system architecture.

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
antifragile Enterprise Architecture	antifragile public sector
antifragile success factor	antifragile VUCA
antifragile system	

Table 3.2.: Antifragile keywords

Enterprise Architecture

As described earlier in the subsection ?? the definition of the Enterprise Architecture (EA) school of Enterprise Ecological Adaptation (EEA) is the school that most likely 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 3.3.: Enterprise Ecological Adaptation (EEA) authors (Lapalme, 2012, p. 42)

For the literature study two sources are in focus. Lapalme (2012) on the three schools of EA, Lapalme et al. (2016) on the future of EA, and Graves (2008) 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 Business Strategy
Enterprise Architecture ecosystem	Enterprise Architecture Business Strategy
Enterprise Architecture public sector	Enterprise Architecture System-in-Environment

Table 3.4.: Enterprise Architecture keywords

Public sector

The literature study on public sector makes use of two primary sources. 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. The second source that is used is Nurmi (2021). Nurmi (2021) is a dissertation thesis with the title ‘Enterprise Architecture in Public Sector Ecosystems: A systems perspective’. The concepts in the dissertation thesis of Nurmi uses some of the same concepts as this research. The only real differences are that it is not about antifragility and that the case is about the Finnish public sector. These articles are 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 3.5.: Public sector keywords

3.2.2. Interviews

The interviews are in the format of semi-structured. A minimal set of questions is used because of time constraints. The set of questions is created by combining multiple attributes into one question. A concept map is created to define which question will give a possible answer to what attribute. The concept map is appended to the thesis, see appendix C. Based on given answers, there will be further elaboration on the topic when there is a suspicion of extra information about EA and antifragile attributes. The interviews are recorded and transcribed. The transcriptions will be summarised and appended to this thesis, see appendix E. The transcriptions will be labeled with the earlier found attributes, section 3.2.1, so that analysis can take place in a numerical form. The labeling will be done with a positive and a negative label. E.g. *Antifragile* and *Not Antifragile*. If the attribute is mentioned with a question per interview, it will only be counted once for that question for that interview. When an attribute is at least mentioned in 75% of the interviews (cases) and the sum of the positive and negatives labels is equal or lower than 0 it could be a success factor. Newly found attributes are scored in the same way.

3.2.3. Expert Group

The Expert Group is used to validate the findings from the interviews. Because the interviews already validated the initially found attributes the Expert Group will validate these for a second time. These findings are a subset of the original set found in the literature. The Expert Group is carefully composed of EA specialists from the public

sector with a balance between the governments and privately-held companies, all part of the public sector or EA specialists with recent experience with the public sector. For the validation by the Expert Group, a meeting will be planned. All the known definitions and the agenda are shared with the Expert Group for preparation. The Group Support System Meeting Wizard supports this meeting. A presentation is used to bring the participants up to speed on the status of the research. Meeting Wizard will facilitate brainstorming for possible missed attributes, ordering the attributes and voting on the attributes. Meeting Wizard will also support surveys to determine the experience in EA and the public sector and the relevance of the research. The output from the Expert Group will be analysed in the same way and with the same rules as that of the interviews. Everything must be normalised and be transformed into numeric values. The outcome of the Expert Group Validation will also trigger a second round of labelling the interviews for the new findings.

3.2.4. Analysis

By combining the outcomes from the literature study, the interviews, and the Expert Group, a list of attributes is made with attributes that are most likely to be success factors. For the analysis, triangulation is used. It will be plausible for the research data set that the attribute is a success factor if it meets three requirements. The first requirement is that the attribute was found in the literature. The second requirement is that the attribute was confirmed with interviews. The last requirement is that the Expert Group agreed on the attribute as a possible success factor. This step in the research will answer the sub-question "Which success factors can positively influence the contribution of Enterprise Architecture in achieving antifragility in the public sector?"

3.2.5. Conclusion and discussions

This chapter will give a definitive answer to the research question "What are the success factors that positively influence the contribution of Enterprise Architecture in achieving antifragility in the public sector?" This chapter states the found and validated attributes as possible success factors for the data set that was used for the research. The chapter also contains a discussion on falsification and other findings.

3.3. Research methods

According to Recker (2013, p. 62), the most popular research methods are either exclusively quantitative or qualitative, with a small fraction of mixed-method studies. Increasingly are studies that rely on design science as a research method (Recker, 2013, p. 62). Recker (2013, p. 62) states that the most popular research methods are either exclusively quantitative or qualitative, with a small fraction of mixed-method studies. Increasingly are studies that rely on design science as a research method (Recker, 2013, p. 62).

3.3.1. Quantitive methods

Following Recker (2013, p. 62) quantitative methods describe a set of techniques to answer research questions with an emphasis on quantitative data. Recker (2013, p. 63) states that quantitative methods tend to specialise in quantities in the sense that numbers are used to represent values and levels of theoretical constructs, and the interpretation of the numbers is viewed as strong scientific evidence of how a phenomenon works. The presence of numeric data is predominant (Recker, 2013, p. 62). According to Recker (2013, p. 64) validity and reliability are the main concerns of this research method. For the validity of the measurement, the variables must measure the theoretical construct we want to measure. This concerns the validity of measurement (Recker, 2013, p. 64). For reliability, the measurement variables must measure the theoretical construct consistently and precisely (Recker, 2013, p. 64–65).

3.3.2. Qualitative methods

Qualitative methods are designed to assist researchers in understanding phenomena in context (Recker, 2013, p. 84). Accordingly to Recker (2013, p. 84) qualitative methods have been developed in the social sciences to enable researchers to study social and cultural phenomena, e.g. case study research, action research, and grounded theory (Recker, 2013, p. 85). Qualitative methods investigate phenomena in a real-life context. Qualitative methods focus on the text, which captures records of what people have said, done, believed or experienced about a particular phenomenon, topic, or event (Recker, 2013, p. 85). Recker (2013, p. 84) tell us that qualitative methods are well suited for exploratory research where a phenomenon is not yet fully understood, not well researched, or still emerging.

Case study

A *case study* is, according to Recker (2013, p. 92), a method involving intensive research on a phenomenon (a case) within its natural setting (one or more case sites) over some time. Recker (2013, p. 92) explains that *Case study* methods are designed for distinctive situations where there are many more variables of interest than data points. As a result, case studies rely on multiple sources of evidence (Recker, 2013, p. 92).

Action research

Action research is described by Recker (2013, p. 96) as an interactive method of inquiry that aims to contribute both to the practical concerns of people in an immediate problem context and the goals of social science by collaboration within a mutually acceptable ethical framework. It builds upon the idea of introducing changes or other sorts of interventions into a context and studying the effects of those actions (Recker, 2013, p. 96). Examples of *Action research*¹ are the Milgram Experiment (1963) and the Stanford Prison Experiment (1971).

¹ <https://online.king.edu/news/psychology-experiments/>

Grounded theory

Grounded theory is qualitative research that relies on the inductive generation of theory based on qualitative data systematically collected and analysed about a phenomenon (Recker, 2013, p.98–99). According to Recker (2013, p. 99), the *grounded theory* approach explores and develops generalised formulations about a phenomenon's basic features while simultaneously grounding the account in empirical observations or data. Recker (2013, p. 99) explains that one of the key advantages of the grounded theory approach is that it is applicable to research domains that are new or emergent and yet lack substantive theory. According to Recker (2013, p. 100), the main disadvantage of the *grounded theory* lies in the detailed and systematic bottom-up analysis of data. It is easy to get bogged down in data analysis on a deficient level of detail, making it difficult to integrate to higher levels of abstraction (Recker, 2013, p. 100).

3.3.3. Mixed-methods

Recker (2013, p. 100–101) explains that *mixed-method* research a type of inquiry is that combines both qualitative and quantitative methods for data collection and analysis. Recker (2013, p. 101) says that *mixed-method* research encourages more robust inferences, provides a greater diversity of divergent views, and enables researchers to simultaneously answer confirmatory and exploratory questions, verifying and generating theory simultaneously.

3.3.4. Design Science research

Hevner et al. (2004, p. 5) defined *Design science research* as a research paradigm in which a designer answers questions relevant to human problems via the creation of innovative artefacts, thereby contributing new knowledge to the body of scientific evidence. The designed artefacts are both valuable and fundamental in understanding that problem (Hevner et al., 2004, p. 5). The fundamental principle of *design science research* is, therefore, acquiring knowledge and understanding of a design problem and its solution in the building and application of an artefact (Recker, 2013, p. 103).

3.3.5. Applied research method

Because the research population for interviews and the expert group is small, the research cannot be regarded as a quantitative method, even though most analyses are performed numerically. As described in section 3.3.2 qualitative methods investigate a phenomenon in a real-life context. In the context of the research, the phenomenon is antifragility in combination with Enterprise Architecture and the context is the public sector. section 3.3.2 also mentions that qualitative methods focus on the text, which captures records of what people have said, done, believed or experienced about this particular phenomenon, topic or event. The research will use a literature study, interviews, and an expert group. The interviews and the expert group are mostly about what people have said, done, believed or experienced about antifragility and Enterprise Architecture

in the public sector. The collected information is qualitative because the interviews and the expert group are sources for data collection. It can be stated that the research uses a qualitative method. The research approach explores and develops generalised success factors for antifragility in the public sector. It uses inductive generation of theory based on qualitative data collected and analysed. The research focuses on a relatively new research domain, is emergent and lacks a substantive theory. This information indicates that the research has a base attitude on the qualitative method, particularly Grounded Theory.

3.4. 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)* from Foster and Deardorff (2017), the *FAIR Guiding Principles* of Wilkinson et al. (2016, Box 2), and the application of *Triangulation*, section 3.4.4.

3.4.1. Quality attributes

Recker (2013, p. 15–17) suggests using four attributes to increase the quality of research. These attributes are Replicability, Independence, Precision, and Falsification. Recker (2013, p. 15) characterises the first attribute *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 *Independence*, which is closely related to reliability, is explained by Recker (2013, p. 16) that *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. 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 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 3.6.

Quality attribute	Operationalisation
Replicability	This thesis contains all the steps taken in detail. Steps taken for the literature review, the interviews, expert group and analysis are all available. The used data sets are available. This is fostered by the use of the Open Science Framework, section 3.4.3.
Independence	The interpretation of data is coded and analyses based on numeric values. The principle rationalise everything is used to remove any bias from the system. The output of interviews and the expert group is normalised to remove possible bias. The result of the research is discussed with multiple people to remove personal opinion.
Precision	For every concept there is a clear definition available. When there are more definitions possible it is researched and a choice has been made based on rationals. All the definitions are stated in chapter 2 or in the Glossary of Terms.
Falsification	The discussion section of this thesis, section 8.2 is used for the falsification of the research.

Table 3.6.: Operationalisation of the quality attributes

3.4.2. 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 *FAIR*ness 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 combined in different settings (GO FAIR, 2017, p. 2). The FAIR Guiding Principles are operationalised in the research as described in table 3.7.

1 <https://www.nature.com/sdata/>

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 3.7.: Operationalisation of the FAIR Guiding Principles

3.4.3. Open Science Framework

The public sector is the context of this research. Social responsibility is important for this sector. To support social responsibility this research and thesis are based on Open Science. UNESCO (2020) states that 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). The Center for Open Science¹ supports this way of research by supplying guidelines and a toolkit. For this research, the Open Science framework is used to support Open Access, Open Data and Open to Society. One of the tools in the framework 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, figure 3.3. See table 3.8 on how the Open Science framework is operationalised for this research.

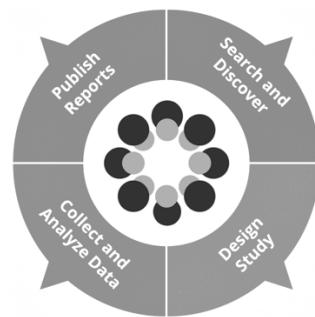


Figure 3.3.: Open Science Framework

¹ <https://www.cos.io/>

Open Science Framework	Operationalisation
Open Science Framework	The Open Science Framework is used to define the processes and used tools. The framework will help in achieving replicability, precision, and reusability.

Table 3.8.: Operationalisation of the Open Science Framework

3.4.4. 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 triangulation¹ (Mortelmans, 2018, p. 88). Following Recker (2013, p. 88) triangulation literally 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. (2016, 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. (2016, 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,

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

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.

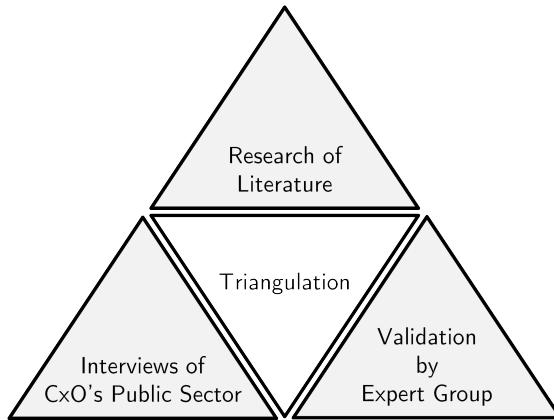


Figure 3.4.: Operationalisation of Triangulation

Triangulation is operationalised as Methodological Triangulation by using, as visualised by figure 3.4, literature study to abstract attributes, interviews with data analysis to validate attributes and an expert group with data analysis to validate attributes.

3.5. Research infrastructure and tooling

For selecting the suitable instruments for the research, the Open Science Framework¹ is used, see figure 3.3. 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 by increasing replicability, findability, accessibility, interoperability, and reusability.

3.5.1. Research execution

For the execution of the research, Microsoft Excel² 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, BibLATEX citation key, title relevance, abstract relevance, content relevance, found at, doi/isbn, url, date found, duplicate, date used, use for, and notes.

1 <https://www.cos.io/products/osf>

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

Researchgate¹, Web of Science², Google Scholar³, and Semantic Scholar⁴ are the main sources for searching for literature. PaperPanda⁵ is used for hard to find literature. The literature administration is, together with the publicly available literature, stored in the repository of the master thesis⁶. 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 DC⁷ is used for reading the PDF, and an Amazon Kindle Oasis⁸ 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 interviews Microsoft Teams is used with the transcript and session recording functionality. The transcript is full of sensitive information and is not publicly available. To make sure that the necessary information is available summaries are created and added to the thesis. The recordings are securely stored and are available upon request by the Antwerp Management School. The transcripts are used in QDA Minder Lite⁹ to label the interviews so that analysis can be done with Microsoft Excel. For the Expert Group, Meetingwizard¹⁰ is used for brainstorming, surveys and voting. The license for using Meeting Wizard is supplied by the Antwerp Management School. The output of the Meeting Wizard session is stored as a Microsoft Excel file in the repository of the thesis (anonymised).

3.5.2. Research administration

The research administration, which includes documentation containing privacy-sensitive information, like the name and contact information of the Expert Group participants, is stored on a non-public GitHub Repository¹¹. The private GitHub Repository is also for staging thesis parts that still need to be anonymised. For taking notes Leuchtturm1917¹² Notebooks are used a mechanical pencil of Rotring¹³.

1 <https://www.researchgate.net/>

2 <https://app.webofknowledge.com/>

3 <https://scholar.google.com/>

4 <https://www.semanticscholar.org/>

5 <https://paperpanda.app/>

6 <https://github.com/JRBliekendaal/master-thesis/tree/main/literature>

7 <https://get.adobe.com/reader/>

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

9 <https://provalisresearch.com/products/qualitative-data-analysis-software/freeware/>

10 <https://www.meetingwizard.nl/>

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

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

13 https://www.rotring.com/pens-pencils/pencils/rotring-600-mechanical-pencil-1/SAP_1904443.html

3.5.3. Thesis creation

I used my corporate laptop (Dell Latitude 7200 2-in-1¹) with Windows 10 Professional installed for creating the thesis. The thesis is created with the markup language L^AT_EX². The used typesetting environment is TexLive³ with the document type of "Report" from KOMA-Script⁴. TexStudio⁵ 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_EX⁶ is used with the reference manager JabRef⁷ with the citation style of APA 7th Edition⁸ and with web browser integration. The files are stored on a personal Dropbox⁹ that is used by GitHub Desktop¹⁰ to synchronise with a public GitHub repository¹¹. GitHub¹² is used for source control but also for reviewing and discussing the topics with my (Co-)Promotor and the planning of the master thesis project. The thesis source files are copied to an Amazon S3 Blob¹³ for backup. The backup rotation is seven versions. Cloudberry Explorer Freeware for Amazon S3¹⁴ is used for backup. Grammarly¹⁵, 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 Professional¹⁶ is used to create figures. The GitHub repository contains all the sources¹⁷.

3.5.4. Summary of used infrastructure and tooling

The following tools are used to execute the research project:

-
- 1 <https://www.dell.com/en-us/work/shop/dell-laptops-and-notebooks/latitude-7200-2-in-1-laptop/spd/latitude-12-7200-2-in-1-laptop>
 - 2 <https://www.latex-project.org/>
 - 3 <https://www.tug.org/texlive/>
 - 4 <https://ctan.org/pkg/koma-script>
 - 5 <https://www.texstudio.org/>
 - 6 <https://ctan.org/pkg/biblatex/>
 - 7 <https://www.jabref.org/>
 - 8 <https://apastyle.apa.org/>
 - 9 <https://www.dropbox.com/>
 - 10 <https://desktop.github.com/>
 - 11 <https://github.com/JRBlikendaal/master-thesis>
 - 12 <https://github.com/>
 - 13 <https://aws.amazon.com/s3/>
 - 14 <https://www.msp360.com/explorer/windows/amazon-s3.aspx>
 - 15 <https://www.grammarly.com>
 - 16 <https://www.microsoft.com/en-ww/microsoft-365/visio/>
 - 17 <https://github.com/JRBlikendaal/master-thesis/tree/main/images/sources>

Search & Discover	Design Study	Collect & Analyse Data	Publish Reports
Web of Science	bibLATEX	bibLATEX	LATEX
ResearchGate	JabRef	JabRef	TeXstudio
Google Scholar	Meetingwizard	PaperPanda	ORCID
Semantic Scholar	Microsoft Excel	GitHub	ResearchGate
doi.org	Adobe Acrobat Reader	Dropbox	Zenodo
Microsoft Excel	Amazon Kindle	QDA Miner Lite	Grammarly
	Microsoft Visio	Cloud Berry Explorer for S3 Microsoft Excel	

Table 3.9.: Used infrastructure & tooling

4. Attributes

This chapter contains the selected attributes for further research. Are the attributes success factors that positively influence the contribution of Enterprise Architecture in achieving antifragility in the public sector? This chapter contains the attributes of anti-fragile and the attributes of Enterprise Architecture.

After the first selection by using the criteria as defined in section 3.2.1

4.1. Attributes of antifragile

Botjes (2020) and Botjes et al. (2021) conducted an extensive literature study on antifragility and organisation design. Botjes (2020) and Botjes et al. (2021) used the literature study to define antifragility and antifragile attributes relevant for organisational design. Botjes et al. (2021, Fig. 8) created a summary that contains all validated attributes, the Extended Antifragile Attribute List.

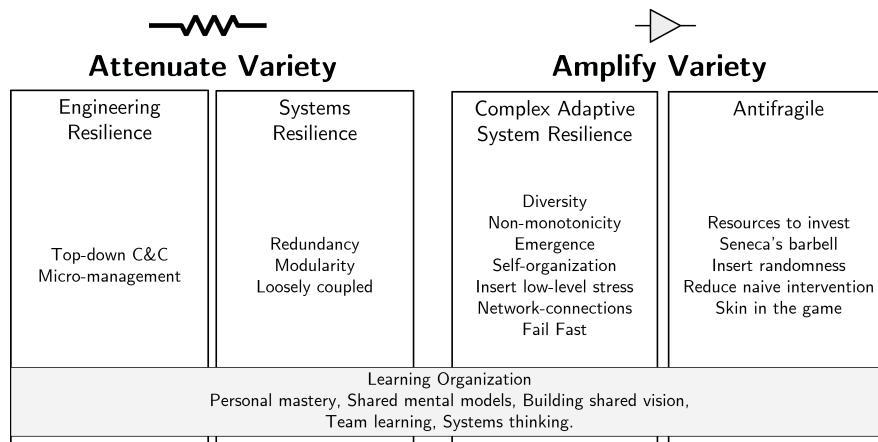


Figure 4.1.: The Extended Antifragile Attribute List (Botjes et al., 2021)

According to Botjes (2020, p. 64) it is stated by Taleb (2016) 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) explains 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 (2021) and Gorgeon (2015) both use the term optionality. Optionality is the availability of options (Taleb, 2021, p. 176–177; Gorgeon, 2015, p. 9). Optionality is an idea advanced by Taleb (2021). 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. Botjes et al. (2021, Table II) refined the definition by adding optionality "Diversity is the ability to solve a problem in more than one way with different components. Optionality, the availability of options, is a specialisation of diversity. An example is that within a team you want diverse co-workers since other types of people come up with other types of solutions." 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, 2021, p. 174). The option is an agent of antifragility (Taleb, 2021, p. 174). Optionality allows the buyer to retain the upper bound and be unaffected by adverse outcomes which makes the buyer antifragile¹. In random, complex environments, convexity, as in optionality, is easier to attain than knowledgesection 4.1. Since this research is about possible success factors and optionality is slightly different than diversity, optionality will be reinstated for further research. With figure 4.2 the attribute optionality is reinstated into the Extended Antifragile Attribute List (Botjes et al., 2021, Fig. 8) for further research.

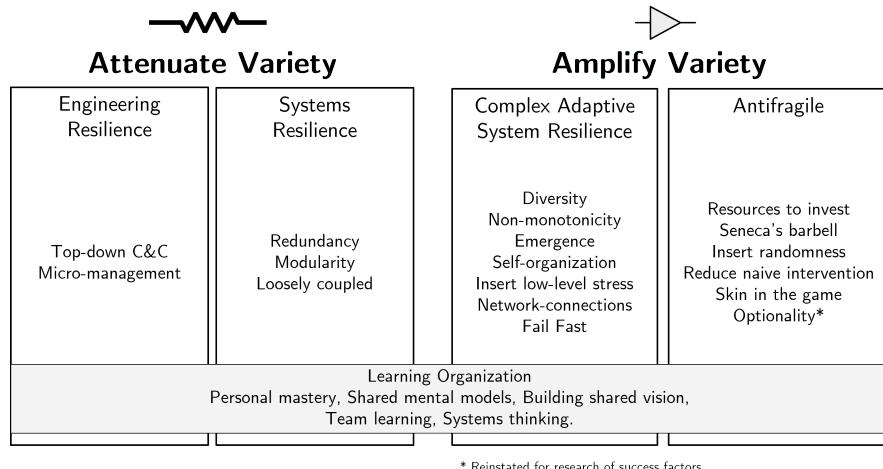


Figure 4.2.: The Extended Antifragile Attribute List (Botjes et al., 2021) with optionality reinstated

Botjes et al. (2021) used three categories to sort attributes based on behaviour. The first two categories are defined by Botjes et al. (2021, p. 4) as a type of variety, see section 2.2.3, *attenuate variety* and *amplify variety*. The third category is the *learning organisation* (Botjes et al., 2021, p. 4). For this research the most important categories

1 <https://nesslabs.com/optionality-fallacy>

are *amplify variety* and the *learning organisation*. Attenuate variety leans more towards robust and resilient and less towards antifragile. We use the same categories to sort the antifragile attributes.

4.1.1. Antifragile attributes

The antifragile attributes that are selected for use for this research are the antifragile attributes of the Extended Antifragile Attribute List of Botjes et al. (2021, p. 7). These attributes define our lens on antifragility in the public sector.

Attenuate variety attributes	
Attribute	Sources
Top-Down Command & Control	(Botjes et al., 2021)
Micro-Management	(Botjes et al., 2021)
Redundancy	(Botjes et al., 2021)
Modularity	(Botjes et al., 2021)
Loosely coupled	(Botjes et al., 2021)

Table 4.1.: Attenuate variety attributes of antifragile

Amplify variety attributes	
Attribute	Sources
Diversity	(Botjes et al., 2021)
Non-monotonicity	(Botjes et al., 2021)
Emergence	(Botjes et al., 2021)
Self-organisation	(Botjes et al., 2021)
Insert low-level stress	(Botjes et al., 2021)
Network-connections	(Botjes et al., 2021)
Fail-Fast	(Botjes et al., 2021)
Resources to invest	(Taleb, 2021; Botjes et al., 2021)
Seneca's barbell	(Taleb, 2021; Botjes et al., 2021)
Insert randomness	(Taleb, 2021; Botjes et al., 2021)
Reduce naive intervention	(Taleb, 2021; Botjes et al., 2021)
Skin in the game	(Taleb, 2021; Botjes et al., 2021)
Optionality	(Taleb, 2021; Gorgeon, 2015)

Table 4.2.: Amplify variety attributes of antifragile

Learning organisation attributes	
Attribute	Sources
Personal mastery	(Botjes et al., 2021)
Shared mental models	(Botjes et al., 2021)
Building shared vision	(Botjes et al., 2021)
Team learning	(Botjes et al., 2021)
Systems thinking	(Botjes et al., 2021)

Table 4.3.: Learning organisation attributes of antifragile

4.2. Attributes of Enterprise Architecture

Enterprise IT Architecting Enterprise IT Architectings	
Attribute	Sources
Enable Business Strategy	(Lapalme, 2012)
Support IT planning and cost reduction	(Lapalme, 2012)
Apply a reductionist (mechanistic) stance	(Lapalme, 2012)
Design organisational dimensions independently	(Lapalme, 2012)

Table 4.4.: Enterprise IT Architecting attributes

Enterprise Integrating attributes	
Attribute	Sources
Enable Business Strategy & Objectives	(Lapalme, 2012)
Apply Systems Thinking	(Lapalme, 2012)
Intra-organisational coherency	(Lapalme, 2012)
Holistic (systemic) stance	(Lapalme, 2012)
Managed the Environment	(Lapalme, 2012)

Table 4.5.: Enterprise Integrating attributes

Enterprise Ecological Adaptation attributes

Attribute	Sources
Systems-in-Environment thinking	(Lapalme, 2012)
Holistic (systemic) stance	(Lapalme, 2012)
Intra-organisational coherency	(Lapalme, 2012)
Organisational learning	(Lapalme, 2012)
Environmental learning	(Lapalme, 2012)
System-in-environment coevolution learning	(Lapalme, 2012)

Table 4.6.: Enterprise Ecological Adaptation attributes

5. Interviews

For triangulation the defined attributes (chapter 4) are validated by conducting interviews. The main concern for the interviews is to get an understanding of the state of antifragility and EA in the public sector. Four C-level Executives of the public sector participated in the interviews (table 5.1). The interviewees were carefully selected to have a balanced understanding. The interviews had a time constraint of one hour. It was not possible to talk about every attribute separately. The interview questions were theme-based. The themes were carefully selected to make sure that there is a possibility that the attributes appear in the interview. Appendix C contains a concept map on how the themes connect to the attributes.

Interviewee	Role
1	A Chief Information Officer from the Central Government
2	A Chief Technology Officer from the Local Government
3	A Chief Executive Officer from an Independent Software Vendor
4	A Chief Operations Officer from a Service Provider

Table 5.1.: Interviewees

Because the interviews were at C-level, the interviews were not in-depth. It was not possible to talk in-depth about the attributes of EA. Instead of analysing the attributes of EA, the analysis was on the EA schools of thought (Lapalme, 2012). The attributes are implicitly part of that particular school of thought. The attributes of antifragile were easier to understand by C-level executives.

The first question is about how the organisation of the interviewee's practices EA. This question was organisational specific. The other questions were about the public sector. The second question is on the agility of the public sector. How agile is the public sector? How fast can it adapt to changes in the environment (stressors)? Are there mechanisms in place to learn and improve? The third question was about how the public sector deals with uncertainty. Does the public sector embrace uncertainty? Is the public sector trying to mitigate or even evade uncertainty? The fourth question has a strong relation to the third question. The fourth question was about how the public sector deals with unexpected events. Is the public sector ready to counter or embrace unexpected events? How do they do this? The fifth question was about the risk appetite of the public sector. How much risk is the public sector willing to take? The penultimate question was explicitly about the attributes diversity and optionality. As we already know from section 2.2 and section 4.1, the concepts of diversity and optionality are stated as important by Taleb (2021), Gorgeon (2015) and Botjes et al. (2021). How

diverse is the public sector? Does the public sector has options to choose from? The last and final question was a closing question. Did the interviewee miss an important subject? Did the interviewees wanted to add something to the subject? Table 5.2 contains the questions asked and to which research concept they relate.

The interviews lasted approximately one hour. The interviewees all wished to remain anonymous. Because of this, the transcriptions and recordings are not publicly available¹. All the interviewees gave consent to transcriptions and recordings for this research. Instead of sharing the transcriptions and recordings, this thesis contains summaries of the interviews (appendix E). The interviewees validated these summaries, and gave their consent to publish those instead.

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 5.2.: Interview questions

5.1. Interview results

The interview results are recordings and transcriptions. It is impossible to use these results for validation unless we transform this text into useful information. The data

¹ The Antwerp Management School can request the recordings and transcriptions only for (re)accreditations and visitations to enable the Antwerp Management School to comply with statutory obligations. The recordings and transcriptions are kept for seven years after graduation before they are deleted.

becomes meaningful after Qualitative Data Analysis (QDA). For every positive and negative instance of an attribute of antifragile a label was created. It is important to know if an attribute exists or not. For EA only a label per school of thought was enough. Alternatively, a school does exist, or it does not exist. Adding labels for newly found attributes helped with discovering possible new attributes. After defining the labels, the coding started. The data set of this analysis is available as a structured Microsoft Excel workbook with multiple worksheets. This file is publicly available in the GitHub repository of this research¹.

The interpretation of the interviews was the next step. Graphs accompany the interpretations. The first graph is about the *frequency of an attribute*. The second graph shows us the *% of cases (interviews)* where an attribute occurs. The interpretation was done on the categories attenuate variety, amplify variety, learning organisation, the Enterprise Architecture schools of thought, and the newly found attributes.

5.1.1. Interview results on attenuate variety

The frequency of the attributes *Top-Down Command & Control* and *Micro-Management* scored the highest (figure 5.1). All four interviewees mentioned both attributes (100% of the cases). During the interviews, the interviewees explained that most of the subsystems of the public sector have a severe risk-avoiding attitude. Everything must be predefined and planned because of public accountability. There is a quick result in crises, but with possible consequences later on because of 'Bureau ICT-toetsing' (BIt) audits or parliamentary inquiries (appendix E.1). One of the interviewees said that to get things done the government should be in continuous crisis (appendix E.3). The consequences are the main reason why the public sector gets very insecure from uncertainty. The public sector does not know how to deal with uncertainty and tries to control it. The common reflex is that the public sector tries to push uncertainty back into a state that it is certain again (appendix E.2). In this way, the public sector can control the environment again.

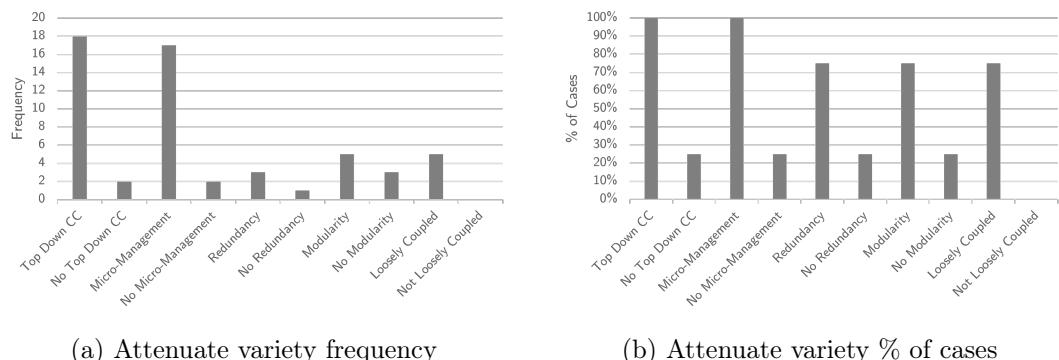


Figure 5.1.: Interview results attenuate variety

¹ https://github.com/JRBlikendaal/master-thesis/blob/57f1489c59832d4c94d8bd6726d4e260f8ad544e/datasets/interviews/raw_interview_data_and_charts.xlsx

E.g. a missing law with the introduction of electric steps (appendix E.2). It is not a bike, not a motorcycle or a car. The electric step did not fit into the current laws and regulations. The result was that the policy-makers did not approve and tolerated it until law-making was finished. Both *modularity* and *loosely coupled* scored (Figure 5.1) because the public sector consists of many sub-systems. Every sub-system has a clear goal and a reason to exist. For E.g. local tax offices have the goal of collecting local taxes, while the social services are in charge of paying benefits. Communication between those subsystems is going through standardised interfaces and is predictable. Although redundancy is almost non-existent. Every sub-system has its particular goal and reason to exist and cannot take on public tasks another sub-system is performing (appendix E.2).

5.1.2. Interview results on amplify variety

The attribute of amplify variety that scored the highest was the attribute *insert low-level stress* (Figure 5.2). It is not that there is much tinkering going on in the public sector. Experimentations are (almost) not possible because of public accountability (appendix E.2). However, because of continuous changing laws, policies and regulations, the subsystems of the public sector are continuously under stress. Nevertheless, the amount of stress differs per layer of the government. Most interviewees stressed that the central government has less stress than the local governments (appendices E.2 to E.4). This difference makes sense because of the subsidiarity principle (section 2.3). The central government performs public tasks when it is impossible at a more local level. The central government is more about policymaking and lawmaking and is a source of stress for the regional and local governments.

A dimension of stress is the factor of time. Implementing the laws and policies cannot take longer than until the next elections. The standard period of reign is four years before the new elections. The policy-makers want to finish the implementation before replacement. It happens that it is not achievable in the time given. Because of social coherence of public servants, they still try to implement a law or policy within the given time, but they often fail (appendices E.2 and E.3).

What stands out is that the attributes *no non-monotonicity* and *no Fail-Fast* are often mentioned. Both have something to do with each other. *Fail-Fast* is about experimentations and working in an agile way. Experimentations are almost non-existing because of public accountability. Working in an agile way is hard for the public sector. The end state is not always clear enough with the agile way of working, which is in conflict with public responsibility and the importance of the attributes *Top-Down Command & Control* and *Micro-Management* for the public sector. With an agile way of working, the attribute *self-organisation* must be present. The *self-organisation* was not mentioned that often in the interviews (figure 5.2. In this case the attribute *self-organisation* conflicts with *Top-Down Command & Control* and *Micro-Management*. The public sector has a very low risk appetite. Everything must be known and explained in advance (appendices E.1 to E.4).

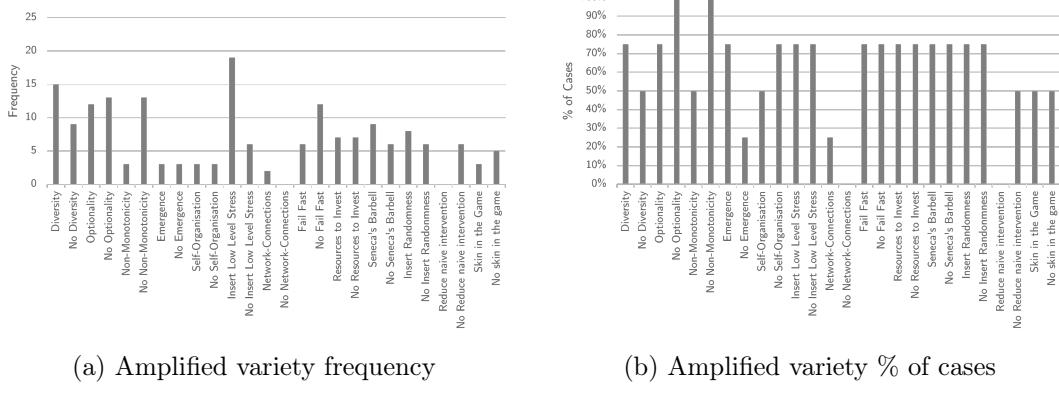


Figure 5.2.: Interview results amplified variety

Non-monotonicity is about learning from previous negative and positive experiences. The attribute *non-monotonicity* is not a common practice in the public sector (appendices E.1 and E.3). One interviewee even deliberately ignored questions about feedback loops, learning and improving.

No optionality scored high in frequency, and all the interviewees talked about this in the interviews. The private sector is applying optionality more often. An example given was that of Shell¹ (appendix E.3). Shell has multiple suppliers for the same product or service. It gives Shell the option to choose between suppliers at any moment in time. Having multiple suppliers for the same product or service are not possible with the public sector. The public sector is obliged to comply with public procurement laws. The tender process is mandatory (appendices E.1 to E.4).

5.1.3. Interview results on learning organisation

All interviewees mentioned that when a crisis occurs that they are glad that there are so many artisans working in the public sector. With a crisis, everyone works toward solutions and acts without conflict of interest. After the crisis is over, everyone falls back into previous behaviour (appendices E.2 to E.4). Many attributes of a learning organisation are in place in the public sector. The attributes related to this behaviour are *personal mastery*, *shared mental models*, and *building shared vision*. Figure 5.3 shows the same.

On the other hand *systems thinking* is less common in the public sector. Every subsystem has its particular goal and reason to exist and cannot perform public tasks another subsystem is responsible for (section 5.1.1). The public sector does not foster thinking outside of a sub-system.

¹ <https://www.shell.com/>

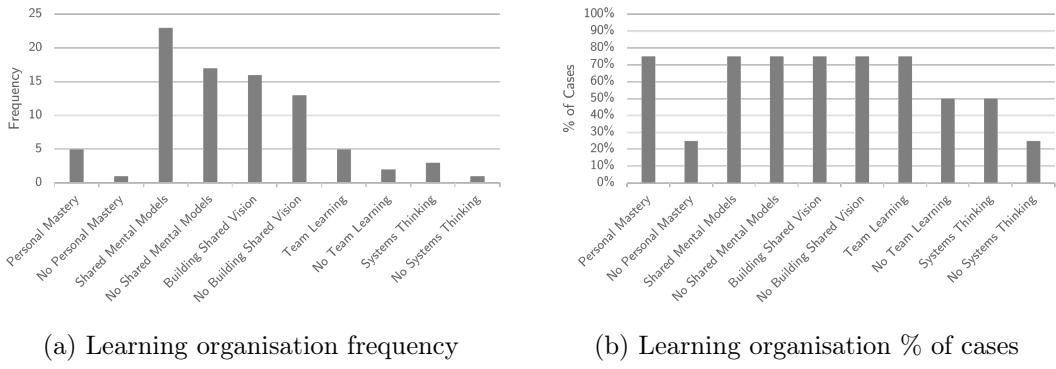


Figure 5.3.: Interview results learning organisation

5.1.4. Interview results on Enterprise Architecture schools of thought

For this category, the concern is what the most common Enterprise Architecture school of thought is in the public sector. All three schools of thought were present in the interviews. Nevertheless, the school of thought *Enterprise IT Architecting* was present in three interviews (figure 5.4). In contrast, the schools *Enterprise Integrating* and *Enterprise Ecological Adaptation* were present in two, but different, interviews.

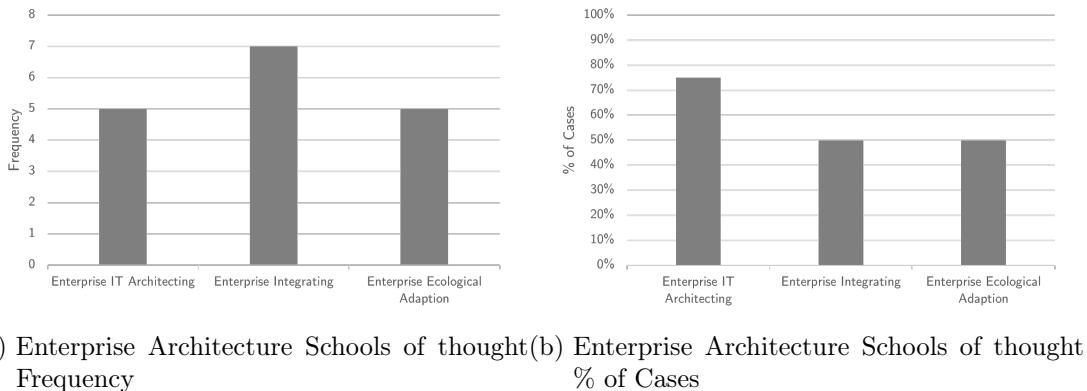


Figure 5.4.: Interview results Enterprise Architecture schools of thought

There are differences in the practice of EA between the organisations of the interviewees. Two of the interviewees are practising EA mainly in the school of thought *Enterprise IT Architecting* (appendices E.1 and E.2). One of the interviewees is in the school of thought *Enterprise IT Architecting* but has already started to show signs of *Enterprise Integrating* (appendix E.4). They are more aware of the environment, and they are starting to use EA as a means to implement the enterprise strategy of the organisation. The last interviewee operates mainly in the school of thought *Enterprise Integrating* and is moving more to *Enterprise Ecological Adaptation* (appendix E.3). The organisation of the interviewee is not only using EA to manage the environment, but

they are starting to use EA to change the environment. They do this by actively participating in decision-making and policy-making in the public sector. However, most of the interviewees agree that practising EA in the public sector as a System-of-Systems is likely the EA school of thought of *Enterprise IT Architecting*.

With the interviews, it became clear that the public sector is not using EA as an instrument for decision-making. EA follows after decision-making in the sub-systems. The result is that EA is always running behind on the policies, laws and decisions. Accordingly to the interviewees, this has its origin in that the policy-makers and decision-makers do not understand EA. One interviewee gave the example of the land surveyor¹ profession (appendix E.2). The land surveyor learns to speak the language of its stakeholders. By using the stakeholder's natural language to communicate measurements and concerns, the stakeholders understand the meaning. The interviewees have the opinion that EA does not communicate in the stakeholder's natural language. As long as EA does not communicate in the natural language of the stakeholder, EA will not be involved in decision-making and policy-making. All four interviews confirmed this finding. This finding is noted as a possible new attribute regarding success factors. This new attribute is noted in figure 5.5.

5.1.5. Interview results on possible new attributes

The last category of attributes for discussion is the category of new findings. The newly found attributes (figure 5.5) were discovered conducting interviews. Not all the findings were attributes. Some are, but others are essential themes for a discussion or it is a notable finding for later use. Rationalisation was done while performing QDA (section 5.2). Most of the findings are already discussed in the previous sub-sections. These are findings like *adapt to business language*, *limited EA*, *governance*, *public responsibility* and *risk avoidance*.

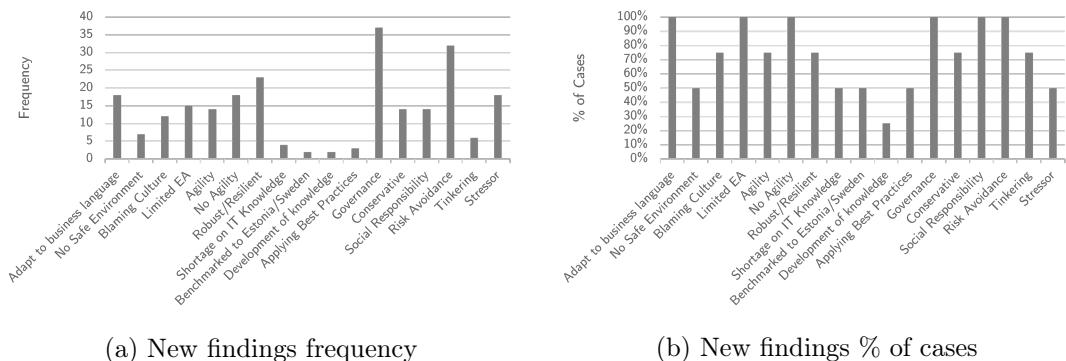


Figure 5.5.: Interview results new findings

Of the new findings that are not yet treated, the most important two are *blaming culture* and *no safe working environment*. The two are related. *No safe working envir-*

¹ <https://en.wikipedia.org/wiki/Surveying>

onment can be the result of a *blaming culture*. All the interviews talked about how in a crisis, people do anything to solve it. However, since the public sector is all about public accountability, all processes need to be followed. Everything must be predefined and planned (section 5.1.1). Most of the time, the processes are slowing it down, while it should go faster in a crisis. After the crisis, there are possible parliamentary inquiries, and there is BIt who is responsible for overseeing and auditing all IT projects of the central governments. Both are not accepting deviations in processes. Even with a successful result, there is a possibility of severe consequences. This is what we call a *blaming culture*. The result of this behaviour in the public sector is that people are not willing to take risks. They are afraid of possible repercussions. There is not a safe working environment in the public sector for people to self-organise or to excel. However, it is not this black and white. It is less with the regional and local governments. It is the strongest with the central governments (appendices E.2 and E.3).

5.2. Qualitative Data Analysis

Until now, we have interview results with an explanation of attribute presence in the public sector. However, with these results, we still cannot say which attributes are of any significance for antifragile and EA in the public sector. As already stated earlier in section 5.1, we need QDA for data interpretation. The data set used for the QDA is available as a structured Microsoft Excel workbook with multiple worksheets. This file is available in the GitHub repository of this research¹. The first step in the QDA is analysing and merging labels (table 5.3). Positive and negative labels were created for the main categories for possible overarching findings. Merging findings with already existing attributes was next. The attributes left are new, not an attribute but something else, or just a note to remember something. The analysis did not include the last two.

Normalising the frequency of attributes prevented bias of the interviewees. The presence of an attribute was only counted once per question per interview. Twenty-eight was the maximum score with four interviews and seven main questions.

Interpretation is still not possible at this moment in the QDA. There are still two attributes for most primary attributes, one negative and one positive. Subtracting the negative attribute from the positive resulted in a score for the primary attribute. The result of normalisation is that the attributes are comparable. If the score is positive, the attribute is already a property of the public sector and inversely. A positive attribute is not of any significance, but a negative attribute could be. A negative attribute is a property that is absent in the public sector.

Before defining the significance of attributes, it is necessary to determine the widely supported attributes. An attribute only mentioned during one interview is not a widely supported attribute. The chance that this is a success factor for the public sector is low. It is at most a success factor for the sub-system of the interviewee. Based on studies (n=75), the median threshold for reaching consensus is 75% (Diamond et al.,

¹ https://github.com/JRBliekendaal/master-thesis/blob/57f1489c59832d4c94d8bd6726d4e260f8ad544e/datasets/interviews/qda_steps.xlsx

2014, p. 404). When 75% or more of the interviews mention the attribute, it could be an attribute of any significance.

Step	Description	Rationale
1	Create, positive and negative main categories of Engineering, Systems, CAS, antifragile, and Learning organisation.	Need extra categories for merging 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 and resilient into Engineering Resilience	How robust and resilient is interpreted by interviewees 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.
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
7	Merge Applying Best practices into non-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
12	Ignored Public Responsibility and Risk Avoidance as attributes as possible success factors	Public Responsibility and Risk Avoidance are attributes of the public sector and are less relevant as an attribute for antifragile and EA.

Table 5.3.: Merging similar labels

5.3. Results of Qualitative Data Analysis

After performing Qualitative Data Analysis (QDA), the interview findings can be interpreted. When there is a score of 0 or less for attenuate variety, amplify variety, and learning organisation attributes, the attribute has some degree of certainty that it has a positive influence on achieving antifragility in the public sector. Attributes that scored 0 or less are *optionality*, *non-monotonicity*, *self-organisation*, *Fail-Fast*, *resources to invest* and *Seneca's barbell* (figure 5.6). All of these attributes are from the category amplify

variety.

The interpretation of the score of the newly found attributes is different. The interpretation of these attributes is that they must exist. Both the attributes mentioned have some degree of certainty that it has a positive influence on achieving antifragility in the public sector. These attributes are *adapt to business language* and *safe working environment* (figure 5.6).

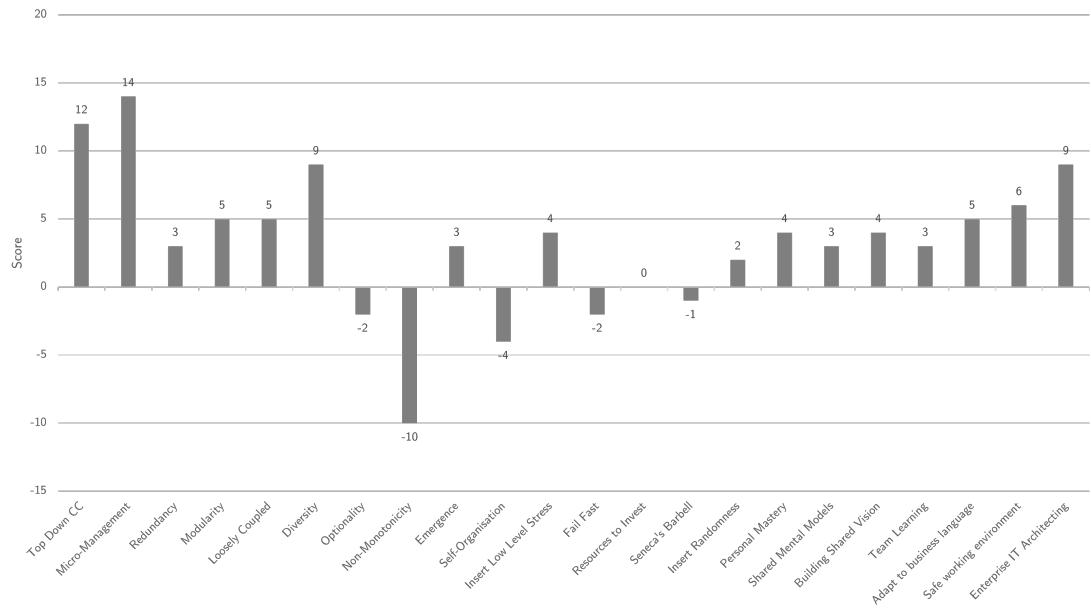


Figure 5.6.: Score of attributes from interviews

The EA school of thought is the last that needs interpretation. The questions on EA were on EA practices in the public sector. Currently, in the public sector the leading school of thought is Enterprise IT Architecting. The EA practise of the public sector must change to achieve antifragility with EA. EA should foster the school of thought of Enterprise Ecological Adaptation. Enterprise Ecological Adaptation is the school that has some certainty that it has a positive influence on achieving antifragility in the public sector (section 2.4).

5.4. Attributes most likely to be a success factor

Based on the used data set and the interpretations of this data set, the attributes (table 5.4) are, with some degree of certainty, possible attributes that have a positive influence on EA in achieving antifragility in the public sector. As already mentioned in chapter 5 the attributes of EA are implicitly part of the school of thought *Enterprise Ecological Adaptation*. The school of thought is an aggregation of its attributes.

Attribute	Category
Optionality	Amplify variety
Non-monotonicity	Amplify variety
Self-organisation	Amplify variety
Fail-Fast	Amplify variety
Resources to invest	Amplify variety
Seneca's barbell	Amplify variety
Systems-in-Environment thinking	EA Enterprise Ecological Adaptation
Holistic (systemic) stance	EA Enterprise Ecological Adaptation
Organisational learning	EA Enterprise Ecological Adaptation
Environmental learning	EA Enterprise Ecological Adaptation
Intra-organisational coherency	EA Enterprise Ecological Adaptation
System-in-environment coevolution learning	EA Enterprise Ecological Adaptation
Safe working environment	New finding
Adapt to business language	New finding

Table 5.4.: Possible success factors identified from interviews

6. Expert group

The selected attributes (section 5.4) are most likely to have a positive influence on EA in achieving antifragility in the public sector. These attributes are the result of literature study (chapter 4) and the Qualitative Data Analysis (QDA) of interviews (chapter 5). The attributes still needed to be validated for triangulation to work. An expert group validated these attributes. All of the expert group participants have experience with EA and the public sector. A survey on experience was part of the expert group session (table 6.1). The expert group participants were selected to balance the group. There was a balanced mix of participants from the central government, the local government, independent software vendors, service providers, and universities. Ten experts participated in the session.

The duration of the expert group session was two hours. The expert group session was online with Microsoft Teams and Meeting Wizard (a group support system). The session was recorded and transcribed. All participants gave their consent. The recording and transcription are not publicly available because they cannot be anonymised¹.

Question	Years	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 6.1.: The average experience of expert group participants

All the participants received information beforehand by email. This information contained the invite, the goal of the session, the agenda and all relevant definitions.

¹ The Antwerp Management School can request the recordings and transcriptions only for (re)accreditations and visitations to enable the Antwerp Management School to comply with statutory obligations. The recordings and transcriptions are kept for seven years after graduation before they are deleted.

Three recorded seminars given by Nassim Nicholas Taleb^{1,2,3} were shared to ensure that the participants had a basic understanding of antifragility. All participants confirmed that they did see at least one of the videos. The book of Taleb (2021) was read by multiple participants. For the session the following agenda was used:

1. Introduction
2. Survey on the experience of the participants
3. Presentation on the results of the research up to now⁴
4. Validation of attributes and EA schools of thought
5. Survey on the relevance of the research

Meeting Wizard supported the surveys and validations. The data set of the surveys and validations is publicly available as a Microsoft Excel file in the public GitHub repository⁵ of this research.

6.1. Validation of attributes

The two newly found attributes *adapt to business language* and *safe working environment* (section 5.4) were moved to the antifragile attributes and EA attributes. *Safe working environment* was moved to the attributes of antifragile and *adapt to business language* was moved to the attributes of EA.

A specific approach was taken to validate the attributes. Through brainstorming as a group, the participants could add new attributes. The new attributes were explained, discussed, combined and sorted. The participants rated the attribute on a scale from one to ten, with a one for least likely and a ten for most likely. There was a rating for the attributes of antifragility and EA and there was a rating for the Enterprise Architecture schools of thought. The participants rated the sets based on the following questions:

1. For the attributes: "To what extent is the attribute a success factor for antifragility in the public sector?"
2. For the Enterprise Architecture schools of thought: "To what extent is the Enterprise Architecture school of thought a success factor for antifragility in the public sector?"

1 <https://youtu.be/B2-QCv-hChY>

2 <https://youtu.be/1NXaafTpVjM>

3 https://youtu.be/C40zwpdc_yo

4 <https://github.com/JRBliekendaal/master-thesis/blob/3666f93bb95308572722082393e684ba40caa5cb/datasets/expertgroup/validationsession.pdf>

5 https://github.com/JRBliekendaal/master-thesis/blob/3666f93bb95308572722082393e684ba40caa5cb/datasets/expertgroup/dataset_expertgroup.xlsx

6.1.1. Validation of antifragile attributes

While brainstorming, the participants came up with twelve possible new attributes. After discussion, only two remained. These two were '*Outside-In and Collaboration*' and '*Data Governance Planes*'. The others were the same as another attribute or were a child of one of the other attributes. The participants rated a total of nine attributes. As table 6.2 shows there are three attributes that had a variability of more than 50%, and only two attributes scored less than a rating of six. The new attributes were among those. There was one abstain on three attributes.

Attribute	Rating	Variability	Abstains
Optionality	6,9	32%	0
Non-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
Outside-In and Collaboration	6,2	55%	0
Data Governance Planes	4,4	56%	1

Table 6.2.: Validation of antifragile attributes

6.1.2. Validation of Enterprise Architecture schools of thought

Validating the Enterprise Architecture schools of thought needed a different approach. The presentation¹ introduced the attributes of antifragile and EA. The expert group could extend the list of attributes with new attributes. There is a high chance of influencing the expert group when presenting the most likely Enterprise Architecture school of thought. The approach was to use the expert group to validate the findings in a non-biased way. The validation used all three schools of thought. The expert group could rate the likelihood of the school of thought positively influencing Enterprise Architecture in achieving antifragility in the public sector.

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

Table 6.3.: Rating of Enterprise Architecture schools of thought

¹ <https://github.com/JRBlikendaal/master-thesis/blob/3666f93bb95308572722082393e684ba40caa5cb/datasets/expertgroup/validationsession.pdf>

The rating had low variability, and no abstains (table 6.3). *Enterprise IT Architecting* had the lowest rating and *Enterprise Ecological Adaptation* had the highest with *Enterprise Integrating* in between. It confirmed the results of the literature research (section 2.4.1) and the interviews (section 5.3).

6.1.3. Validation of Enterprise Architecture attributes

The validation of the EA attributes used the same approach like that of the antifragile attributes. The validation contained the attributes of the Enterprise Architecture school of thought of Enterprise Ecological Adaptation. Brainstorming resulted in nine new identified attributes. After discussion, five remained. These five were *Agile Enterprise*, *Real-Time Trust*, *foster dialogue*, *architecture validation* and *Always Fitting Enterprise Architecture*. The participants rated the attributes.

Attribute	Rating	Variability	Abstains
Systems-in-Environment thinking	7,7	28%	0
Holistic (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	5,6	54%	1
Foster dialogue	6,9	32%	0
Architecture validation	7,4	24%	0
Always Fitting Enterprise Architecture	5,8	46%	1

Table 6.4.: Rating of Enterprise Architecture attributes

The rating shows that two attributes have a variability of 50% or higher, and only one attribute got a rating of less than six (table 6.4). All three were from the five new attributes from the expert group. There were only two abstains on a total of two attributes.

6.2. Relevance of the research

The final part of the expert group session was about the relevance of the research. A survey determined the research's relevance. The expert group rated the research on different areas of application. These areas of relevance were, *in general, for themselves, for the public sector and for the organisation of the expert*. The last question asked was if the expert group session fulfilled their expectations.

The variability of the ratings was low. There was only one abstain on the relevance of the research for the public sector. The question that scored the least was about the relevance for the organisation of the expert. The expert group finds the research relevant. They rated it with a rating of 8,2 (table 6.5).

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 6.5.: Rating of the relevance of the research

7. Analysis

7.1. Identified success factors

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.: Identifying success factors of antifragile in the public sector

Attribute	<i>Literature</i>	<i>Interviews</i>	<i>Validation group</i>	<i>Score (n out of 3)</i>
Optionality	✓	✓	✓	3
Non-monotonicity	✓	✓	✓	3
Self-organisation	✓	✓	✓	3
Fail-Fast	✓	✓	✓	3
Resources to invest	✓	✓	✓	3
Seneca's barbell	✓	✓	✓	3

Table 7.2.: Identified success factors of antifragile in the public sector

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

Table 7.3.: Identified the relevant Enterprise Architecture school of thought

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
Systems-in-Environment thinking	✓	✓	✓	3
Holistic (systemic) stance	✓	✓	✓	3
Organisational learning	✓	✓	✓	3
Environmental learning	✓	✓	✓	3
Intra-organisational coherency	✓	✓	✓	3
System-in-environment coevolution learning	✓	✓	✓	3
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 7.4.: 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 7.5.: 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 7.6.: Identified the relevant Enterprise Architecture school of thought

8. Conclusion and discussions

8.1. Conclusion

If

Based on the data set used, it is likely that the following attributes can be regarded as success factors.

Attribute	Category	Definition
Optionality	Antifragile	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
Non-monotonicity	Antifragile	Non-monotonicity is about not only learning from the good but also from the bad. For example the lessons learned during a retrospective session
Self-organisation	Antifragile	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
Fail-Fast	Antifragile	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 adageum "Fail Fast". Opportunities 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
Resources to invest	Antifragile	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
Seneca's barbell	Antifragile	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

Table 8.1.: Identified success factors

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
- Discuss is the public sector really different from that of the private sector?
- Discuss is the Dutch public sector different than that from other countries?

8.2.1. Is the public sector in The Netherlands unique?

Is the public sector in The Netherlands the same as in the rest of the world? This needs further research and needs to be confirmed so that the outcome of this research is universally applicable. Maybe the outcome can be generalised. Further research should demonstrate this.

8.2.2. Is the public sector different then the private sector?

8.2.3. Size of Expert Group

Is the size of the delphi group large enough to determine....

8.2.4. The composition of the Expert Gropu

Is the composition of the Delphi Group a good reflection of the Public Sector Market?

8.2.5. Causal Loop Diagram

8.3. Recommendations

- Research not on the public sector but only parts of the public sector

9. Retrospective

9.1. Quality of Research

9.2. Process of Research

9.3. Researcher

"I have found out how little I actually know"

- The added value of a Co-Promotor

References

- Ackoff, R. L. (1973). Science in the systems age: Beyond ie, or, and ms. *Operations Research*, 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., & Mesarović, M. D. (1964). *Views on general systems theory. proceedings of the second systems symposium at case institute of technology*. J. Wiley. <https://www.amazon.com/dp/B002EZJH4Y>
- Aghina, W., Ahlback, K., Smet, A. D., Lackey, G., Lurie, M., Murarka, M., & Handscomb, C. (2018, January). *The five trademarks of agile organizations*. . Retrieved February 25, 2022, from <https://www.mckinsey.com/business-functions/people-and-organizational-performance/our-insights/the-five-trademarks-of-agile-organizations>
- Ashby, W. R. (1979). *An introduction to cybernetics* (Sixth Repr.). Methuen. ISBN: 978-04-166-8300-4. <http://www.worldcat.org/oclc/256234995>
- 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>
- Beer, S. (1994). *The heart of enterprise*. John Wiley & Sons Ltd. ISBN: 978-04-719-4837-7. <http://www.worldcat.org/oclc/1050651698>
- Bennett, N., & Lemoine, G. J. (2014). What a difference a word makes: Understanding threats to performance in a vuca world. *Business Horizons*, 57(3), 311–317. <https://doi.org/10.2139/ssrn.2406676>
- Berg, M. v. d., Luijpers, J., Steenbergen, M. van, & Wagter, R. (2005). *Dynamic enterprise architecture*. John Wiley & Sons. ISBN: 978-04-716-8272-1. <http://www.worldcat.org/oclc/928551730>
- Botjes, E. A. (2020). *Defining antifragility and the application on organisation design* (Master's thesis). Antwerp Management School. Antwerp, Belgium, Zenodo. <https://doi.org/10.5281/ZENODO.3719389>
- Botjes, E. A., Berg, M. van den, Gils, B. van, & Mulder, H. (2021). Attributes relevant to antifragile organizations. *23rd IEEE International Conference on Business Informatics*. <https://doi.org/10.1109/CBI52690.2021.00017>
- Brafman, O., & Beckstrom, R. A. (2006). *The starfish and the spider: The unstoppable power of leaderless organizations*. Portfolio. ISBN: 978-15-918-4183-8. <http://www.worldcat.org/oclc/992173727>
- 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), 201–234. <https://doi.org/10.1504/ijtm.2009.023374>

- De Haes, S., Grembergen, W. V., Joshi, A., & Huygh, T. (2020). *Enterprise governance of information technology: Achieving alignment and value in digital organizations* (Third Edition). Springer International Publishing. ISBN: 978-30-302-5918-1. <http://www.worldcat.org/oclc/1264794440>
- 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>
- Digitaleoverheid. (2021). *I-strategie rijk*. . Retrieved September 16, 2021, from <https://www.digitaleoverheid.nl/overzicht-van-alle-onderwerpen/i-strategie-rijk-2021-2025/>
- Eggers, W. D., & Bellman, J. (2015, October 1). *The journey to government's digital transformation*. . Retrieved September 5, 2021, from <https://www2.deloitte.com/global/en/pages/public-sector/articles/digital-government-transformation.html>
- Foster, E. D., & Deardorff, A. (2017). Open science framework (OSF). *Journal of the Medical Library Association*, 105(2), 203–206. <https://doi.org/10.5195/jmla.2017.88>
- Gartner. (n.d.). *Definition of enterprise architecture (ea)*. . 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* (Third Edition). Morgan Kaufmann. ISBN: 978-01-238-5915-0. <http://www.worldcat.org/oclc/1103560139>
- GO FAIR. (2017). *Fair principles*. . Retrieved August 2, 2021, from <https://www.go-fair.org/fair-principles/>
- Gomes, L., Facin, A., Salerno, M. S., & Ikenami, R. (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). Anti-fragile information systems. In T. A. Carte, A. Heinzl & C. Urquhart (Eds.), *Proceedings of the international conference on information systems - exploring the information frontier, ICIS 2015, fort worth, texas, usa, december 13-16, 2015*. Association for Information Systems. <http://aisel.aisnet.org/icis2015/proceedings/BreakoutIdeas/6>
- Graves, T. (2008). *Real enterprise architecture: Beyond it to the whole enterprise*. Tetradian Books. ISBN: 978-19-066-8100-5. <http://www.worldcat.org/oclc/815729887>
- Graves, T. (2009). *Enterprise architecture: A pocket guide*. IT Governance Publishing (ITGP). ISBN: 978-18-492-8016-7. <http://www.worldcat.org/oclc/697598744>
- Guggenberger, T., Möller, F., Haarhaus, T., Gür, I., & Otto, B. (2020). Ecosystem types in information systems. https://aisel.aisnet.org/ecis2020_rp/45/
- Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. *MIS Quarterly*, 28(1), 75–105. <https://doi.org/10.2307/25148625>
- Hole, K. J. (2016). *Anti-fragile ict systems* (First Edition). Springer International Publishing. ISBN: 978-33-193-0068-9. <http://www.worldcat.org/oclc/958800432>

- Hoogervorst, J. (2009). *Enterprise governance and enterprise engineering* (First Edition). Springer Berlin Heidelberg. ISBN: 978-35409-2670-2. <http://www.worldcat.org/oclc/1156015507>
- 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(3), 68–78.
- International Council on Systems Engineering. (2018). *Systems of systems primer*. . Retrieved March 22, 2022, from <https://www.incose.org/products-and-publications/sos-primer>
- Jaaron, A. A. M., & Backhouse, C. J. (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 Arts. London, Great Britain.
- 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*, 4069–4078. <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., Merwe, A. van der, Zachman, J., Vries, M. de, & 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(1), 19. <https://doi.org/10.5751/ES-01606-110119>
- 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., & Bruyn, P. D. (2016). *Normalized systems theory: From foundations for evolvable software toward a general theory for evolvable design*. Kermt NSI-Press. ISBN: 978-90-771-6009-1. <http://www.worldcat.org/oclc/1050060943>
- Mark, J. J. (2010). *Heraclitus of Ephesus*. Retrieved September 20, 2021, from https://www.worldhistory.org/Heraclitus_of_Ephesus/
- Martin-Breen, P., & Anderies, J. M. (2011). Resilience: A literature review.

- Moore, J. F. (1993). Predators and prey: A new ecology of competition. *Harvard business review*, 71(3), 75–86.
- Mortelmanns, D. (2018). *Handboek kwalitatieve onderzoeksmethoden* (Second Edition). Acco. ISBN: 978-90-334-9360-7. <https://www.worldcat.org/oclc/1281878372>
- 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. M. (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>
- Papazoglou, M. P., & Heuvel, W. J. van den. (2006). Service-oriented design and development methodology. *International Journal of Web Engineering and Technology*, 2(4), 412–442. <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)*. . Retrieved November 12, 2021, from <https://psychtimes.com/metathesiophobia-fear-of-change/>
- Recker, J. (2013). *Scientific research in information systems: A beginner's guide*. Springer Publishing Company, Incorporated. ISBN: 978-36-423-0047-9. <http://www.worldcat.org/oclc/835896025>
- 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*. Harvard Business Review Press. ISBN: 978-14-221-4817-4. <https://www.worldcat.org/oclc/1015886391>
- 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. <https://doi.org/10.1177/1847979019866337>
- Saunders, M. N. K., Lewis, P., & Thornhill, A. (2016). *Research methods for business students* (Seventh Edition). Pearson Education. ISBN: 978-12-920-1662-7. <http://www.worldcat.org/oclc/938548927>
- Sinha, D., & Sinha, S. (2020). Managing in a vuca world: Possibilities and pitfalls. *Journal of Technology Management for Growing Economies*, 11(1). <https://doi.org/10.15415/jtmge.2020.111003>
- Spewak, S. (1993). *Enterprise architecture planning: Developing a blueprint for data, applications, and technology*. Wiley. ISBN: 978-04-715-9985-2. <http://www.worldcat.org/oclc/1106823246>
- Taleb, N. N. (2016). *The black swan: The impact of the highly improbable* (Second, Revised Edition). Random House. ISBN: 978-08-129-7381-5. <http://www.worldcat.org/oclc/1141137171>

- Taleb, N. N. (2021). *Antifragile: Things that gain from disorder* (Paperback Edition). Random House. ISBN: 978-08-129-7968-8. <http://www.worldcat.org/oclc/1012852528>
- Tansley, A. G. (1935). The use and abuse of vegetational concepts and terms. *Ecology*, 16(3), 284–307. <https://doi.org/10.2307/1930070>
- UNESCO. (2020). *Open science*. . Retrieved September 22, 2021, from <https://en.unesco.org/science-sustainable-future/open-science>
- Wal, Z. van der, Graaf, G. de, & 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>
- von Bertalanffy, K. L. (1951). Problems of general systems theory. *Human Biology*, 23(4), 302–312. <https://www.jstor.org/stable/i40070691>
- von Bertalanffy, K. L. (1968). *General system theory: Foundations, development, applications*. Braziller. ISBN: 0-80-760452-6. <http://www.worldcat.org/oclc/1263587160>
- 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., Silva Santos, L. B. da, 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. ISBN: 978-14-503-2476-2. <https://doi.org/10.1145/2601248.2601268>
- Ylinen, M., & Pekkola, S. (2018). Enterprise architecture as a scapegoat for difficulties in public sector organizational transformation [International Conference on Information Systems]. *International Conference on Information Systems (ICIS'2018)*.
- 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)*. ISBN: 978-17-336-3251-5. <https://aisel.aisnet.org/ecis2020/>

List of Figures

1.1.	The opposite of fragile	4
1.2.	Conceptual Research Model	5
1.3.	Examples of stressors on the public sector	6
2.1.	The House of 'Thorbecke'	16
2.2.	Public sector collaboration models	17
2.3.	Public Sector as a System-of-Systems	18
3.1.	Research Model	21
3.2.	Snowballing literature	22
3.3.	Open Science Framework	31
3.4.	Operationalisation of Triangulation	33
4.1.	The Extended Antifragile Attribute List (Botjes et al., 2021)	37
4.2.	The Extended Antifragile Attribute List (Botjes et al., 2021) with optionality reinstated	38
5.1.	Interview results attenuate variety	44
5.2.	Interview results amplified variety	46
5.3.	Interview results learning organisation	47
5.4.	Interview results Enterprise Architecture schools of thought	47
5.5.	Interview results new findings	48
5.6.	Score of attributes from interviews	51
C.1.	Concept map of Antifragile Attributes	93
G.1.	Rating of antifragile attribute Optionality	113
G.2.	Scoring of antifragile attribute Mono-Monotonicity	114
G.3.	Scoring of antifragile attribute Self-Organisation	115
G.4.	Scoring of antifragile attribute Fail-Fast	116
G.5.	Scoring of antifragile attribute Resources to Invest	117
G.6.	Scoring of antifragile attribute Seneca's Barbell	118
G.7.	Scoring of antifragile attribute Safe working environment	119
G.8.	Scoring of antifragile attribute Naar buiten kijken	120
G.9.	Scoring of antifragile attribute Data Governance Planes	121
G.10.	Scoring of school of thought Enterprise IT Architecting	122
G.11.	Scoring of school of thought Enterprise Integrating	123
G.12.	Scoring of school of thought Enterprise Ecological Adaptation	124

G.13.Scoring of EA attribute Systems-in-Environment thinking	126
G.14.Scoring of EA attribute Holistic (systemic) stance	127
G.15.Scoring of EA attribute Organisational learning	128
G.16.Scoring of EA attribute Environmental learning	129
G.17.Scoring of EA attribute Intra-Organisational coherency	130
G.18.Scoring of EA attribute System-in-Environment Co-Evolution learning . .	131
G.19.Scoring of EA attribute adapt to business language	132
G.20.Scoring of EA attribute Agile Enterprise	133
G.21.Scoring of EA attribute Real Time Trust	134
G.22.Scoring of EA attribute Foster Dialogue	135
G.23.Scoring of EA attribute Validation	136
G.24.Scoring of EA attribute Always fitting EA	137

List of Tables

2.1. Literature of interest (2020–March 2022)	15
3.1. System keywords	23
3.2. Antifragile keywords	24
3.3. Enterprise Ecological Adaptation (EEA) authors (Lapalme, 2012, p. 42) .	24
3.4. Enterprise Architecture keywords	24
3.5. Public sector keywords	25
3.6. Operationalisation of the quality attributes	30
3.7. Operationalisation of the FAIR Guiding Principles	31
3.8. Operationalisation of the Open Science Framework	32
3.9. Used infrastructure & tooling	36
4.1. Attenuate variety attributes of antifragile	39
4.2. Amplify variety attributes of antifragile	39
4.3. Learning organisation attributes of antifragile	40
4.4. Enterprise IT Architecting attributes	40
4.5. Enterprise Integrating attributes	40
4.6. Enterprise Ecological Adaptation attributes	41
5.1. Interviewees	42
5.2. Interview questions	43
5.3. Merging similar labels	50
5.4. Possible success factors identified from interviews	52
6.1. The average experience of expert group participants	53
6.2. Validation of antifragile attributes	55
6.3. Rating of Enterprise Architecture schools of thought	55
6.4. Rating of Enterprise Architecture attributes	56
6.5. Rating of the relevance of the research	57
7.1. Identifying success factors of antifragile in the public sector	59
7.2. Identified success factors of antifragile in the public sector	60
7.3. Identified the relevant Enterprise Architecture school of thought	60
7.4. Identified success factors of Enterprise Architecture	61
7.5. Identified success factors	62
7.6. Identified the relevant Enterprise Architecture school of thought	63
8.1. Identified success factors	64

A.1. Properties of Enterprise IT Architecting	88
A.2. Properties of Enterprise Integrating	89
A.3. Properties of Enterprise Ecological Adaptation	90
B.1. Authors of the Enterprise Architecture schools of thought	91
D.1. Literature search 2020–March 2022 all sources	96
F.1. Interview results Engineering Resilience	108
F.2. Interview results Systems Resilience	108
F.3. Interview results Complex Adaptive Systems Resilience	109
F.4. Interview results Antifragile	109
F.5. Interview results Learning Organisation	110
F.6. Interview results Enterprise Architecture schools of thought	110
F.7. Interview results Findings	111
G.1. Rating of antifragile attribute Optionality	113
G.2. Scoring of antifragile attribute Mono-Monotonicity	114
G.3. Scoring of antifragile attribute Self-Organisation	115
G.4. Scoring of antifragile attribute Fail-Fast	116
G.5. Scoring of antifragile attribute Resources to Invest	117
G.6. Scoring of antifragile attribute Seneca’s Barbell	118
G.7. Scoring of antifragile attribute Safe working environment	119
G.8. Scoring of antifragile attribute Naar buiten	120
G.9. Scoring of antifragile attribute Data Governance Planes	121
G.10. Validation of Enterprise Architecture schools of thought	122
G.11. Scoring of school of thought Enterprise IT Architecting	122
G.12. Scoring of school of thought Enterprise Integrating	123
G.13. Scoring of school of thought Enterprise Ecological Adaptation	124
G.14. Validation of Enterprise Architecture attributes	125
G.15. Scoring of EA attribute Systems-in-Environment thinking	126
G.16. Scoring of EA attribute Holistic (systemic) stance	127
G.17. Scoring of EA attribute Organisational learning	128
G.18. Scoring of EA attribute Environmental learning	129
G.19. Scoring of EA attribute Intra-Organisational coherency	130
G.20. Scoring of EA attribute System-in-Environment Co-Evolution learning	131
G.21. Scoring of EA attribute adapt to business language	132
G.22. Scoring of EA attribute Agile Enterprise	133
G.23. Scoring of EA attribute Real Time Trust	134
G.24. Scoring of EA attribute Foster Dialogue	135
G.25. Scoring of EA attribute Validation	136
G.26. Scoring of EA attribute Always fitting EA	137
G.27. Follow-up Survey	137

Glossary of Terms

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

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.

Agile Enterprise

to be written.

agility

The state of being agile.

Always Fitting Enterprise Architecture

to be written.

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 validation

to be written.

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.

attribute

A quality or characteristic that someone or something has.

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.

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.

concept map

A concept map or conceptual diagram is a diagram that depicts suggested relationships between concepts. Concept maps may be used by instructional designers, engineers, technical writers, and others to organize and structure knowledge.

D

Data Governance Planes

to be written.

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"..

FAIR Guiding Principles

The FAIR Guiding Principles provide guidelines to improve the **F**indability, **A**ccessibility, **I**nteroperability, and **R**euse of digital assets.

foster

To promote the growth or development of.

foster dialogue

to be written.

fragile

The quality of being easily broken or destroyed.

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 meticulous 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

Open Science

Open science is the movement to make scientific research (including publications, data, physical samples, and software) and its dissemination accessible to all levels of society, amateur or professional.

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.

Outside-In and Collaboration

to be written.

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

Real-Time Trust

to be written.

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.

robustness

The state of being robust.

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 built.

social responsibility

Social responsibility is an ethical framework in which an individual is obligated to work and cooperate with other individuals and organizations for the benefit of the community that will inherit the world that individual leaves behind.

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.

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.

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 a 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.

triangulation

Triangulation means you are seeking convergence and corroboration of results from different methods and designs studying the same phenomenon.

U

uncertainty

the state of being uncertain.

Abbreviations

A | B | C | D | E | I | K | M | O | Q | S | V

A

API

Application Programming Interface.

ASD

Antifragile Systems Design.

B

Blt

'Bureau ICT-toetsing'.

BoK

Body of Knowledge.

C

CAS

Complex Adaptive System.

CCO

Chief Commercial Officer.

CEO

Chief Executive Officer.

CIO

Chief Information Officer.

COO

Chief Operations Officer.

CTO

Chief Technology Officer.

D

DYA

DYnamic Architecture.

E

EA

Enterprise Architecture.

EAAL

Extended Antifragile Attribute List.

EAM

Enterprise Architecture Management.

EEA

Enterprise Ecological Adaptation.

I

idEA

Interactive Dynamic Enterprise Architecture.

IS

Information System.

ISV

Independent Software Vendor.

IT

Information Technology.

K

KPI

Key Performance Indicator.

M

MIT

Massachusetts Institute of Technology.

O

OSF

Open Science Framework.

Q**QDA**

Qualitative Data Analysis.

S**SaaS**

Software-as-a-Service.

SiE

System-in-Environment.

SoS

System-of-Systems.

V**VNG-R**

'Vereniging Nederlandse Gemeenten - Realisatie'.

VUCA

Volatility, Uncertainty, Complexity and Ambiguity.

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. Conceptmap of interview questions mapped to attributes

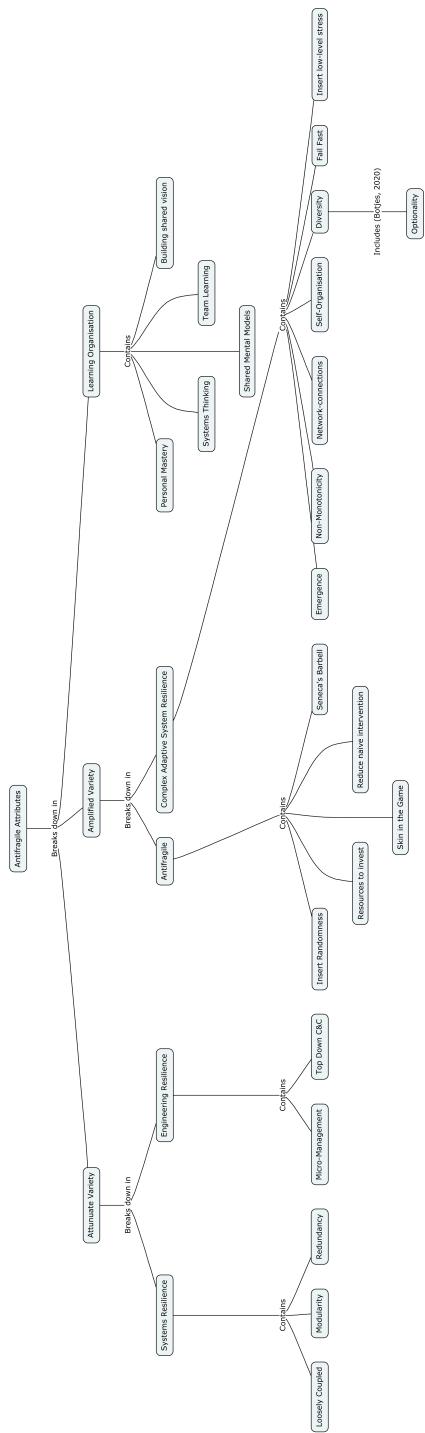


Figure C.1: Concept map of Antifragile Attributes

D. Literature catch-up

This appendix contains the newly found literature as a catch-up on the literature research of Botjes (2020).

Title	Author	Year
A Barbell Strategy-oriented Regulatory Framework and Compliance Management	Gallina, Barbara	2020
A collaborative approach to resilient and antifragile business ecosystems	Ramezani, Javaneh and Camarinha-Matos, Luis M.	2019
A Game Theoretic Approach for Quality Assurance in Software Systems Using Antifragility-Based Learning Hooks	Vimaladevi, M. and Zayaraz, G.	2020
A Literature Review of Organizational Resilience	Ping, Li Peter and Jiazhe, Zhu	2021
A Philosophy of Security Architecture Design	Koien, Geir M.	2020
Agile architecture	Kruchten, Philippe	2013
An Introduction to Residuality Theory: Software Design Heuristics for Complex Systems.	O'Reilly, Barry M.	2020
Antifragility as a design criterion for modelling dynamic systems	de Bruijn, Harald and Groessler, Andreas and Videira, Nuno	2020
Approaches for resilience and antifragility in collaborative business ecosystems	Ramezani, Javaneh and Camarinha-Matos, Luis M.	2020
Architecture Principles for Resilience	Furrer, Frank J	2019
Beyond Resilience in Sociotechnical Systems	Simonette, Marcel and Magalhaes, Mario and Bertassi, Eduardo and Spina, Edison	2019
Black-Swan Type Catastrophes and Antifragility/Supra-resilience of Urban Socio-Technical Infrastructures	Timashev, S. A.	2020

Title	Author	Year
Conceptualizing resilience in engineering systems: An analysis of the literature	Wied, Morten and Oehmen, Josef and Welo, Torgeir	2020
Cybersecurity in the Internet of Things in Industrial Management	Raimundo, Ricardo Jorge and Rosario, Alberico Travassos	2022
Ecosystem antifragility: beyond integrity and resilience	Equihua, Miguel and Espinosa Aldama, Mariana and Gershenson, Carlos and Lopez-Corona, Oliver and Munguia, Mariana and Perez-Maqueo, Octavio and Ramirez-Carrillo, Elvia	2020
Emerging risk management in industry 4.0: an approach to improve organizational and human performance in the complex systems	Brocal, Francisco and Gonzalez, Cristina and Komljenovic, Dragan and Katina, Polinpapilinho F and Sebastian, Miguel A	2019
Enterprise Architecture Resilience by Design: A Method and Case Study Demonstration	Aldea, Adina and Vaicekauskaite, Egle and Daneva, Maya and Piest, Jean Paul Sebastian	2021
Enterprise Development Management through managed chaos	Kasianova, Nataliia and Tarasova, Elena and Kravchuk, Nataliia	2019
Facing uncertainty: An entrepreneurial view of the future?	Bridge, Simon	2021
Microservice Architecture	Nadareishvili, Irakli and Mitra, Ronnie and McLarty, Matt and Amundsen, Mike	2019
No More Snake Oil: Architecting Agility through Antifragility	O'Reilly, Barry	2019
On the meaning and operationalization of antifragility: Comment on the paper by Grossler	van Daalen, Els	2020
Resilience, robustness, and antifragility: Towards an appreciation of distinct organizational responses to adversity	Munoz, Albert and Billsberry, Jon and Ambrosini, Veronique	2022
Self-Improving Autonomic Systems for Antifragile Cyber Defence: Challenges and Opportunities	Chhetri, Mohan Baruwal and Uzunov, V, Anton and Vo, Quoc Bao and Nepal, Surya and Kowalczyk, Ryszard	2019

Title	Author	Year
The Business Transformation Framework and Enterprise Architecture Framework for Managers in Business Innovation The role of legacy processes in automated business environments	Trad, Antoine and IBISTM, France and Kalpic, Damir	2017
The Machine in the Ghost: Autonomy, Hyperconnectivity, and Residual Causality	O'Reilly, Barry M.	2021
The Philosophy of Residuality Theory	O'Reilly, Barry M.	2021
The Tao way to anti-fragile software architectures: the case of mobile applications	Grassi, Vincenzo and Mirandola, Raffaela	2021
Toward a commonly shared public policy perspective for analyzing risk coping strategies	Li, Yanwei and Taeihagh, Araz and de Jong, Martin and Klinke, Andreas	2021
Tutorial on systems with antifragility to downtime	Hole, Kjell Jorgen	2022
We need more Anti-Fragility!	Dirzus, Dagmar	2020

Table D.1.: Literature search 2020–March 2022 all sources

E. 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.

E.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.

E.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

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

2 <https://commonground.nl/>

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

4 https://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.

E.3. Interview Independent Software Vendor

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

1 https://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

1 https://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.

E.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 BI 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 BI 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.

F. 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.

F.1. Interview results Engineering Resilience attributes

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 F.1.: Interview results Engineering Resilience

F.2. Interview results Systems Resilience attributes

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 F.2.: Interview results Systems Resilience

F.3. Interview results Complex Adaptive Systems Resilience attributes

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 F.3.: Interview results Complex Adaptive Systems Resilience

F.4. Interview results Antifragile attributes

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 F.4.: Interview results Antifragile

F.5. Interview results learning organisation attributes

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 F.5.: Interview results Learning Organisation

F.6. Interview results Enterprise Architecture schools of thought

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 F.6.: Interview results Enterprise Architecture schools of thought

F.7. Interview results new attributes

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 F.7.: Interview results Findings

G. Validation findings

G.1. Validation of antifragile attributes

G.1.1. Validation of optionality

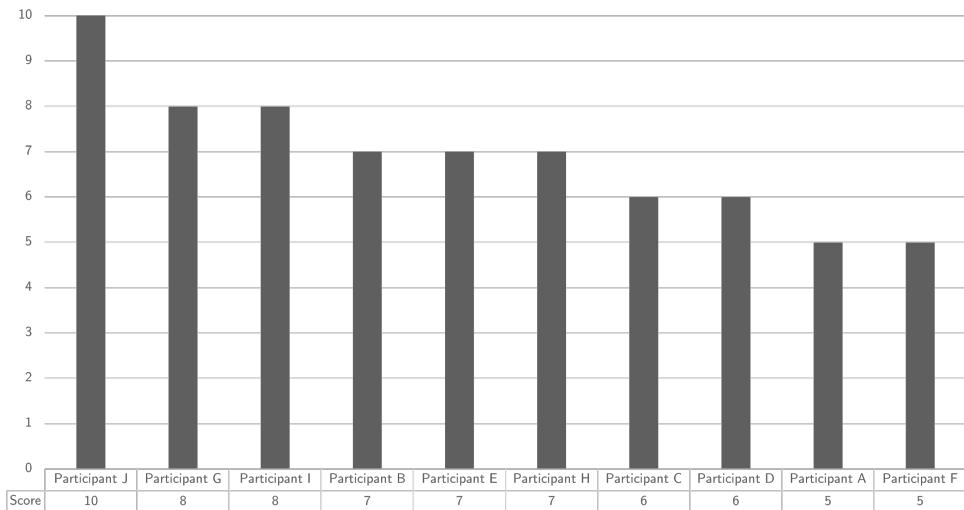


Figure G.1.: Rating of antifragile attribute Optionality

Attribute	Rating	Variability	Abstains
Optionality	6,9	32%	0

Table G.1.: Rating of antifragile attribute Optionality

G.1.2. Validation of non-monotonicity

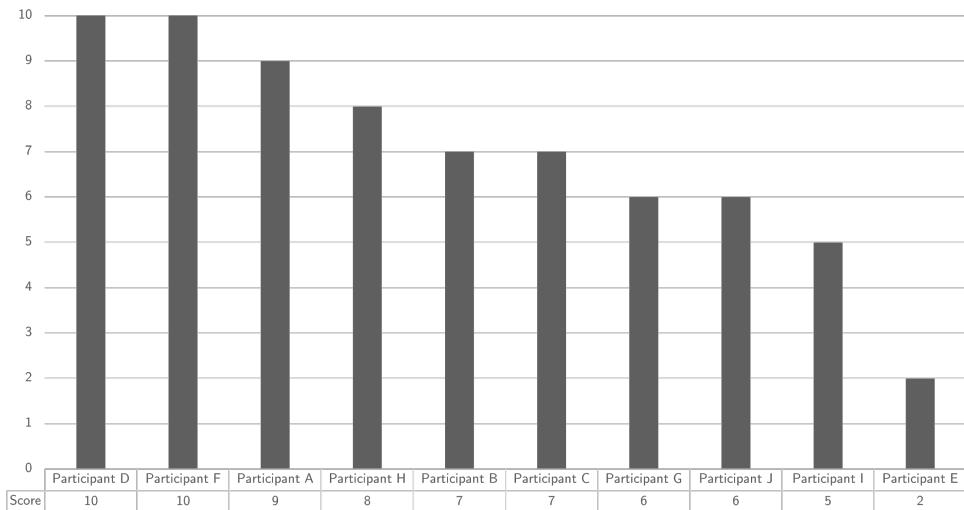


Figure G.2.: Scoring of antifragile attribute Mono-Monotonicity

Attribute	Rating	Variability	Abstains
Mono-Monotonicity	7	51%	0

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

G.1.3. Self-Organisation

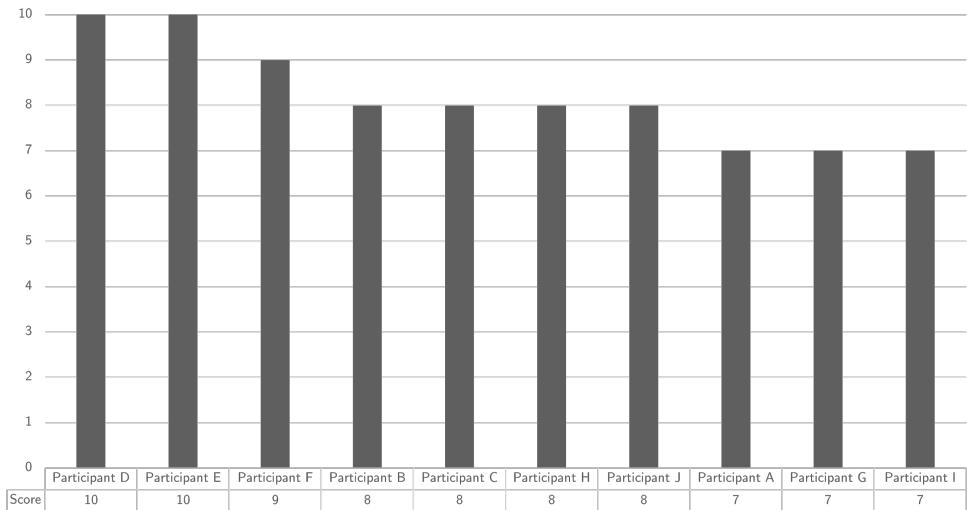


Figure G.3.: Scoring of antifragile attribute Self-Organisation

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

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

G.1.4. Fail-Fast

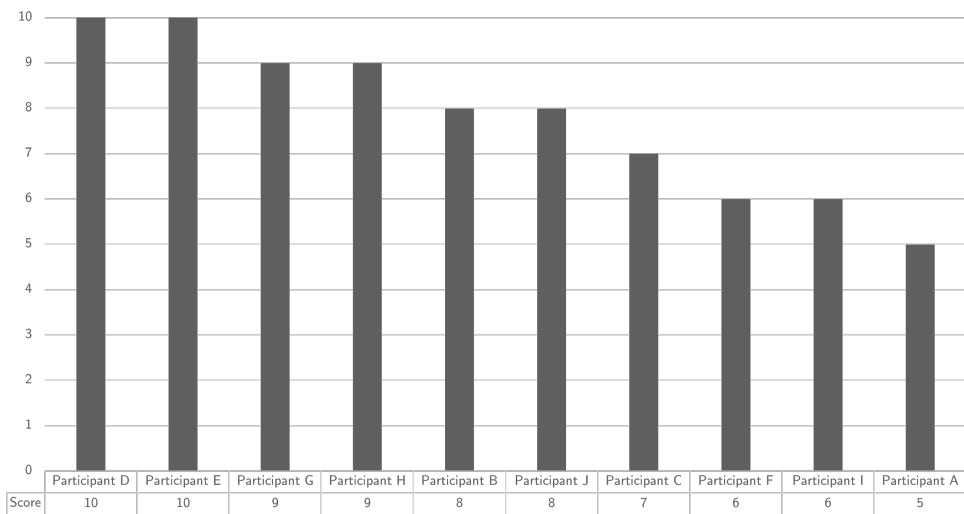


Figure G.4.: Scoring of antifragile attribute Fail-Fast

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

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

G.1.5. Resources to invest

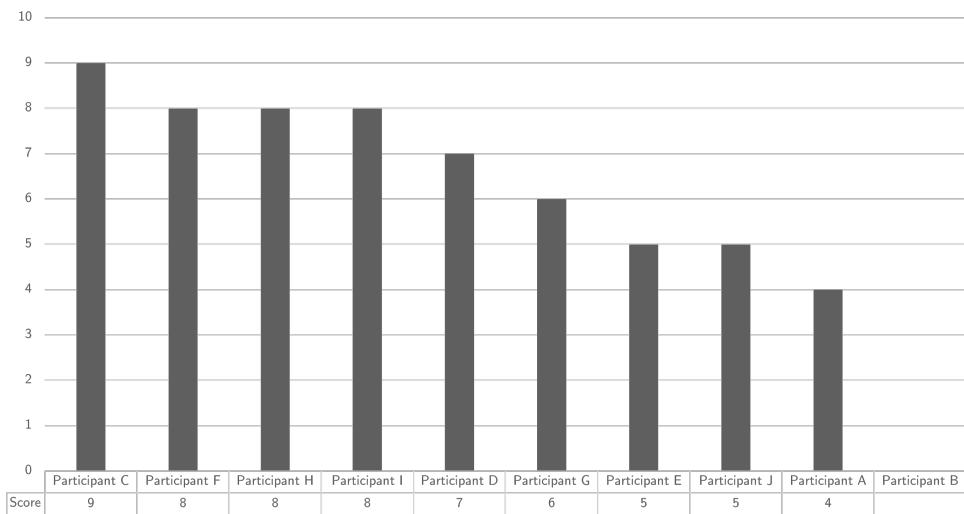


Figure G.5.: Scoring of antifragile attribute Resources to Invest

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

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

G.1.6. Senenca's Barbell

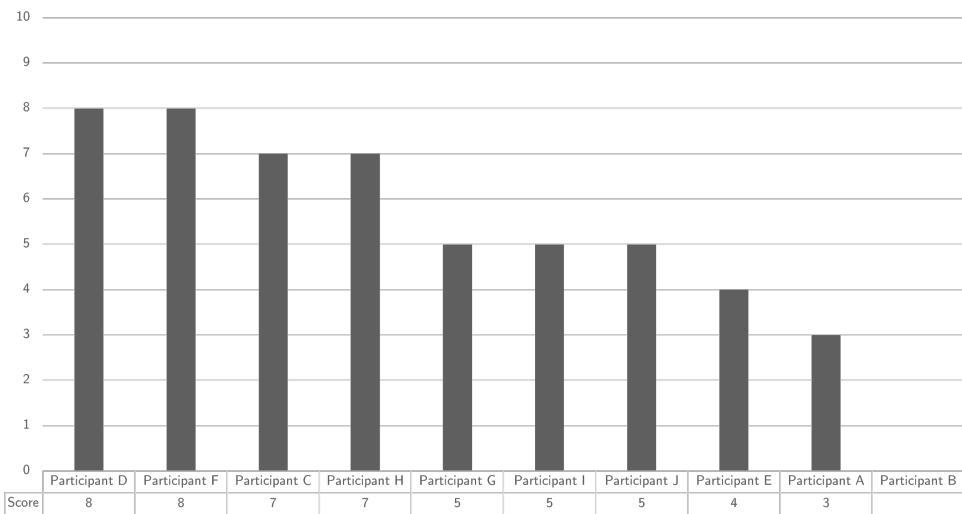


Figure G.6.: Scoring of antifragile attribute Seneca's Barbell

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

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

G.1.7. Safe working environment

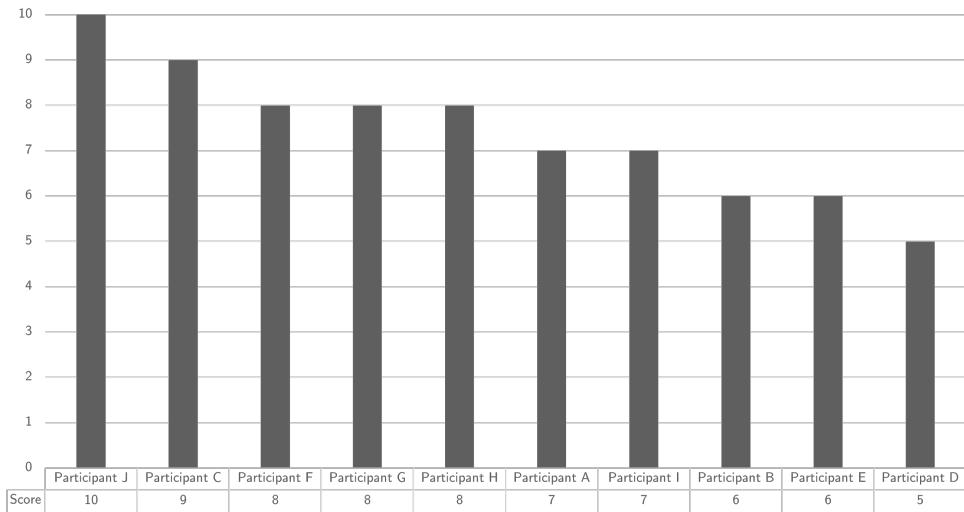


Figure G.7.: Scoring of antifragile attribute Safe working environment

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

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

G.1.8. Naar buiten kijken, samenwerking zoeken

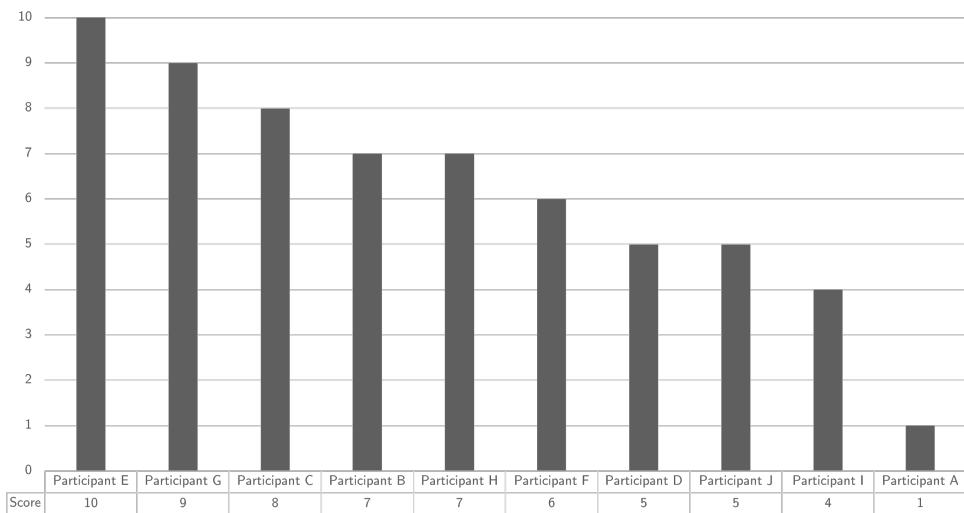


Figure G.8.: Scoring of antifragile attribute Naar buiten kijken

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

Table G.8.: Scoring of antifragile attribute Naar buiten

G.1.9. Data Governance Planes

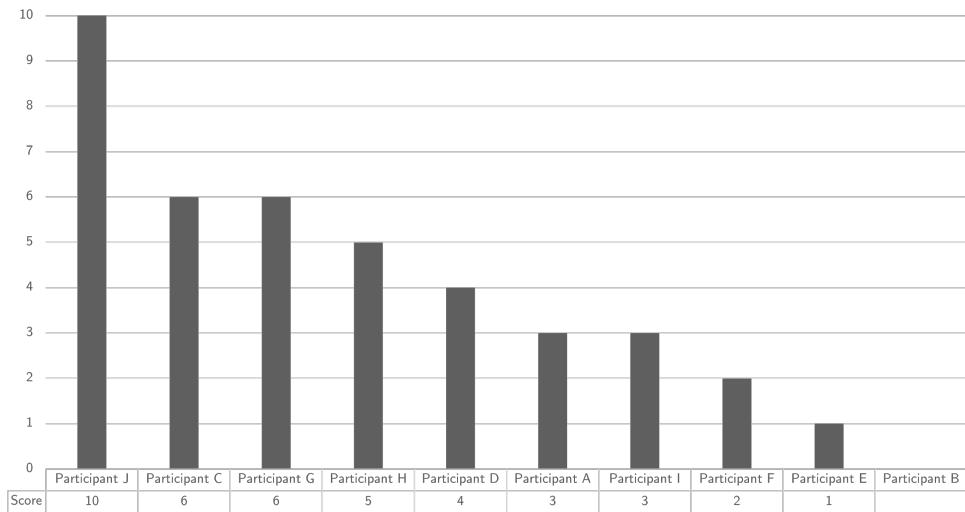


Figure G.9.: Scoring of antifragile attribute Data Governance Planes

Rating	Variability	Abstains
4,4	56%	1

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

G.2. 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.10.: Validation of Enterprise Architecture schools of thought

G.2.1. Enterprise IT Architecting

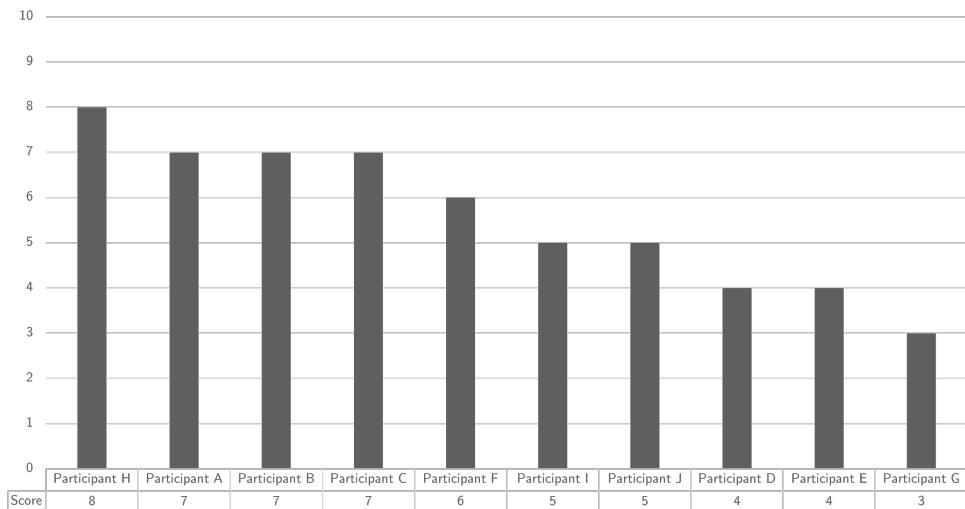


Figure G.10.: Scoring of school of thought Enterprise IT Architecting

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

Table G.11.: Scoring of school of thought Enterprise IT Architecting

G.2.2. Enterprise Integrating

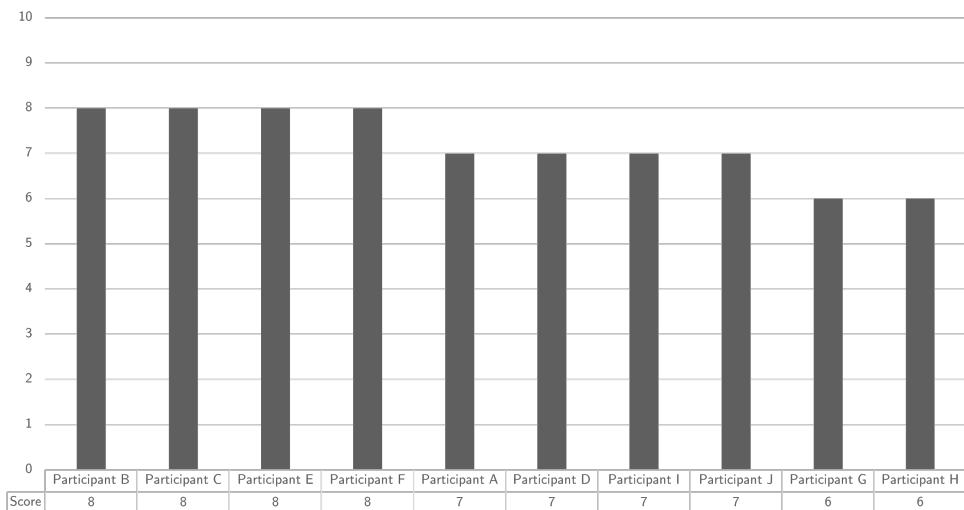


Figure G.11.: Scoring of school of thought Enterprise Integrating

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

Table G.12.: Scoring of school of thought Enterprise Integrating

G.2.3. Enterprise Ecological Adaptation

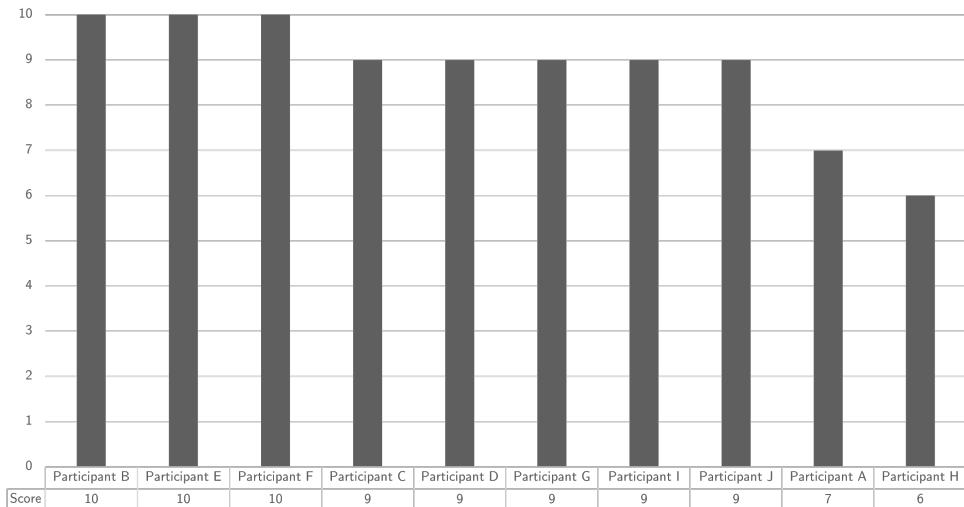


Figure G.12.: Scoring of school of thought Enterprise Ecological Adaptation

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

Table G.13.: Scoring of school of thought Enterprise Ecological Adaptation

G.3. 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.14.: Validation of Enterprise Architecture attributes

G.3.1. Systems-in-Environment thinking

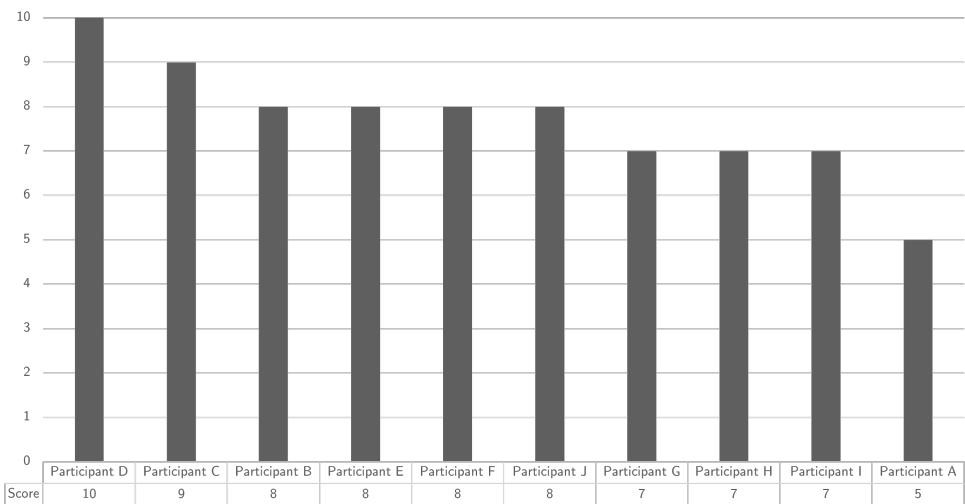


Figure G.13.: Scoring of EA attribute Systems-in-Environment thinking

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

Table G.15.: Scoring of EA attribute Systems-in-Environment thinking

G.3.2. Holistic (systemic) stance

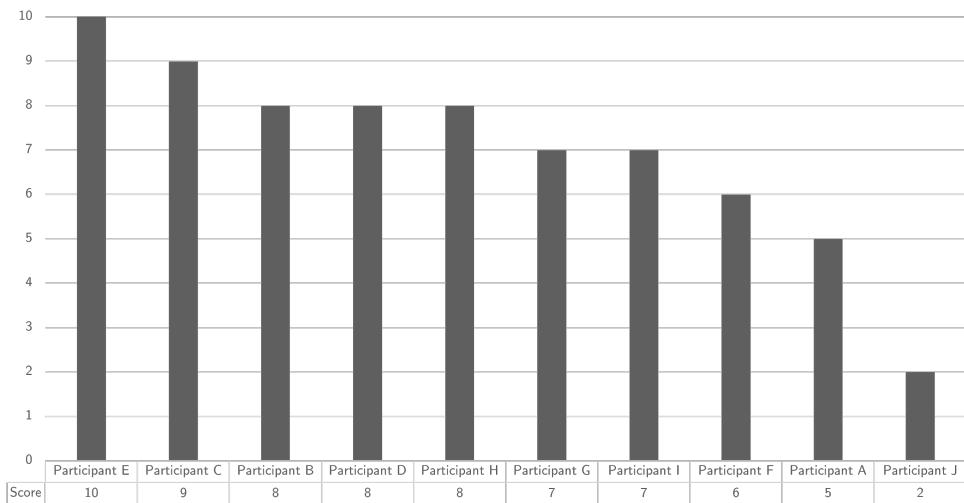


Figure G.14.: Scoring of EA attribute Holistic (systemic) stance

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

Table G.16.: Scoring of EA attribute Holistic (systemic) stance

G.3.3. Organisational learning

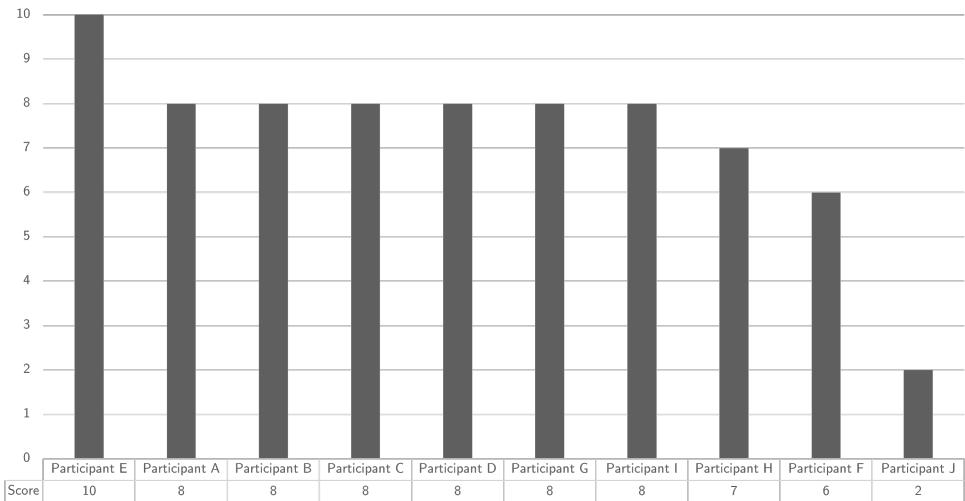


Figure G.15.: Scoring of EA attribute Organisational learning

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

Table G.17.: Scoring of EA attribute Organisational learning

G.3.4. Environmental learning

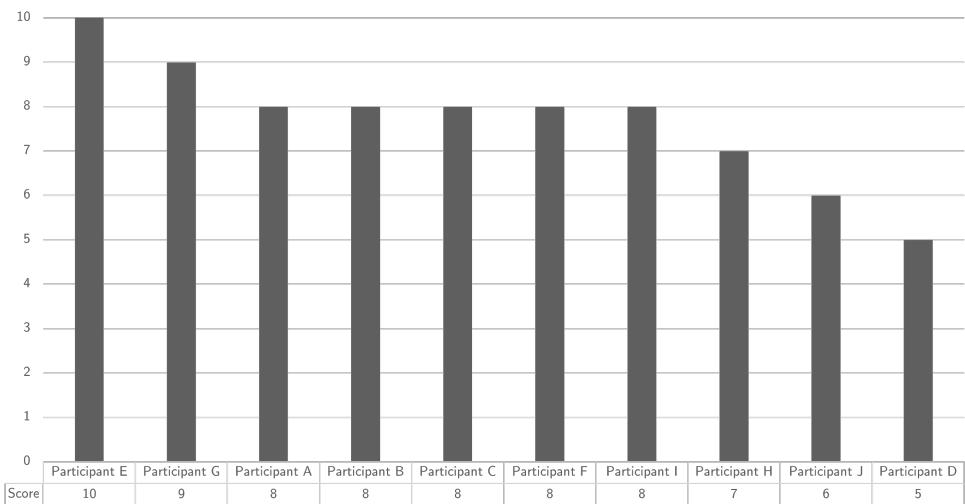


Figure G.16.: Scoring of EA attribute Environmental learning

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

Table G.18.: Scoring of EA attribute Environmental learning

G.3.5. Intra-organisational coherency

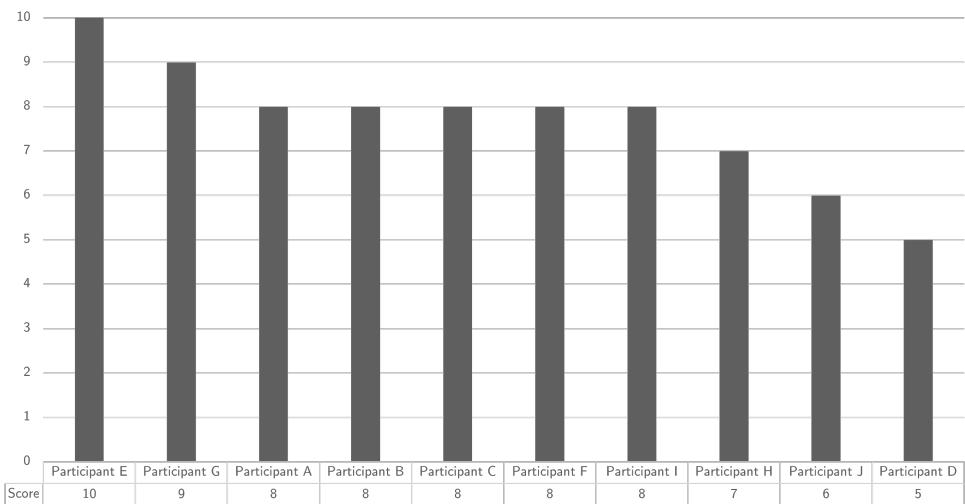


Figure G.17.: Scoring of EA attribute Intra-Organisational coherency

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

Table G.19.: Scoring of EA attribute Intra-Organisational coherency

G.3.6. System-in-Environment Co-Evolution learning

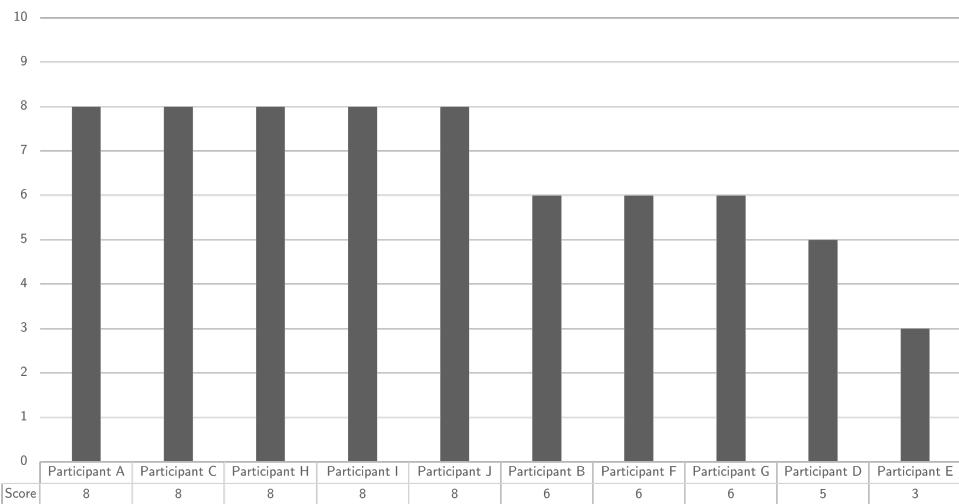


Figure G.18.: Scoring of EA attribute System-in-Environment Co-Evolution learning

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

Table G.20.: Scoring of EA attribute System-in-Environment Co-Evolution learning

G.3.7. Adapt to business language

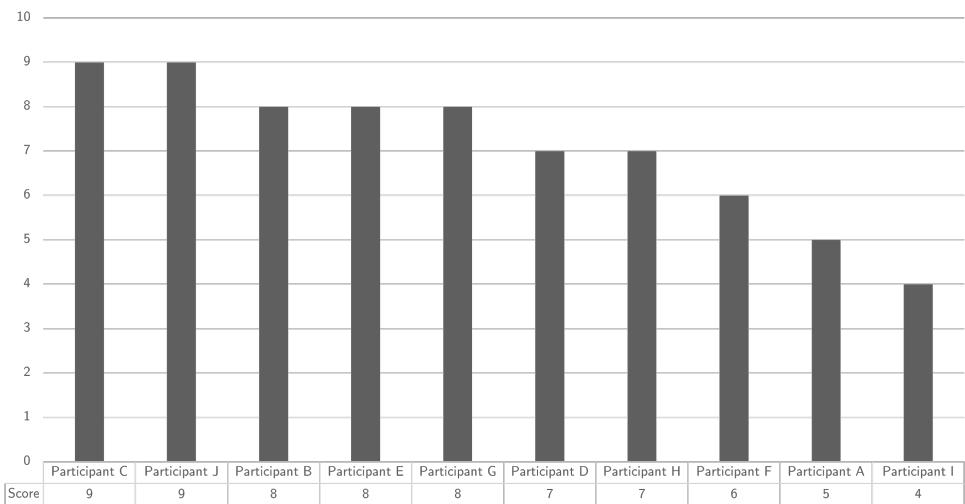


Figure G.19.: Scoring of EA attribute adapt to business language

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

Table G.21.: Scoring of EA attribute adapt to business language

G.3.8. Agile Enterprise

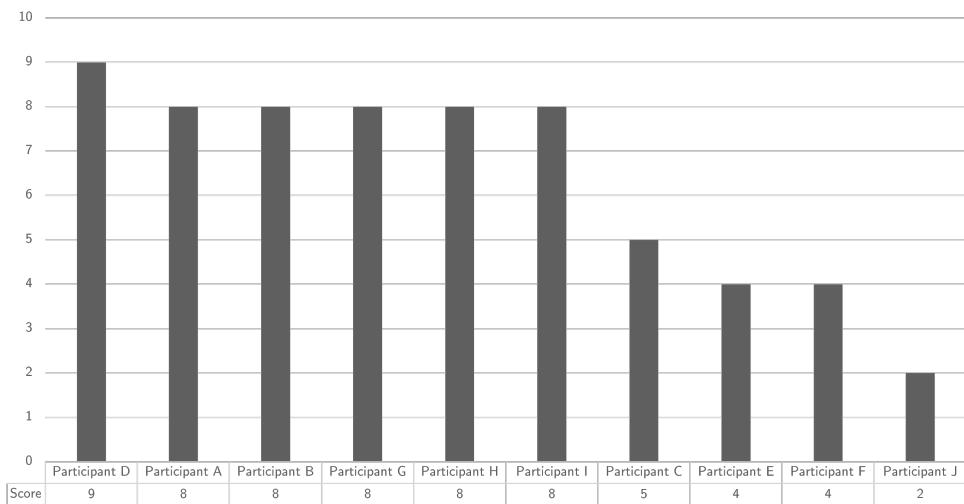


Figure G.20.: Scoring of EA attribute Agile Enterprise

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

Table G.22.: Scoring of EA attribute Agile Enterprise

G.3.9. Real Time Trust

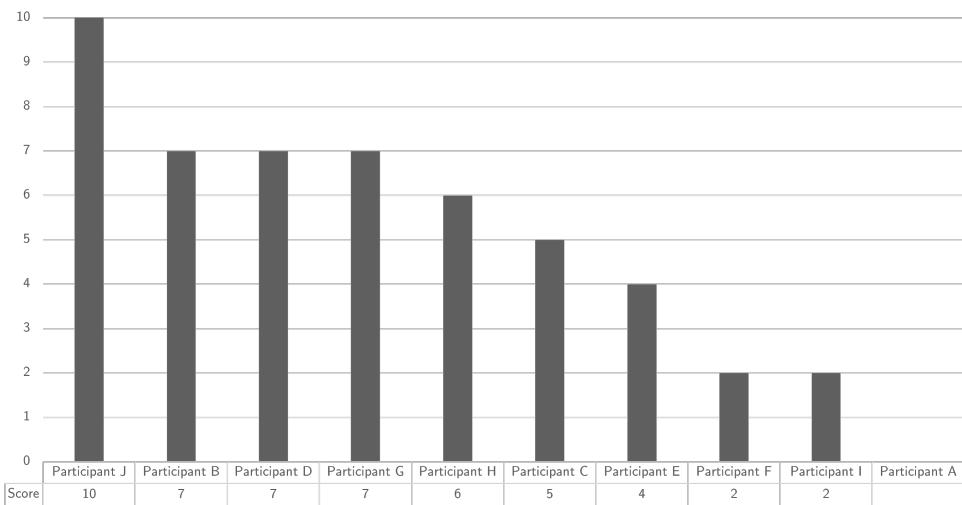


Figure G.21.: Scoring of EA attribute Real Time Trust

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

Table G.23.: Scoring of EA attribute Real Time Trust

G.3.10. Foster Dialogue

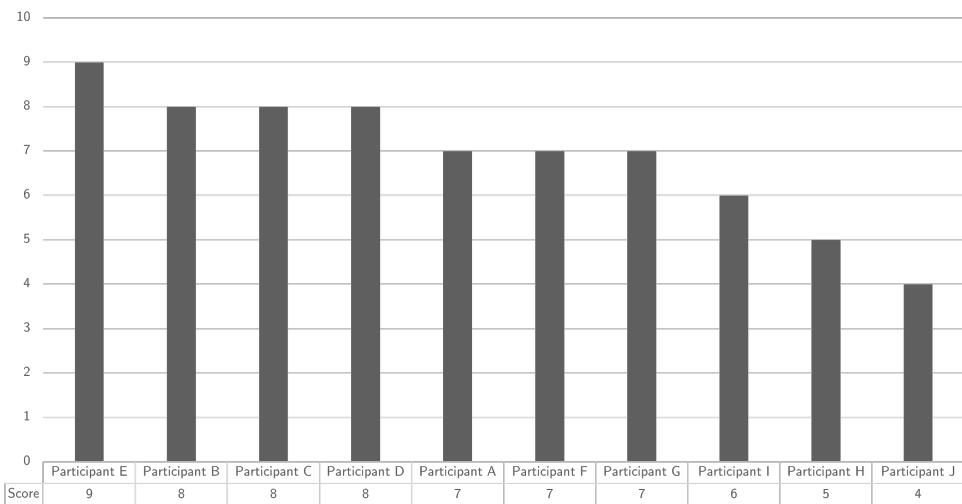


Figure G.22.: Scoring of EA attribute Foster Dialogue

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

Table G.24.: Scoring of EA attribute Foster Dialogue

G.3.11. Validation

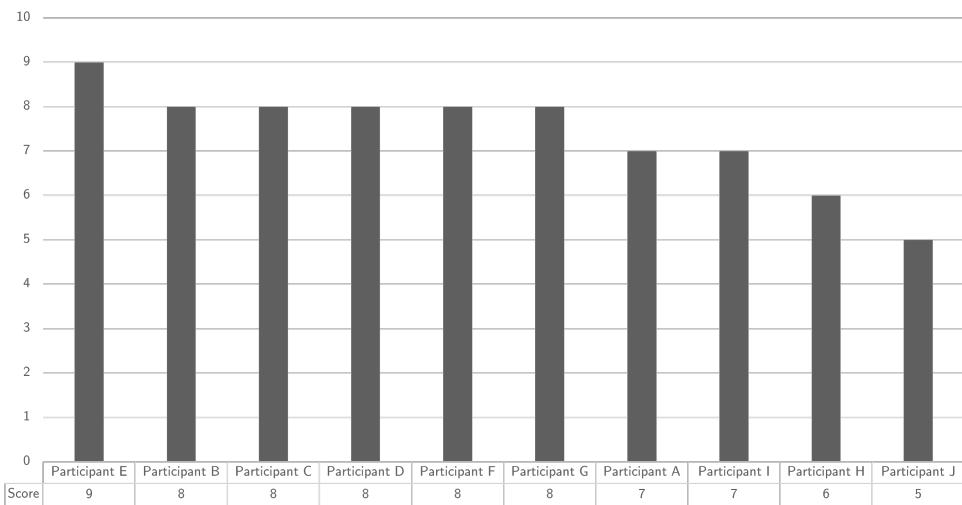


Figure G.23.: Scoring of EA attribute Validation

Attribute	Rating	Variability	Abstains
Validation	7,4	24%	0

Table G.25.: Scoring of EA attribute Validation

G.3.12. Always fitting Enterprise Architecture

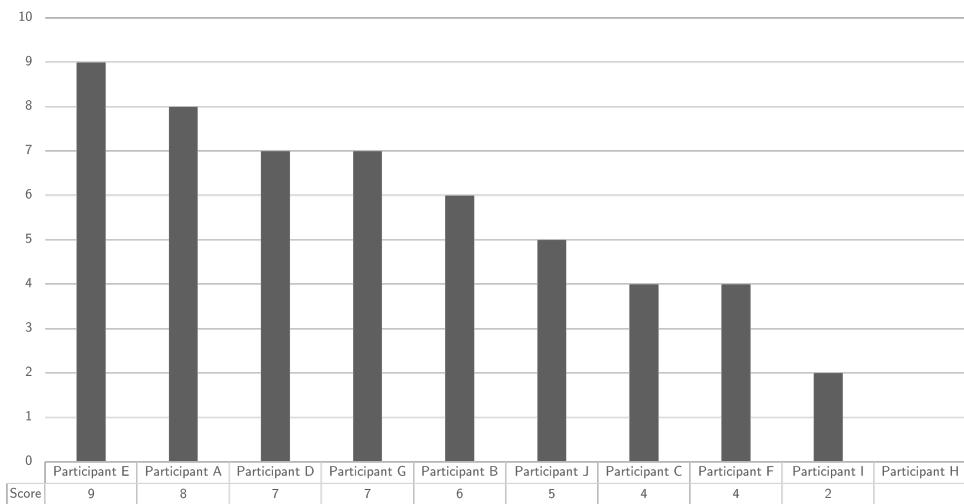


Figure G.24.: Scoring of EA attribute Always fitting EA

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

Table G.26.: Scoring of EA attribute Always fitting EA

G.4. Closing Survey

G.5. 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.27.: Follow-up Survey