

Accelerating in a world of chaos

by using Enterprise Architecture with the concept of antifragile

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

– *Nassim Nicholas Taleb*

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

– *Plato*

”The only constant is change.”

– *Heraclitus*

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” I have found out how little I actually know ”

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Accelerating in a world of chaos

by using Enterprise Architecture with the concept Antifragility

René Bliekendaal

Abstract

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1. Introduction

The Greek philosopher Heraclitus once said that one constant since the beginning of time is change. However, the fear of change is also a constant. His central claim is summed up in the phrase Panta Rhei ("life is flux"), recognising life's essential, underlying essence as change¹. Nothing in life is permanent, nor can it be, because the very nature of existence is change. Since times 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 1.4, 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. 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.

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

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. ?? describes the found attributes from the literature that can be success factors. ?? ends with an overview of found attributes of EA and antifragile that could contribute to the public sector to become antifragile. These attributes are the point of departure for further investigation. chapter 4 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 5 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 ?? 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 7. This thesis ends with chapter 8 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.

1.2. 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.

1.3. 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).

1.4. Introduction of the concept of antifragility

Taleb (2016) describes a Black Swan event as an event that is so rare that even the possibility that it might occur is unknown, has a catastrophic impact when it does occur, and is explained in hindsight as if it were predictable (Taleb, 2021, p. 4).

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

1.5. 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 1.3, 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.

1.6. Research subject

As described in section 1.3, 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?

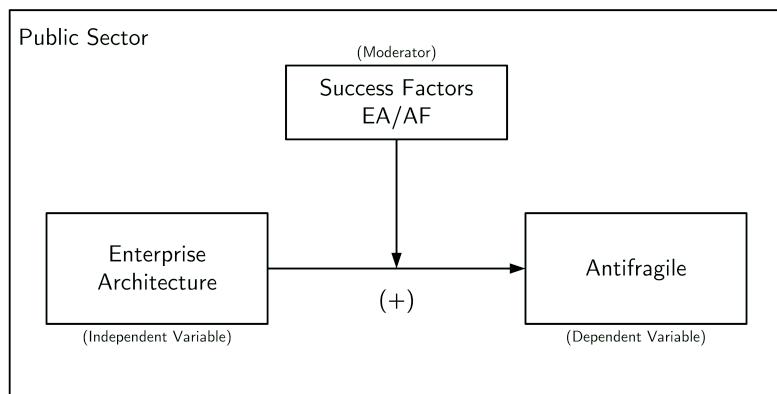


Figure 1.2.: Conceptual Research Model

1.7. Research question

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

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

The following sub-questions support answering the research question:

1. What is 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?

1.8. 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.

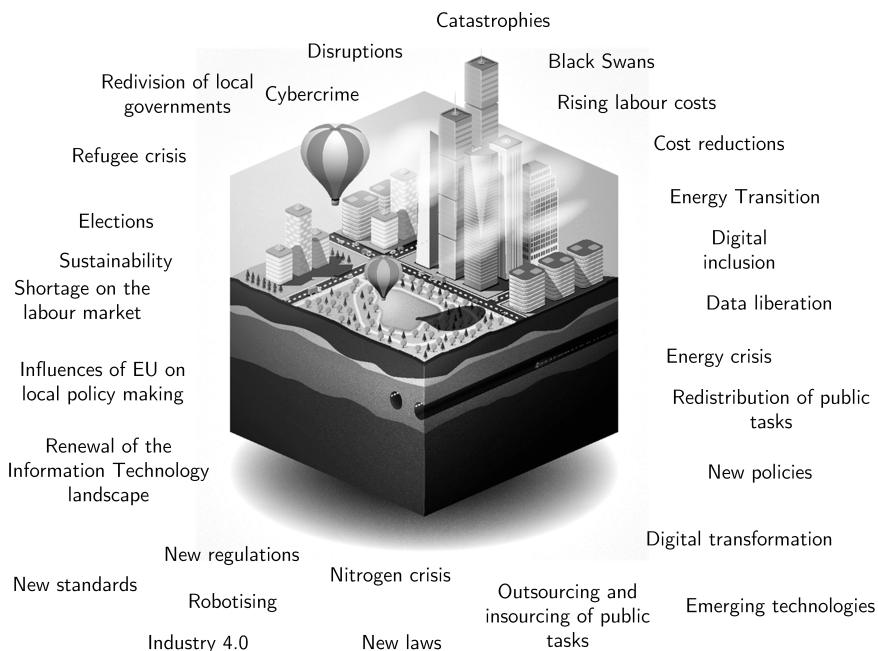


Figure 1.3.: Examples of stressors on the public sector

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

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 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 research uses three main concepts of interest: the *public sector*, *antifragile*, and *Enterprise Architecture*. Understanding the interpretation of these concepts is essential for a shared mental model. Besides the three main concepts, it is vital to understand the concept system. The three main concepts use *system* as a concept. The concepts *public sector*, *antifragile*, *EA*, and *system* are defined for this shared mental model.

2.1. System

Literature often uses the same concept of system but with a different meaning (Lapalme, 2012, p. 37). System is used for many different things like software applications, interrelated people, systems of numerous interrelated elements (economical, socal, technological) and others (Lapalme, 2012, p. 37).

System has various definitions and types. E.g. open and closed, linear and nonlinear, dynamic and deterministic systems (Rickles et al., 2007). A system can be an area of interest (Mannaert et al., 2016, p. 13). However, with another definition, a system is an object that is studied in the field (Rickles et al., 2007, p. 933). Both definitions are similar. The former acknowledged that the system is not isolated. The system of concern and systems in the environment have interactions (Mannaert et al., 2016, p. 13–14). 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).

A system is more than the sum of its parts. It is an indivisible whole (Ackoff et al., 1964, p. 51–69; Ackoff, 1973, p. 664). A system loses its essential properties when taken apart. The elements of a system can also themselves be systems. Every system can be a part of another system. These systems are also called sub-systems. This managerial idea of systems thinking is to focus on the interactions of the parts rather than their behaviour separately (Ackoff et al., 1964).

A mental model to understand a system is dependent on specific characteristics of the behaviour of a system. Understanding the behaviour of a system can only be in its environment (Gharajedaghi, 2011, p. 29). The boundary of a system is defined by the variables that can be influenced or controlled by the actors of that system (Gharajedaghi, 2011, p. 182). 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). Understanding the environment will help to influence the environment. The *Why they do* and *What they do* of the actors in the environment help with influencing the environment (Gharajedaghi, 2011, p. 33). To

understand the inner workings, one needs the ability to see complementary relations in opposing tendencies and to create feasible wholes with infeasible parts (Gharajedaghi, 2011, p. 38). However, the properties of a system are not the properties of its parts but that of the whole (Ackoff, 1973; Gharajedaghi, 2011). Because of these properties, actions intended to produce the desired outcome may generate opposite results, resulting in counter-intuitive behaviour (Gharajedaghi, 2011, p. 48).

The concepts of the public sector, EA and antifragility use different specialisations of the concept system. These specialisations are *System-of-Systems (SoS)*, *System-in-Environment (SiE)*, and *Ecosystem*.

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

A collection of independent systems that are part of a more extensive system has unique capabilities (INCOSE, 2018). The independent systems working together have unique behaviour that they do not have on their own (INCOSE, 2018). A System-of-Systems is composed of multiple systems (Ackoff, 1973; Gharajedaghi, 2011). Using System-in-Environment stresses that a system is part of and should be aware of its environment (Gharajedaghi, 2011; Lapalme, 2012; Korhonen et al., 2016; Mannaert et al., 2016). Another variation is that of a System-in-Environment. System-in-Environment is a means to enforce environmental learning. With environmental learning, an enterprise adapts its desired goals to be more compatible with its environment (Lapalme, 2012, p. 41).

2.1.2. Ecosystem

The concept of ecosystem originated from the field of ecology. It was firstly defined by Tansley (1935, p. 229) (Rich, 1988, p. 19). "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", is the ecosystem as defined by Tansley (1935, p. 299). There are multiple transfers of the ecological ecosystem concept onto additional domains (Guggenberger et al., 2020, p. 3). 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 (Moore, 1993, p. 76). A business ecosystem is a concept that various businesses form value creation networks together (Guggenberger et al., 2020, p. 3). Ecosystems can be described as "a set of actors with varying degrees of multilateral, non-generic complementarities that are not fully hierarchically controlled" (Jacobides et al., 2018, p. 2255). There are different ways to order kinds of ecosystems. One way is that of dividing ecosystems into five specialisations. Business ecosystem (Moore, 1993, p. 76), platform ecosystem (Guggenberger et al., 2020, p. 5), service ecosystem (Barros & Dumas, 2006; Papazoglou & van den Heuvel, 2006; Huang et al., 2014), innovation ecosystem (Iansiti & Levien, 2004; Carayannis & Campbell, 2009; Gomes et al., 2018), and software ecosystem (Manikas & Hansen, 2013; Guggenberger et al., 2020, p. 5) are possible specialisations (Guggenberger et al., 2020, p. 5).

The definitions of System-of-Systems and System-in-Environment are within the general definition of a system previously defined by Ackoff (1973), Gharajedaghi (2011,

p. 183) and Mannaert et al. (2016, pp. 13–14).

2.2. Antifragile

What is antifragile, where did it originate, what can you achieve with it, and why is antifragile important? These questions are the first things that come to mind when hearing antifragile for the first time.

Antifragile originated from the domain of risk management. Antifragile was coined for the first time by Taleb (2021) as an answer to Black Swan events (Taleb, 2016). Black Swan events are large-scale unpredictable, and rare events of massive consequences (Taleb, 2021, p. 6). The rarer the event, the less tractable, and the less we know about how frequent its occurrence (Taleb, 2021, p. 7). The odds of rare events are not computable (Taleb, 2021, p. 7). "Given the unattainability of perfect robustness, we need a mechanism by which the system regenerates itself continuously by using, rather than suffering from, random events, unpredictable shocks, stressors, and volatility" (Taleb, 2021, p. 8). With random events robust is not good enough. Everything with the most minute vulnerability breaks. Robustness cannot just be it, perfect robustness is needed not to end up crashing the system (Taleb, 2021, p. 8). Fragile systems fail when exposed to stressors (Ghasemi & Alizadeh, 2017, p. 21). However, antifragile systems prosper and improve in response to unpredictability, volatile, randomness, chaos and disturbance (Ghasemi & Alizadeh, 2017, p. 21). Antifragility goes beyond resiliency or robustness (Ghasemi & Alizadeh, 2017, p. 21) (figure 2.1).

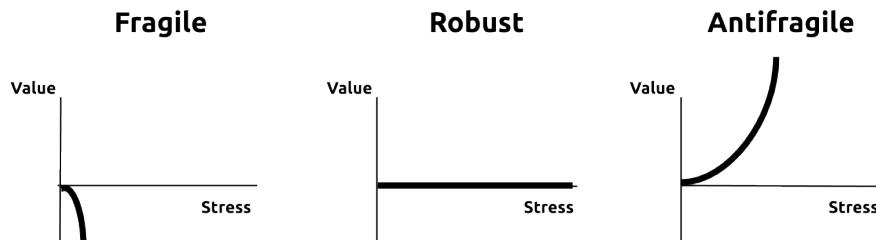


Figure 2.1.: Triad of fragile, robust, and antifragile (Botjes et al., 2021)

Antifragile means that a system gains more than it loses. Positive asymmetry is achievable by reducing possible losses (Russo & Ciancarini, 2017, p. 942). Reducing possible losses will reduce the harmful effects of exposure to damaging elements such as stressors and Black Swan event (Russo & Ciancarini, 2017, p. 942). Fragility and antifragility mean potential gain or harm from exposure to something related to volatility (Taleb, 2021, p. 13). That something is what Taleb (2021) calls a member of the extended disorder family. This disorder family consists of uncertainty, variability, imperfect, incomplete knowledge, chance, chaos, volatility, disorder, entropy, time, the unknown, randomness, turmoil, stressors, error, dispersion of outcomes, unacknowledged (Taleb, 2021, p. 13). The disorder family is interpreted by Botjes (2020, p. 12), based on the works of Taleb (2021, p. 436) and Gorgeon (2015, p. 3), as Volatility, Uncertainty,

Complexity and Ambiguity from Bennis and Nanus (1985). Antifragility is not only an answer to a Black Swan event but also to random events, unpredictable shocks, stressors, and volatility (Taleb, 2021, p. 8).

2.2.1. Stressor

Publications on the subject of antifragile often use *stressor* (Botjes, 2020, p. 32). What is a *stressor*? Ghasemi and Alizadeh (2017, p. 23) defined *stressor* based on Turner II et al. (2003) and Chrouzos (2009) as "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." (Ghasemi & Alizadeh, 2017, p. 23). *Stressors* include natural disasters, customer demand randomness, financial crises, volatile customer tastes, and other unanticipated factors (Dongxia & Kan, 2011, p. 1981).

2.2.2. Antifragile as a system property

A diversity of researchers define that fragility, robustness and antifragility are properties of a system, like Jaaron and Backhouse (2014), Kastner (2017), O'Reilly (2019) and Botjes et al. (2021). It is important to realise that the degree of antifragility of a system is often a function of its internal structure (O'Reilly, 2019, p. 886). The ability to change under stress is governed by the interconnectedness of its sub-systems, how loosely coupled those sub-systems are and how much of a change ripples through the system (O'Reilly, 2019, p. 886). Self-organisation, ownership, diversity, shared mental models and a shared vision are some of the properties that an antifragile system should possess (Jaaron & Backhouse, 2014; Hole, 2016; Kastner, 2017; O'Reilly, 2019; Botjes et al., 2021). Botjes et al. (2021) conducted extensive research to define antifragility and the application of antifragility on organisation design. Botjes et al. (2021) used multiple sources (table 2.1) to define a list of attributes.

Sources used by Botjes et al. (2021)	
Ghasemi and Alizadeh (2017)	Johnson and Gheorghe (2013)
Kennon et al. (2015)	Markey-Towler (2018)
Hendriksson et al. (2016)	Kastner (2017)
Gorgeon (2015)	Hole (2016)
O'Reilly (2019)	

Table 2.1.: Sources used for antifragile attributes

The result of Botjes et al. (2021) is the Extended Antifragile Attribute List (EAAL) (figure 2.2). The Extended Antifragile Attribute List (EAAL) of Botjes et al. (2021) is recent. Botjes et al. (2021) used a data set collected by Botjes (2020). Botjes (2020)

created the data set through extensive literature research, but it only covers literature until June 2019 (Botjes et al., 2021, p. 5).

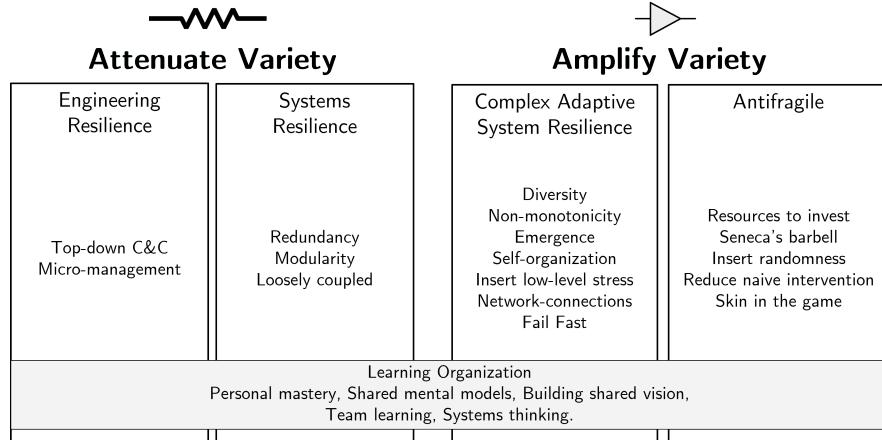


Figure 2.2.: Extended Antifragile Attribute List (Botjes et al., 2021)

Searching for *new* literature makes sure that Botjes et al. (2021) is recent and is not rebutted. Using the time frame of June 2019 until April 2022 makes sure that only new literature is found. The result of the search was thirty-one new sources. These sources are new articles, books and in-proceedings (appendix C). Of those thirty-one new sources, three were already in the literature set of Botjes (2020). Eight were not found or publicly available, and thirteen were not relevant. Only seven were of interest to look at. After finalising the research, none of the literature added something new or rebutted the work of Botjes (2020). Botjes et al. (2021) is recent and contains attributes for a system, System-of-Systems, and a System-in-Environment to become more antifragile.

The Extended Antifragile Attribute List classifies attributes in two primary and five secondary categories. *Attenuate variety* and *amplify variety* are the two primary categories. The five secondary categories are *engineering resilience*, *systems resilience*, *complex adaptive systems resilience*, *antifragile* and *learning organisation*. The Extended Antifragile Attribute List does not contain resilience as a secondary category but multiple types of resilience. The Extended Antifragile Attribute List assigned the secondary categories to the primary categories. *Engineering resilience* and *systems resilience* are assigned to *attenuate variety*, while *complex adaptive systems resilience* and *antifragile* to *amplify variety*. *Learning organisation* is the only category assigned to both *attenuate variety* and *amplify variety*.

2.2.3. Resilience

Resiliency is mentioned often in relation to antifragility. Botjes et al. (2021, p. 3) uses the definitions of Martin-Breen and Anderies (2011, pp. 5–8). Martin-Breen and Anderies (2011, pp. 5–8) identified several types of resiliency. These types are *engineering resilience*, *systems resilience*, and *complex adaptive systems resilience*. The definitions

of resiliency (table 2.2) have focus on the avoidance of harmful stressors and failure, including uncertainty and volatility (Martin-Breen & Anderies, 2011, pp. 5–8).

Type	Description
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.
Complex adaptive systems resilience	The ability to withstand, recover from, and re-organise 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.

Table 2.2.: Types of resilience (Martin-Breen & Anderies, 2011)

2.2.4. Learning organisation

One of the secondary categories of Extended Antifragile Attribute List is learning organisation. But what is the learning organisation? The learning organisation is a way to create resilient organisations. These resilient organisations can cope better with unknown and unpredictable events. "Continuous improvement requires commitment to learning." (Garvin, 1993). The learning organisation is an organisation that is equipped for creating, acquiring, and transferring knowledge (Garvin, 1993). The result of this is that a learning organisation can modify its behaviour to reflect new knowledge and insights (Garvin, 1993). Senge (1994) defined the attributes of the learning organisation that Botjes et al. (2021) used in Extended Antifragile Attribute List (figure 2.3). These attributes are *personal mastery*, *shared mental models*, *building shared vision*, *team learning*, and *systems thinking*.

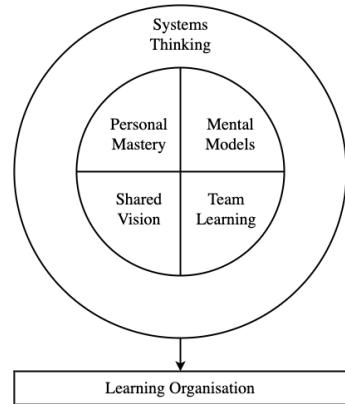


Figure 2.3.: The fifth discipline

2.2.5. Attenuate variety and amplified variety

The two main categories in the Extended Antifragile Attribute List are attenuate variety and amplify variety. What is attenuate variety and amplify variety? Variety originated from Cybernetics and was coined by Ashby (1956). Variety denotes the count of states

of a system (Ashby, 1956; Ashby, 1958). "Ashby and Beer stated the Law of Requisite Variety as 'variety can destroy variety' (Ashby, 1956, p. 207) and 'variety absorbs variety' (Beer, 1979, p. 286)." (Botjes, 2020, p. 31). Heylighen and Joslyn (2001) described it with one single statement: "If a system is to be stable, the number of states of its control mechanism must be greater than or equal to the number of states in the system being controlled." But what about the types of attenuate and amplify? Attenuate variety is reducing the variety in a system, while amplify variety is increasing the variety in a system. "To amplify internal variety is about increasing the chance of a higher entropy and, therefore, more capable of absorbing the increasing external variety caused by change." (Botjes et al., 2021, p. 31). Attenuate variety is about increasing the chance of a lower entropy and, therefore, less capable of absorbing increasing external variety caused by change (Botjes et al., 2021, p. 31). Engineering resilience and systems resilience result from attenuate variety, while complex adaptive systems resilience and antifragile are a result of amplify variety (Botjes et al., 2021, p. 31). Another interpretation is possible. Attenuate variety increases the fragility of a system, while amplify variety decreases the fragility and increases the antifragility of a system.

2.2.6. Is agility antifragile?

What is the relation between agile and antifragile? Is agile fragile, robust or antifragile? This question is improperly framed according to Tomov (2019, p. 6). Agility can be fragile, robust or antifragile. Antifragility and robustness are mathematically defined as properties, while agility is not (Tomov, 2019, p. 6). 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. By architecting antifragility, businesses can gain agility. We must build systems that aim to be antifragile to change is better than trying to control change O'Reilly (2019, abstract). It results in the possibility of creating business and technical architectures that enable agility through design. Aghina et al. (2018, p. 7) defined five trademarks and twenty-three practices for organisational agility. When you combine these trademarks and practices with the Extended Antifragile Attribute List 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 the Extended Antifragile Attribute List it is possible to achieve agility in a system,. Agility can be the result of applying antifragile attributes. Agility is a result of implementation, while antifragile is a properties of a system.

2.2.7. Antifragile system attributes

The Extended Antifragile Attribute List is selected as a source and starting point for antifragile attributes (section 2.2.2). Optionality is stated as an essential attribute by Taleb (2021) and Botjes (2020, p. 64). Optionality is excluded from the Extended Antifragile Attribute List because of the overlap with diversity (Botjes, 2020, p. 64). But Taleb (2021) and Gorgeon (2015, p. 9) both use the term optionality. Optionality is an idea advanced by Taleb (2021). At the most basic level, optionality means having lots of

options. The difference between optionality and diversity is very subtle. Optionality allows the buyer to retain the upper bound and be unaffected by adverse outcomes which makes the buyer antifragile¹. Despite the minimal difference between optionality and diversity, optionality can still have a distinctive character in the public sector. Adding optionality to the already defined set of the Extended Antifragile Attribute List brings a total of twenty-three attributes. The Extended Antifragile Attribute List categorised the attributes into attenuate variety, amplify variety, and learning organisation. Adding optionality to amplify variety makes it equal to diversity. For the overview of the attributes for antifragile see table 2.3.

Attribute	Category
Top-Down Command & Control	Attenuate variety
Micro-Management	Attenuate variety
Redundancy	Attenuate variety
Modularity	Attenuate variety
Loosely coupled	Attenuate variety
Diversity	Amplify variety
Non-monotonicity	Amplify variety
Emergence	Amplify variety
Self-organisation	Amplify variety
Insert low-level stress	Amplify variety
Network-connections	Amplify variety
Fail-Fast	Amplify variety
Resources to invest	Amplify variety
Seneca's barbell	Amplify variety
Insert randomness	Amplify variety
Reduce naive intervention	Amplify variety
Skin in the game	Amplify variety
Optionality	Amplify variety
Personal mastery	Learning organisation
Shared mental model	Learning organisation
Building shared vision	Learning organisation
Team learning	Learning organisation
Systems thinking	Learning organisation

Table 2.3.: Antifragile system attributes

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

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 1.2 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.

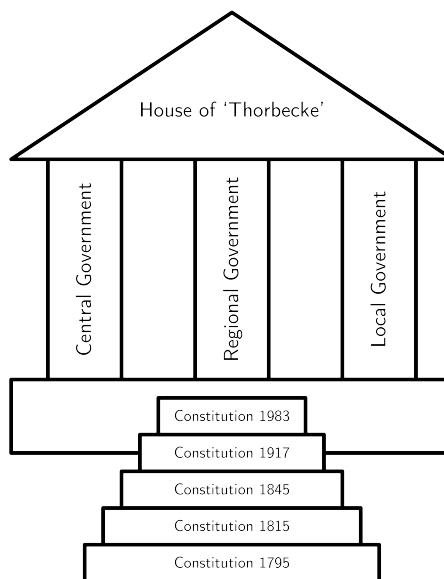


Figure 2.4.: The House of 'Thorbecke'

I will focus this research on the public sector level local government of the Netherlands. In section 7.2 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.

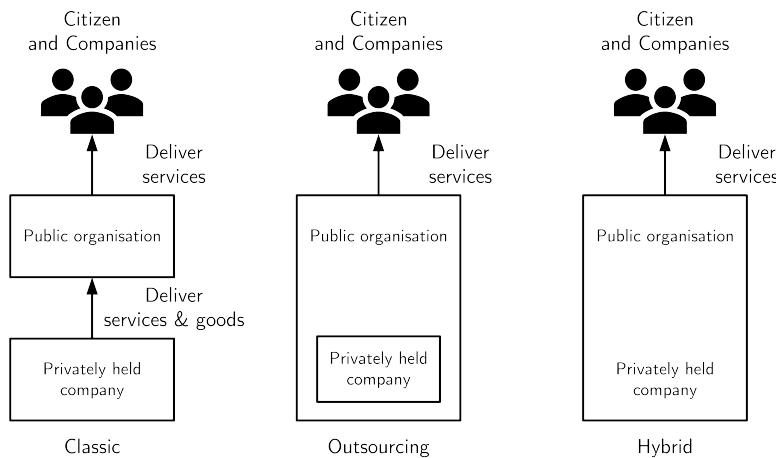


Figure 2.5.: Public sector collaboration models

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

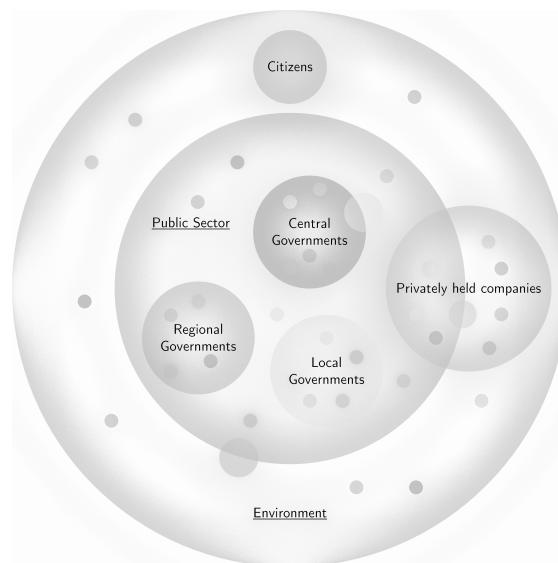


Figure 2.6.: Public Sector as a System-of-Systems

2.4. Enterprise Architecture

This research is about which success factors positively influence Enterprise Architecture (EA) in achieving antifragility in the public sector. This statement already assumes that EA is a means to achieve a goal. Is this correct? Does the world have the same idea about EA, or do they see it differently? Can EA contribute to reaching the goals of an

organisation or even a system? Regardless of the attention EA gets, many researchers and practitioners have indicated that there is a lack of a shared mental model (Saint-Louis et al., 2019, p. 2). The various definitions are not always complimentary, and sometimes they are even opposite (Hoogervorst, 2009; Lapalme, 2012; Saint-Louis et al., 2019). A lens on Enterprise Architecture needs to be defined for this research to create a shared understanding of Enterprise Architecture. There is no shared mental model of Enterprise Architecture (Saint-Louis et al., 2019, p. 2). The lack of a shared mental model can create confusion and conflicts concerning the purpose of Enterprise Architecture and its practice (Saint-Louis et al., 2019, p. 1). The definitions vary in the scope of application. Some definitions only focus on IT systems, while others focus on the business, the enterprise, the environment, or any other combination. E.g. the definitions from Gartner (n.d.), Graves (2009), Ross et al. (2014) and White (2018).

Definition of Gartner (n.d.): Enterprise Architecture analyses the execution of change toward a desired business vision and outcomes. Enterprise Architecture leads the enterprise proactively and holistically, responding to disruptive forces.

Definition of Graves (2009, p. 5): Enterprise Architecture is the organising logic for business processes and IT infrastructure, reflecting its operating model's integration and standardisation requirements. It provides a long term view of a company's processes, systems and technologies so that individuals can build capabilities and not just fulfil immediate needs.

Definition of Ross et al. (2014, p. 9): Enterprise Architecture is the organising logic for business processes and IT infrastructure, reflecting its operating model's integration and standardisation requirements. It provides a long term view of a company's processes, systems and technologies so that individuals can build capabilities and not just fulfil immediate needs.

Definition of White (2018): Enterprise Architecture is the process by which organizations standardize and organize IT infrastructure to align with business goals. These strategies support digital transformation, IT growth and the modernization of IT as a department. EA is the practice of analysing, designing, planning and implementing enterprise analysis to successfully execute on business strategies. EA helps to lay out how information, business and technology flow together.

All four Enterprise Architecture definition examples provide decision-support for direction and change at any level of the enterprise. 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 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). Enterprise

Architecture assists in managing changes imposed on the organisation from the outside, by the market, by regulations, or at an operations level, by system failures, environmental incidents or customer complaints (Graves, 2009, p. 5). EA can support re-designs and re-organisation, especially during significant organisational changes, mergers or acquisitions (White, 2018). System development, IT Management, decision-making, and IT risk management are examples of capabilities supported by EA (Graves, 2009; Ross et al., 2014; White, 2018). Because a shared mental model is absent, there is also no clear approach to practising Enterprise Architecture (Saint-Louis et al., 2019, p. 2).

2.4.1. Approaches of Enterprise Architecture

There are several perspectives to the practice of EA (Lapalme, 2012; Kotusev et al., 2015; Ylinen & Pekkola, 2018; Ylinen & Pekkola, 2020). One of the perspectives is an approach that distinguishes two groups of EA experts. A modelling-focused group forms a comprehensive view of an organisation, and a development-focused group using EA for organisational development (Ylinen & Pekkola, 2020, p. 6).

Approach	Description
Traditional	A four-step sequential process. Document the current (as-is, baseline) state, develop the desired future (to-be, future) state and the transition plan to migrate from the current to the target state, and implement the plan and repeat the process.
MIT	Advocates the development of a long-term enterprise-level architectural vision to be translated into concrete project-level decisions through IT governance mechanisms. These decisions involve business and IT managers on different organisational levels.
DYA	“Just enough, just in time” architecture. The development of EA starts no earlier than there is a need for it. Business initiatives trigger the activities of EA to make sure that needed projects fit nicely into the existing EA and in the strategic plans of the enterprise.

Table 2.4.: Three approaches to Enterprise Architecture

However, another perspective distinguished three approaches (Kotusev et al., 2015, p. 4071). The traditional (Spewak, 1993), the Massachusetts Institute of Technology (MIT) (Ross et al., 2014), and the DYnamic Architecture (DYA) (Berg et al., 2005) approach (Kotusev et al., 2015, pp. 4071–4072) (table 2.4). When you scrutinise the definitions of the three approaches, it becomes clear that the approaches are focused on organisations and not the environment. The EA three schools of thought from Lapalme

(2012) gives another perspective. Three possible schools of thought in the practice of EA are, Enterprise IT Architecting, Enterprise Integrating, and Enterprise Ecological Adaptation (Lapalme, 2012, pp. 38–41) (table 2.5 and appendix A).

Approach	Description
Enterprise IT Architecting	EA is the glue between business and IT. EA is an enabler for executing the business strategy. This school is about aligning an enterprise's IT assets to execute business strategy effectively and various operations using the proper IT capabilities. The school Enterprise IT Architecting focuses on the IT capabilities while not questioning the business capabilities.
Enterprise Integrating	Enterprise Integrating links strategy and execution. It is not only enabling enterprise strategy it also implements it. Designing all the organisational dimensions is fostered with systems thinking. Enterprise Integrating is aware of its environment and tries to manage the environment.
Enterprise Ecological Adaptation	EA fosters organisational learning by designing all facets of the enterprise. It changes the environment and systematically designs the enterprise, including its relationship to the environment. The enterprise's relationship to its environment is an indisputably connected facet. This school of thought enables innovation and System-in-Environment adaptation. It looks for bidirectional incoherence between the enterprise and its environment. Nevertheless, it is the means for organisational innovation and sustainability. It is about enterprise and environment co-evolution.

Table 2.5.: Enterprise Architecture schools of thought

2.4.2. Defining Enterprise Architecture

Antifragile deals with stressors and Black Swan events originating from the (environment of the) system of interest. The Extended Antifragile Attribute List of Botjes et al. (2021) fosters organisational learning and systems thinking capabilities to deal with stressors and Black Swan events (Botjes et al., 2021, pp. 2–4). Exploring the Enterprise Architecture schools of thought (Lapalme, 2012) makes it clear that *Enterprise Ecological Adaptation* is the best school in the context of antifragility. *Enterprise Ecological Adaptation* has a clear focus on the environment, fosters organisational and environmental learning, and embraces systems thinking (Lapalme, 2012, pp. 40–41). Although the school *Enterprise Integrating* already has the notion of the environment, it is not changing the environ-

ment like the school *Enterprise Ecological Adaptation*. At the same time, *Enterprise IT Architecting* has its main focus on the IT organisation of the enterprise itself. If an organisation want to survive in the turbulence of today's markets, the organisation must learn to adapt and innovate (Lapalme, 2012, p. 42). The school *Enterprise Ecological Adaptation* is about adapt and innovate.

It is still necessary to define the definition of EA. The lens of EA is partly defined. '*The how*' is known. The Enterprise Architecture school of thought Enterprise Ecological Adaptation is selected. The properties of this school are known (appendix A.3). We still miss the definition of EA. '*The what*' is still unknown. Lapalme (2012, p 42) mapped Enterprise Architecture authors and literature to the three schools of thought (appendix B).

Author(s)	Description
Gharajedaghi	Gharajedaghi (2011) is about systems theories and does not have its focus on EA.
Hoogervorst	Hoogervorst (2009) is about Enterprise Governance and Enterprise Engineering. It addresses EA and provides definitions. EA is more a design discipline.
Graves	Graves (2008) is about EA, the goal and use of EA, and it contains definitions of EA.
Martin	Martin (1995) is about aligning enterprise engineering to people, technology, and strategy. EA is more a design discipline.
Smith and Graves	Smith and Graves (2011) is about an EA framework. It does not contain definitions on EA.
Lapalme and de Guerre	Lapalme and de Guerre (2012) is not publicly available and accessible. It is about socio-technical systems strengthen EA.

Table 2.6.: Authors of Enterprise Ecological Adaptation

A definition of Enterprise Architecture must be aligned with the Enterprise Architecture school of thought of Enterprise Ecological Adaptation. Using the list of authors and sources for the school of thought of Enterprise Ecological Adaptation (table 2.6) shows that two sources contain definitions of Enterprise Architecture. The first source that contains definitions is Hoogervorst (2009). Hoogervorst (2009, p. 8) defines EA as something that provides normative guidance for design in order for the enterprise to operate satisfied. EA comprises four sets of architecture business, organisation, information, and technology, which are associated with the corresponding enterprise design domains.

The second is that of Graves (2008). "Enterprise Architecture is the integration of everything the enterprise is and does." (Graves, 2008, p. 1). Enterprise Architecture is about the structure of the whole of the enterprise—the whole rather than a single sub-system. There are no simple states of 'as is' and 'to be'. The world is dynamic and not static. Everything in a business system depends on everything else (Graves, 2008,

p. 14).

Graves's definition directly relates to the Enterprise Architecture school of thought of Enterprise Ecological Adaptation and antifragility. This research uses the definition of Graves (2008) as a lens.

2.4.3. Enterprise Architecture system attributes

The Enterprise Architecture school of thought of Enterprise Ecological Adaptation has the best alignment with antifragile (section 2.4). The attributes used for Enterprise Architecture will be those of the school of Enterprise Ecological Adaptation. It contains attributes related to learning and systems thinking. Organisational learning, environmental learning, and system-in-environment coevolution learning are related to learning and Systems-in-Environment thinking, holistic (systemic) stance, and intra-organisational coherency to systems thinking. See for a full overview table 2.7.

Attribute	Category
Systems-in-Environment thinking	Enterprise Ecological Adaptation
Holistic (systemic) stance	Enterprise Ecological Adaptation
Intra-organisational coherency	Enterprise Ecological Adaptation
Organisational learning	Enterprise Ecological Adaptation
Environmental learning	Enterprise Ecological Adaptation
System-in-environment coevolution learning	Enterprise Ecological Adaptation

Table 2.7.: Enterprise Architecture system attributes

3. Methodology

How do we conduct the research to get answers to the questions asked? How can we ensure that the research is of the highest possible quality? These are the questions this chapter will answer. We first show the research's design before we go into depth and zoom in on the steps of this research.

3.1. Research design

What is the quality we pursue, and how do we reach this quality? What methods do we have for our research, and which ones do we use? What is our research model? We need answers to these questions before we can start with our research. We firstly will answer what the attributes or principles of quality are. Secondly, we will briefly explain possible research methods before beginning a high-level design. We close this section with our choice of research method and how we think we can comply with the quality attributes.

3.1.1. Research quality

We increase the rigorousness of the research by applying quality principles. Applying four principles to the research increases the quality of the research (Recker, 2013, p. 15–17). These principles are replicability, independence, precision and falsification. Replicability makes sure that a third party can repeat the research, while independence frees the research from subjective judgement. Precision defines all the concepts, constructs, and measurements to allow others to use, apply and challenge those concepts, constructs and measurements. Falsification implies that the research results can be disproven.

Preparing the research for replicability and reusability is essential. We believe that the results of this research should be available to the public. It is about the public sector and should be available to the public sector. We adopt the FAIR principles² to support us in achieving this replicability and reusability. FAIR stands for findability, accessibility, interoperability, and reuse of digital assets. Findability is about that research data, and metadata is easy to find for both humans and computers. Accessibility is that it can also be accessed when the data is found. Interoperability is about that data must support integration with other data. The last principle is reusability. With reusability, the data and metadata are well described for combining and replicating.

² <https://www.nature.com/sdata/>

3.1.2. Research method

The most popular research methods are either quantitative or qualitative (Recker, 2013, p. 62). A quantitative method uses quantitative data, while a qualitative method is about assisting researchers in understanding a phenomenon in a context (Recker, 2013, p. 84). Qualitative research is for exploratory research where a phenomenon is not yet fully understood, not well researched, or still emerging Recker (2013, p. 84). Qualitative methods focus on the text, which captures records of what people have said, done, believed or experienced about a particular phenomenon (Recker, 2013, p. 85). There are different qualitative research methods, such as case study research, action research, and grounded theory. Grounded theory is about collecting data in order to develop new theories. A case study is a detailed study of a specific subject, such as a person, group, place, event, organisation, or phenomenon. At the same time, action research introduces changes and interventions into a context and studies the effects. (Recker, 2013, pp. 96–99).

3.1.3. Triangulation

Stating something by only using one source is not reliable. The statement can be biased or can be coincidental. A statement is better when a second source validates it. The more sources validate the statement, the more likely it is that it is true. This validation method is called triangulation. "Triangulation means seeking convergence and corroboration of results from different methods and designs studying the same phenomenon" (Recker, 2013, p. 110). Using different sources for cross-validation strengthens the findings to be more reliable and valid. The researcher gains a more nuanced picture of the situation by doing so (Recker, 2013, p. 88). Triangulation increases the validity, credibility, and authenticity of research data, analysis and interpretation. Triangulation can be used in quantitative as well as qualitative methods (Recker, 2013, p. 88). Triangulation will increase the robustness of the research results.

3.1.4. Research model

The topic of antifragile is still relatively young, and as far as we have been able to find, it has not been used in practice yet in the context of systems. Let alone with a System-of-Systems, the Dutch public sector. Little information is therefore available to perform a quantitative analysis. The chosen research method is qualitative. This method focuses on what people said, done, believed or experienced. The research approach explores and develops generalised success factors for antifragility in the public sector. 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 of the qualitative method, particularly Grounded Theory. The challenge of this method is the validation of the results. How can we ensure that we have done everything to remove possible subjectivity? Using the triangulation method, we minimise possible subjectivity by using multiple research tools and different sources. Triangulation will increase the validity and reliability.

So how do we apply the qualitative research method with triangulation? We are searching for an 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?' How can we ensure that the answer we will give is reliable and valid? To answer the main research question, we have split the question into several sub-questions (section 1.7). Studying literature will answer the first five sub-questions. The first step in the research is a literature study on antifragile, Enterprise Architecture, and the public sector. From the literature study, we get a list of possible success factors on antifragile and Enterprise Architecture.

We need to validate these results with multiple sources with multiple qualitative research tools. For the first qualitative tool, we use interviews. We use interviews with CxOs in the public sector for the first validation. Attributes that are confirmed will go for validation to the expert group. It can also happen that we discover new attributes. When we have discovered new attributes, we will go back to the literature study step for validation to ensure that they do or do not occur in the literature. The result is a confirmed, cumulative but filtered list of attributes. There is a possibility that the newly found attributes are specific to the Dutch public sector. Therefore, we do not rule them out and put them on the list to be validated by an expert group.

An expert group is the second qualitative tool we use. The expert group consists of experts in Enterprise Architecture, antifragility, and the public sector. We use a rating session to validate the attributes. We use a brainstorming session before the rating session to collect possible missing attributes from the perspective of the experts. These attributes are part of the rating session. The result is a list of attributes that the expert group confirmed. As we did with the newly found attributes of the interviews, we will go back to the interview transcripts and the literature study to make sure we did not miss the new attributes. The end result is a confirmed list of attributes, confirmed by interviews and an expert group. These attributes can be the success factors and answer our research question. This approach is summarised in our research model (figure 3.1).

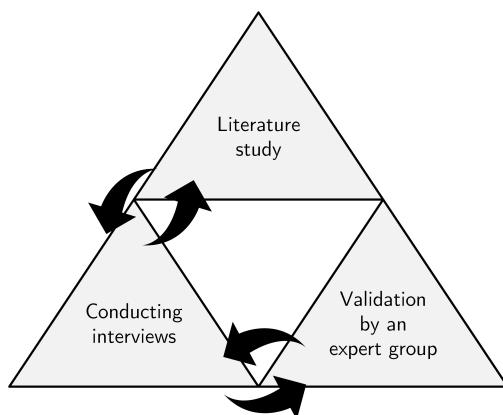


Figure 3.1.: Research model

3.2. Research approach

How will we conduct the literature study, interviews, and the validation with an expert group? This question is what this section will answer. This section describes the approach in detail to make the research replicable.

3.2.1. Literature study

The literature study answers the first five sub-question section 1.7 of this research. We use specific keywords to find literature in online scientific libraries. The online scientific libraries we use are Web of Science, Researchgate, Google Scholar, and Semantic Scholar. We use the full name and the abbreviation of the concept to search for literature. E.g. Enterprise Architecture and EA. Literature is accepted if it complies with quality attributes. These quality attributes are accuracy, authority, objectivity, currency and coverage¹. For currency, we assessed if the information is current and that it was published. We used a rule of thumb of 10 to 15 years to be current. For coverage, we assess the literature on relevance. The literature must be on the concept itself, but there must be a link with one or more concepts of this research. For replicability and reusability, we administrate the found literature.

System

We use two key literature sources for the system concept. These two sources are Ackoff (1973) and Gharajedaghi (2011). Gharajedaghi (2011) is one of the authors recognised by Lapalme (2012) as a follower of the Enterprise Architecture school of thought of Enterprise Ecological Adaptation. Ackoff (1973) was one of the pioneers of modern systems science. He used the work of von Bertalanffy (1968), who coined systems theory in 1940², as a base for his research. We researched citations on the works of Ackoff (1973) and Gharajedaghi (2011) to start the literature study on system. We boardenth the scope by using the following keywords for the online scientific libraries: *system*, *System-of-Systems*, *System-in-Environment*, *ecosystem*, *antifragile system*, and *Enterprise Architecture system*.

Antifragile

We use two key literature sources for the antifragile concept. These two sources are Taleb (2021), Botjes (2020) and Botjes et al. (2021). **Taleb2018** is the author who coined the concept of antifragile while Botjes (2020) conducted extensive literature research on antifragility. We use Botjes (2020) to find literature on antifragile. Botjes et al. (2021) is an published article but misses the extensive reference to literature. Botjes et al. (2021) is only used as literature and not as a source. We do not search for literature on antifragile before July 2020, but only between July 2020 and April 2022. The research of Botjes (2020) ended in June 2020 so we only need literature after the research of Botjes (2020).

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

2 https://en.wikipedia.org/wiki/Systems_theory#/Founding_and_early_development

We use the following keywords for the online scientific libraries: antifragile, antifragile robust resilient, antifragile Enterprise Architecture, antifragile public sector, antifragile success factor, antifragile system.

Enterprise Architecture

We use three sources to start the literature research. These sources are Graves (2008), Hoogervorst (2009) and Lapalme and de Guerre (2012). Why these sources. The literature of these authors do align best with the concepts antifragile, system in systems and system in environment. We use the following keywords for the online scientific libraries: Enterprise Architecture, Enterprise Architecture success factors, Enterprise Architecture antifragile system, Enterprise Architecture ecosystem, Enterprise Architecture public sector, Enterprise Architecture System-in-Environment, Enterprise Architecture System-of-Systems.

Public sector

We use two key references for the concept of public sector to start off the literature research. These two sources are van der Wal et al. (2008) and Nurmi (2021). van der Wal et al. (2008) compares the public and private sectors on core values while Nurmi (2021) researches the use of ecosystems in the public sector. We use the following keywords for the online scientific libraries: public sector, public sector antifragile, public sector resilient, public sector system, public sector ecosystem, public sector System-of-Systems, public sector System-in-Environment, public sector collaboration with the private sector, and public sector differences to the private sector.

3.2.2. Interviews

We use semi-structured interviews to have the possibility to capture more information than a structured interview. The benefits of a semi-structured interview are that a semi-structured interview encourages two-way communication (Recker, 2013, pp. 87–88). We can validate our findings while at the same time we can collect new data. Furthermore, the interviewees may discuss sensitive issues more easily. We select interviewees from the public sector with a different profile than the expert group. The different profile helps with the triangulation of the research. We decided to use CxO for the interviews to get the business perspective of the public sector. We defined a set of topics for discussion. These topics are Enterprise Architecture, agility, uncertainty, unexpected events, risk appetite, diversity and optionality. We expect to cover all the attributes using the topics. The interviews are recorded and transcribed for further processing.

3.2.3. Expert Group

We decide to use another qualitative tool for the last part of the triangulation. An expert group will brainstorm for possible new attributes, discuss the attributes, and rate the attributes. The expert group is another qualitative tool. By using a different

tools, we strengthen the findings to be more reliable and valid (Recker, 2013, p. 88). We use a different perspective for the expert group members than for the interviewees. Instead of using a business perspective, we decide to use the Enterprise Architecture perspective of the public sector. Again, this approach will strengthen the findings to be more reliable and valid. A group support system supports the expert group session with the administration, reporting and needed tools. The expert group session is recorded and transcribed for further processing.

3.2.4. Conclusion and discussions

Before we can answer the research question, we combine the triangulation results so we can sort and rate the attributes. An attribute is most likely a success factor when the literature identifies the attribute, the interviews confirm it, and the expert group agree with it. However, with this approach, we risk missing attributes that are specific to the public sector. These attributes can be essential distinguishing factors for the public sector. The attributes from the literature are not specific to the public sector but generic. We decided on an additional rule to overcome this shortcoming. An attribute is likely a success factor when the attribute meets two out of three requirements. Attributes that do not meet these two rules are not confirmed to be a success factor. This result gives us an answer to the main research question "What are the success factors that positively influence the contribution of Enterprise Architecture in achieving antifragility in the public sector?"

3.3. Implementation of research quality

The research model is defined. But how do we ensure that this approach also fulfils our quality requirements? We have two sets of quality principles we want to fulfil. The principles of Recker (2013) and the FAIR principles of GO FAIR (2017).

When we look at the principles of Recker (2013, pp. 15–17) we have the principles replicability, independence, precision, and falsification. We ensure that the thesis contains a description of all steps. Steps taken for the literature study, the interviews, and the expert group. To support replicability the used data sets are publicly available for use.

Replicability, independence, precision, and falsification are the principles (Recker, 2013, pp. 15–17). We ensure that the thesis contains a detailed approach for replication. The used data sets are made publicly available to support replicability. By rationalising everything, we remove as much subjectivity as possible. The output of the interviews and the expert group are normalised to remove possible bias from the system. This approach supports the principle of independence. Defining every concept supports the principle of precision. For every concept, there is a clear definition available. When there are more definitions, research is necessary. Using a rationale makes it clear why we did choose a particular definition. All the definitions are available in chapter 2 or the Glossary of Terms. Using discussions (section 7.2) helps with the falsification of this research.

Findable, accessible, interoperable, and reusable are the principles of FAIR (GO FAIR, 2017). Keywords, links, structures, and metadata that can be indexed support

findability. GitHub, Zenodo, and Researchgate publish the thesis and the used data sets. We created objects with a location for acquiring the source for sources that are not to be published publicly. Publishing based on Open Access supports the principle of accessibility. The principle that is least relevant for this research is interoperable. It is least relevant because this principle is mostly for quantitative methods. Nevertheless, the datasets are available as Microsoft Excel files for analysis. The files are easy to import, reuse, or combine in other environments to support the principle of reusability. The publication of the thesis and the used datasets use a Creative Commons license (CC-BY-SA 4.0). The thesis and the used data sets can be shared and adapted as long as the original author is attributed and the possible derivate uses the same license.

3.3.1. Research infrastructure and tooling

We describe how we worked with the tools we used to increase the quality of the research. We expect to increase replicability, findability, accessibility, interoperability, and reusability. We describe this in three subsections: the research execution, the administration and the creation.

Research execution

For the administration of literature research, Apple Numbers¹ is used. The administration is saved as a Microsoft Excel² file for accessibility and reusability. The literature is administrated with the following headers: 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. Researchgate³, Web of Science⁴, Google Scholar⁵, and Semantic Scholar⁶ are the main sources for searching for literature. PaperPanda⁷ is used for hard to find literature. The literature administration is, together with the publicly available literature, stored in the repository of the master thesis⁸. For non-public available literature, the administration contains the location where the literature is retrievable. We add the literature to a bibLATEX file for future reference. For traceability, the entries in the bibLATEX file contain the same Unique ID in the comments field. We work paperless. All the literature is in pdf or in ebook format. We use Acrobat Reader DC⁹ and an Amazon Kindle Oasis¹⁰ for reading. We use the highlight function of the Amazon Kindle, but these are not stored on GitHub. The highlights are under the copyright of the author(s). We use Microsoft Teams for interviews. We use the transcript and session

1 <https://apps.apple.com/us/app/numbers/id409203825>

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

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

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

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

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

7 <https://paperpanda.app/>

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

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

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

recording functionality. The transcript and recordings are full of sensitive information and are not publicly available. The transcripts and recordings are securely stored and are available upon request by the Antwerp Management School. We used QDA Data Minder Lite¹ to label transcripts so that analysis can be done with Apple Numbers. For the Expert Group, Meetingwizard² is used for brainstorming, surveys and rating. The Antwerp Management School supplies the license for using Meeting Wizard. The data set of the Meeting Wizard session is stored as a Microsoft Excel file in the repository of the thesis (anonymised).

Research administration

We use a non-public GitHub repository to store privacy-sensitive information. The same GitHub repository is used for staging thesis parts that still need to be anonymised. For note-taking, Leuchtturm1917³ notebooks are used together with a mechanical pencil of Rotring⁴ and a Tombow Mono Zero eraser⁵.

Thesis creation

An Apple Macbook Air⁶ with model number A2337 is used to write the thesis. We use the markup language L^AT_EX⁷ with the typesetting environment of MacTex⁸ with the document type of "Report" from KOMA-Script⁹. The editor TexStudio^{https://www.texstudio.org/} is used with BibL^AT_EX¹⁰ for managing references with the style of APA 7th Edition¹¹. We store the thesis files on Apple iCloud¹² that is used by GitHub Desktop¹³ to synchronise with a public GitHub repository¹⁴. GitHub¹⁵ is used for source control and for reviewing and discussing the topics with the research organisation. The thesis source files are archived in zip format and copied to an Amazon S3 Blob¹⁶ for backup. We use a backup rotation of seven versions. Using MSP360 Explorer¹⁷ help us in creating backups. Grammarly¹⁸ (with a paid subscription) performs

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

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

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

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

5 https://www.tombow.com/en/products/mono_zero/

6 [https://en.wikipedia.org/wiki/MacBook_Air_\(Apple_silicon\)](https://en.wikipedia.org/wiki/MacBook_Air_(Apple_silicon))

7 <https://www.latex-project.org/>

8 <https://www.tug.org/mactex/>

9 <https://ctan.org/pkg/koma-script>

10 <https://ctan.org/pkg/biblatex/>

11 <https://apastyle.apa.org/>

12 <https://www.icloud.com/>

13 <https://desktop.github.com/>

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

15 <https://github.com/>

16 <https://aws.amazon.com/s3/>

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

18 <https://www.grammarly.com>

spelling, grammar, style, and plagiarism checking. Microsoft Visio Professional¹ is used to create figures. The GitHub repository contains all the sources².

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

2 <https://github.com/JRBliekendaal/master-thesis/tree/main/images/sources>

4. Interviews

For triangulation the defined attributes (??) 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 4.1). 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. ?? 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 4.1.: 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 ??, 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 4.2 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 D). 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 4.2.: Interview questions

4.1. 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.

4.1.1. Interview results on attenuate variety

The frequency of the attributes *Top-Down Command & Control* and *Micro-Management* scored the highest (figure 4.1). 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 D.1). One of the interviewees said that to get things done the government should be in continuous crisis (appendix D.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 D.2). In this way, the public sector can control the environment again.

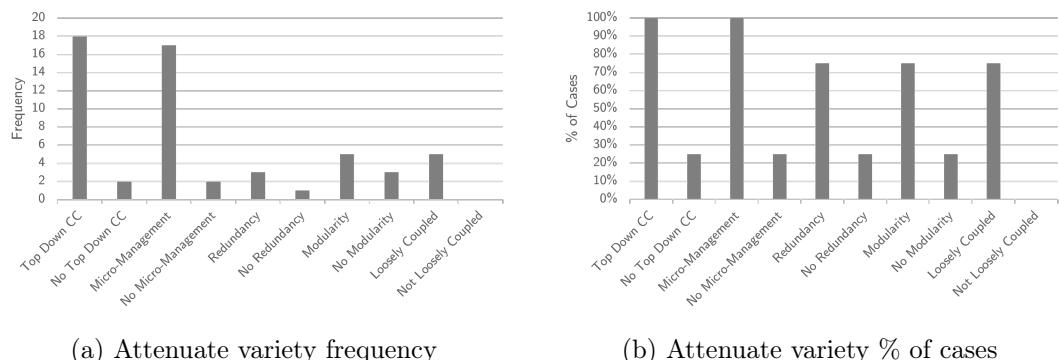


Figure 4.1.: Interview results attenuate variety

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 D.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 4.1) 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 D.2).

4.1.2. Interview results on amplify variety

The attribute of amplify variety that scored the highest was the attribute *insert low-level stress* (Figure 4.2). It is not that there is much tinkering going on in the public sector. Experimentations are (almost) not possible because of public accountability (appendix D.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 D.2 to D.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 D.2 and D.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 4.2. 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 D.1 to D.4).

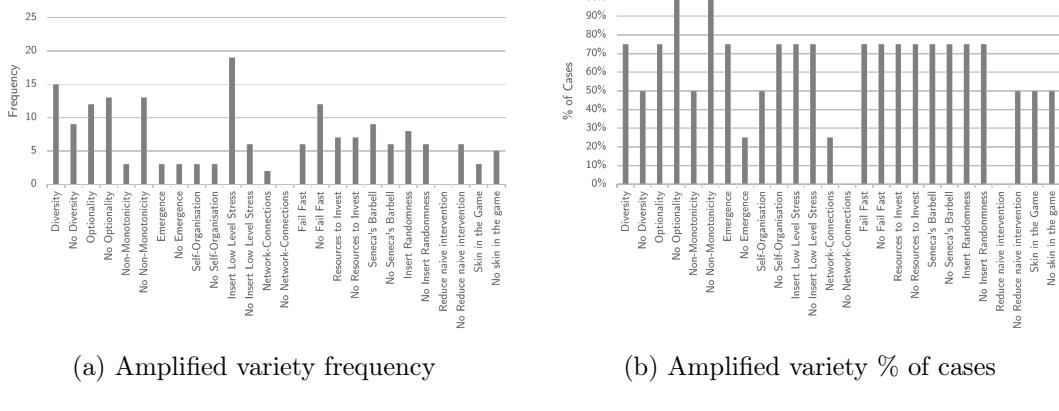


Figure 4.2.: Interview results amplified variety

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 D.1 and D.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 D.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 D.1 to D.4).

4.1.3. 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 D.2 to D.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 4.3 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 4.1.1). The public sector does not foster thinking outside of a sub-system.

¹ <https://www.shell.com/>

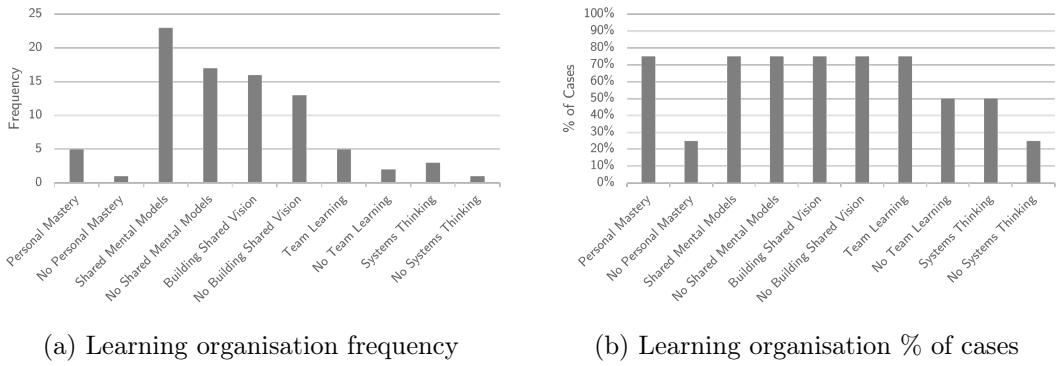


Figure 4.3.: Interview results learning organisation

4.1.4. 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 4.4). In contrast, the schools *Enterprise Integrating* and *Enterprise Ecological Adaptation* were present in two, but different, interviews.

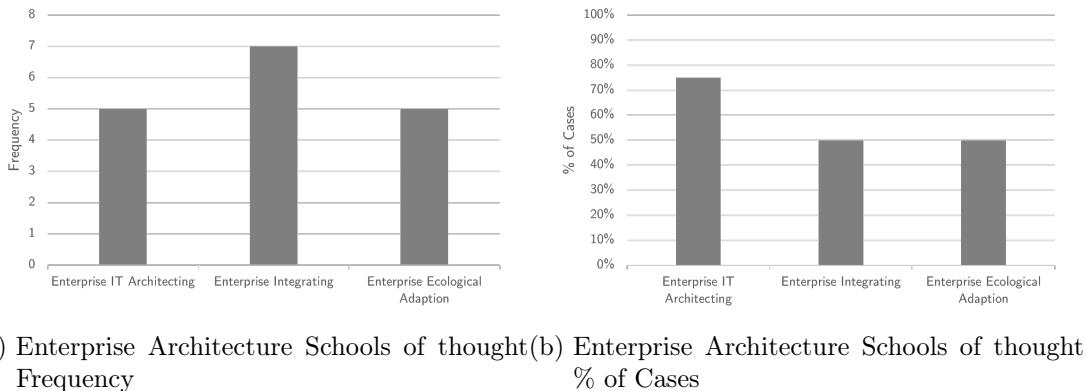


Figure 4.4.: Interview results Enterprise Architecture schools of thought

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 D.1 and D.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 D.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 D.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 D.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 4.5.

4.1.5. Interview results on possible new attributes

The last category of attributes for discussion is the category of new findings. The newly found attributes (figure 4.5) 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 4.2). 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*.

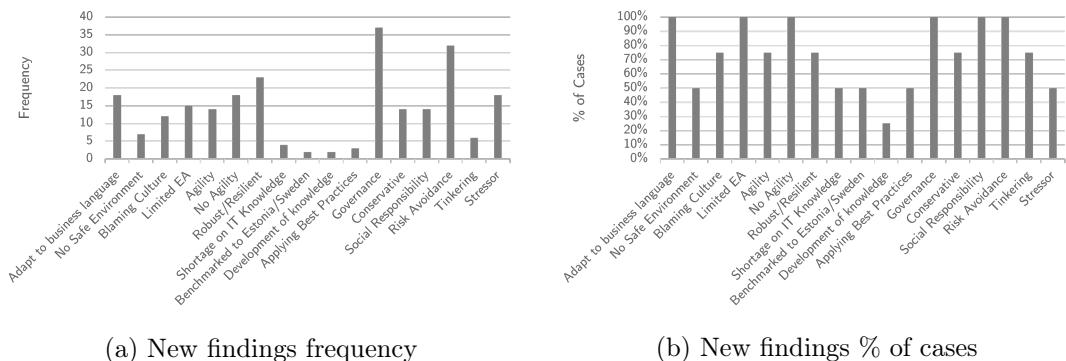


Figure 4.5.: Interview results new findings

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 4.1.1). 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 D.2 and D.3).

4.2. 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 4.1, 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 4.3). 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.

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.

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

Step	Description	Rationale
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 4.3.: Merging similar labels

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

an attribute of any significance.

After performing QDA, the interview findings are 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 4.6). 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 4.6).

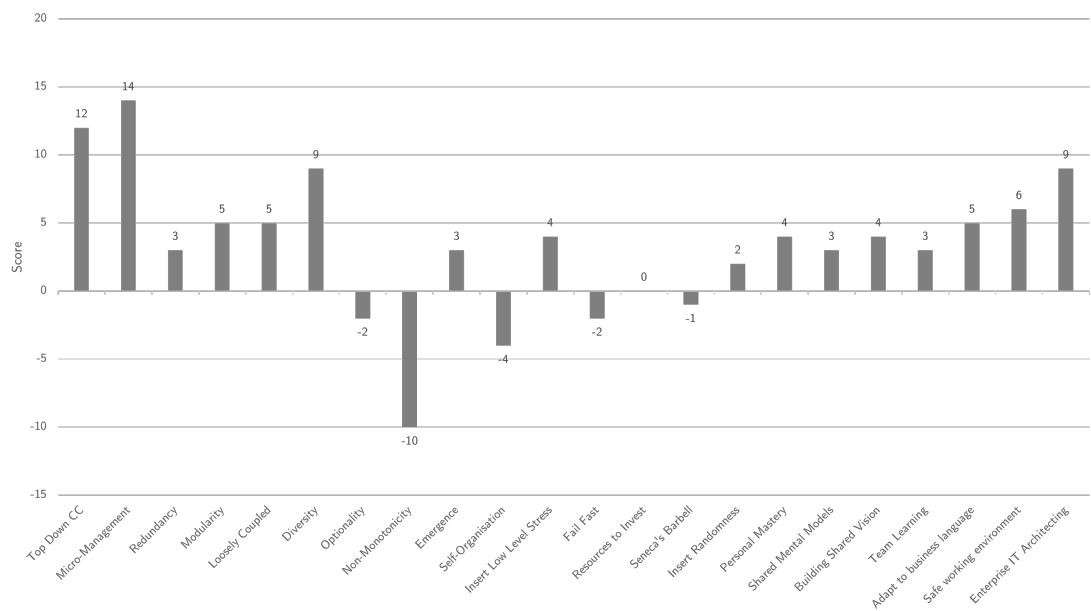


Figure 4.6.: Score of attributes from interviews

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).

4.3. Attributes most likely to be a success factor

Based on the used data set and the interpretations of this data set, the attributes (table 4.4) 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 4 the attributes of EA are implicitly part of the school of thought *Enterprise Ecological Adaptation*.

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 4.4.: Possible success factors identified from interviews

5. Expert group

The selected attributes (section 4.3) 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 (??) and the Qualitative Data Analysis (QDA) of interviews (chapter 4). 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 5.1). 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 5.1.: 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.

5.1. Validation of attributes

The two newly found attributes *adapt to business language* and *safe working environment* (section 4.3) 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

5.1.1. 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 5.2 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 5.2.: Validation of antifragile attributes

5.1.2. 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 5.3.: 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 5.3). *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 (??).

5.1.3. 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 5.4.: 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 5.4). All three were from the five new attributes from the expert group. There were only two abstains on a total of two attributes.

5.2. 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 5.5).

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 5.5.: Rating of the relevance of the research

5.3. Attributes most likely to be a success factor

Threshold of six out of ten. the higher the higher the quality and more valid. Variability cannot be used. It is not xxx because of n=10

Attribute	Category
Optionality	Antifragile
Non-monotonicity	Antifragile
Self-organisation	Antifragile
Fail-Fast	Antifragile
Resources to invest	Antifragile
Safe working environment	New Antifragile
Outside-In and Collaboration	New Antifragile
Systems-in-Environment thinking	Enterprise Architecture
Holistic (systemic) stance	Enterprise Architecture
Organisational learning	Enterprise Architecture
Environmental learning	Enterprise Architecture
Intra-organisational coherency	Enterprise Architecture
System-in-environment coevolution learning	Enterprise Architecture
Adapt to business language	Enterprise Architecture
Agile Enterprise	New Enterprise Architecture
Foster dialogue	New Enterprise Architecture
Architecture validation	New Enterprise Architecture

Table 5.6.: Possible success factors identified by the expert group

6. Analysis

6.1. 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	✓	✓		2
Insert randomness	✓			1
Reduce naive intervention	✓			1
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
Agile Enterprise**			✓	1
Foster dialogue**			✓	1
Architecture validation**			✓	1

* Result of the used interviews data set.

** Results of the used expert group data set.

Table 6.1.: 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 6.2.: 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 6.3.: Identified the relevant Enterprise Architecture school of thought

6.2. Scoring of Success Factors

6.3. 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 6.4.: 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 6.5.: 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 6.6.: Identified the relevant Enterprise Architecture school of thought

7. Conclusion and discussions

7.1. 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 7.1.: Identified success factors

7.2. 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?

7.2.1. 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.

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

7.2.3. Size of Expert Group

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

7.2.4. The composition of the Expert Gropu

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

7.2.5. Causal Loop Diagram

7.3. Recommendations

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

8. Retrospective

8.1. Quality of Research

8.2. Process of Research

8.3. Researcher

"I have found out how little I actually know"

- The added value of a Co-Promotor

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Glossary of Terms

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

A

adapt to business language

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

agile

The ability to adjust before failure happens.

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

complex adaptive systems resilience

The system is able to become more resilient and to generate new system relationships by reorganisation. The function is maintained, but the system's structure may change. A continuously evolving system.

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.

engineering resilience

Prevent disruption and changes and to bounceback to the fixed function/basis.

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.

entropy

The entropy of the universe increases in all natural processes. Isolated systems tend towards greater disorder and entropy is a measure of that disorder.

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 adage "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.

fragility

The state of being fragile.

H

holistic (systemic) stance

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

I

immemorial

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

insert low-level stress

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

insert randomness

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

intra-organisational coherency

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

J

joint venture

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

L

learning organisation

the learning organisation is a way to create resilient organizations which let them cope with unknown and unpredictable events.

loosely coupled

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

M

micro-management

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

modularity

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

N

network-connections

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

non-monotonicity

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

O

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

Oportunies 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 model

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

skin in the game

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

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.

specialisation

An element that is a particular kind of another element. E.g. a travel insurance is a specialisation of insurance.

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 resilience

The system is able to withstand the impact of any interruption and recuperate while resuming its operations, the function of the system stays the same over time.

systems thinking

a discipline for seeing wholes. It is a framework for seeing inter-relationships rather than things, for seeing patterns of change rather than static snapshots. The fifth discipline of Senge states that it must contain personal mastery, shared mental models, building shared vision, and team learning for a learning organisation..

systems-in-environment thinking

A system (enterprise) in its environment, including not only the enterprise but also its environment and the bidirectional relationship and transactions between the enterprise and its environment.

T

team learning

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

the house of thorbecke

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

top-down command & control

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

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.

V

volatile

Likely to change in a very sudden or extreme way.

volatility

The state of being volatile.

Abbreviations

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

A

API

Application Programming Interface.

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

DY

DYnamic Architecture.

E**EA**

Enterprise Architecture.

EAAL

Extended Antifragile Attribute List.

EEA

Enterprise Ecological Adaptation.

I**idEA**

Interactive Dynamic Enterprise Architecture.

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. 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 C.1.: Literature search 2020–March 2022 all sources

D. Interview summaries

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

D.1. Interview central government

Question 1 / Enterprise Architecture

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

Question 2 / Agility of the public sector

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

Question 3 / Dealing with uncertainty and unexpected events

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

Question 5 / The risk appetite of the public sector

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

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

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

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

Closing statements

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

D.2. Interview local government

Question 1 / Enterprise Architecture

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

Question 2 / Agility of the public sector

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

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

Question 3 / Dealing with uncertainty

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

Question 4 / Dealing with unexpected events

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

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.

D.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.

D.4. Interview with consultancy firm/service provider

Question 1 / Enterprise Architecture

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

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

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

Question 2 / Agility of the public sector

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

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

If we compare this to, for example, the Estonian model, we see a world of difference. We are not there (yet). We have to invest more in this. If we think of the public sector as an aggregate and you go lower in the aggregation, you already see that it is going better. We see that the public sector has been taking significant steps in the last ten years. Administrative governmental agencies have more responsibilities to operationalise, develop and maintain systems. We have been able to leave a mark in the on the technical quality of systems. It is a good development that the 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.

E. Interview findings

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

E.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 E.1.: Interview results Engineering Resilience

E.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 E.2.: Interview results Systems Resilience

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

E.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 E.4.: Interview results Antifragile

E.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 E.5.: Interview results Learning Organisation

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

E.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 E.7.: Interview results Findings

F. Validation findings

F.1. Validation of antifragile attributes

F.1.1. Validation of optionality

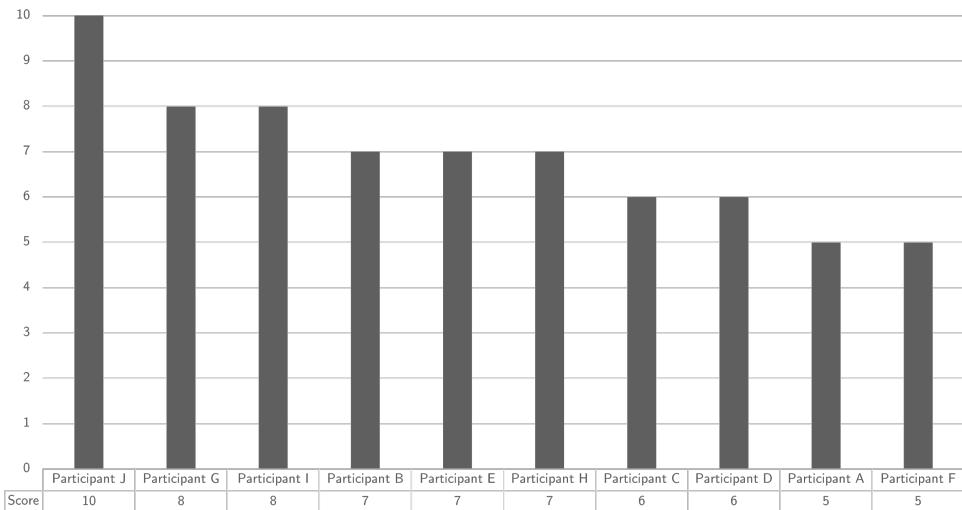


Figure F.1.: Rating of antifragile attribute Optionality

Attribute	Rating	Variability	Abstains
Optionality	6,9	32%	0

Table F.1.: Rating of antifragile attribute Optionality

F.1.2. Validation of non-monotonicity

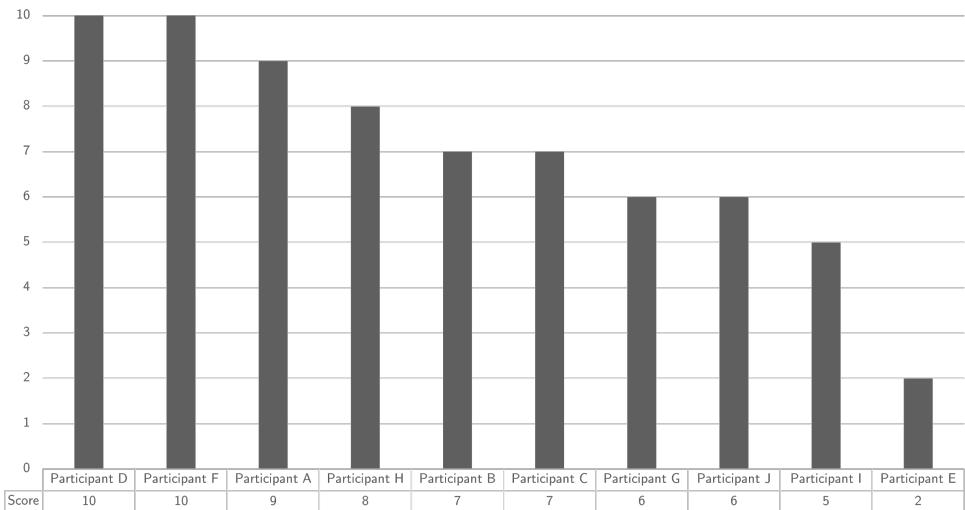


Figure F.2.: Scoring of antifragile attribute Mono-Monotonicity

Attribute	Rating	Variability	Abstains
Mono-Monotonicity	7	51%	0

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

F.1.3. Self-Organisation

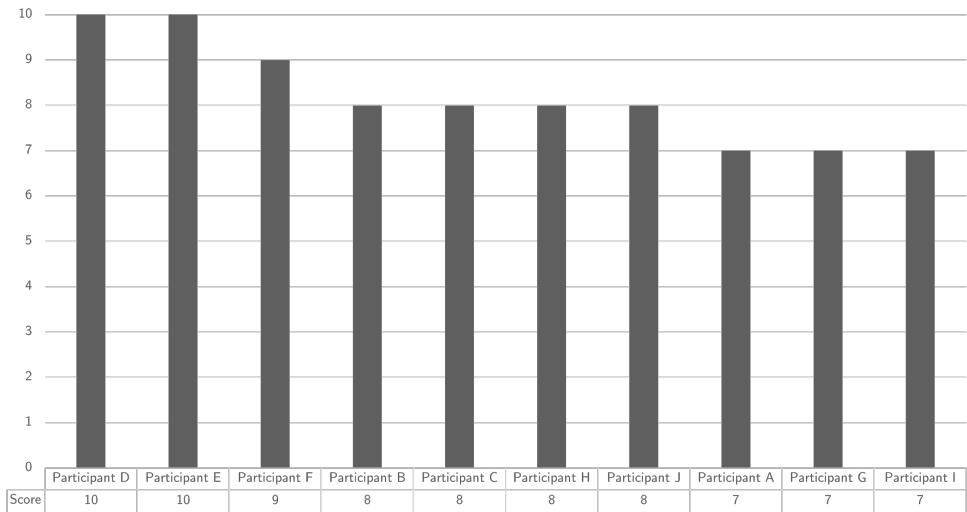


Figure F.3.: Scoring of antifragile attribute Self-Organisation

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

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

F.1.4. Fail-Fast

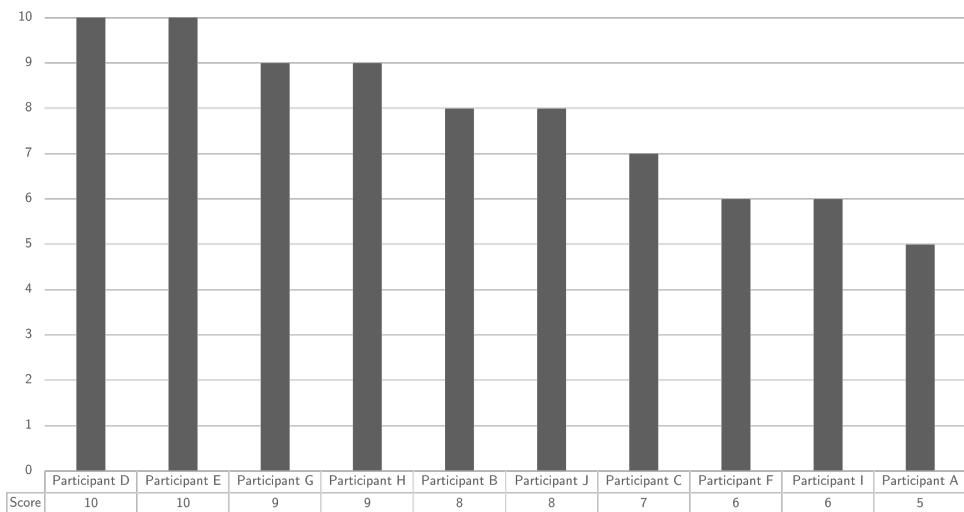


Figure F.4.: Scoring of antifragile attribute Fail-Fast

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

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

F.1.5. Resources to invest

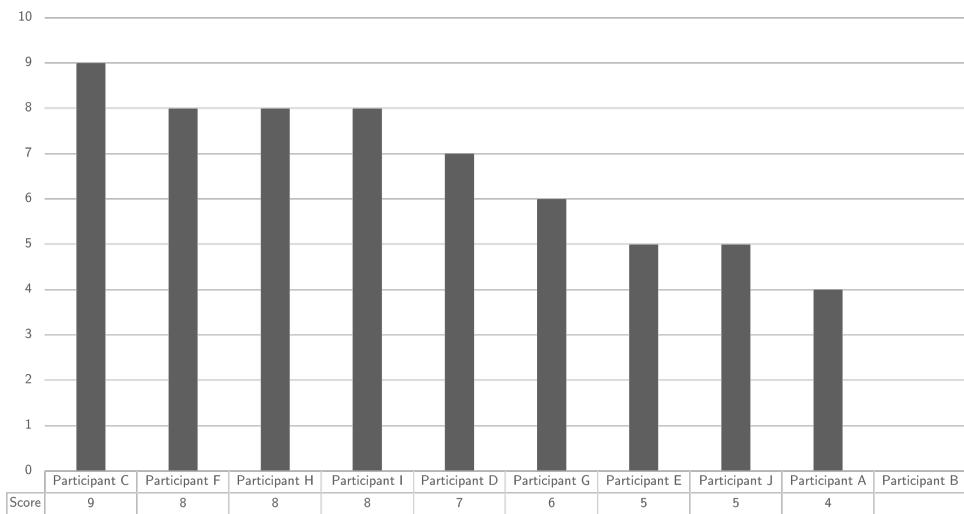


Figure F.5.: Scoring of antifragile attribute Resources to Invest

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

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

F.1.6. Senenca's Barbell

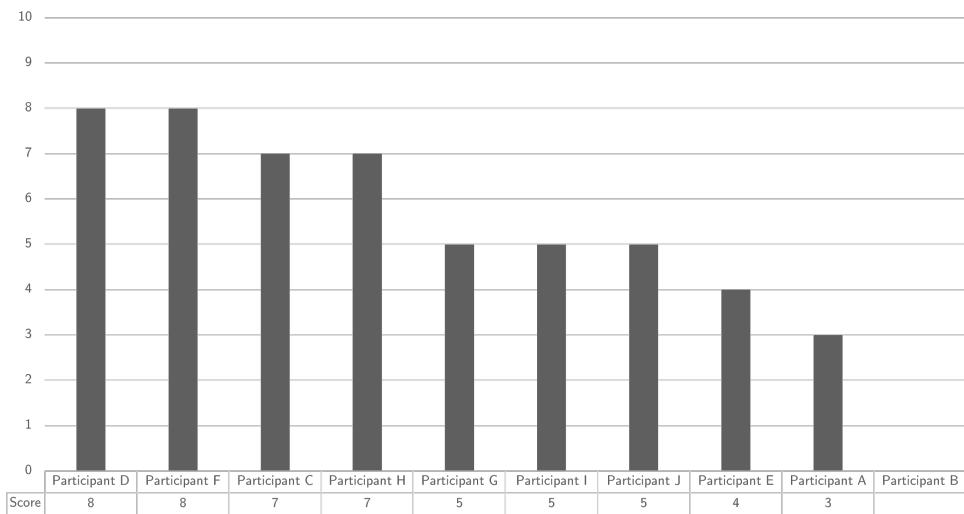


Figure F.6.: Scoring of antifragile attribute Seneca's Barbell

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

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

F.1.7. Safe working environment

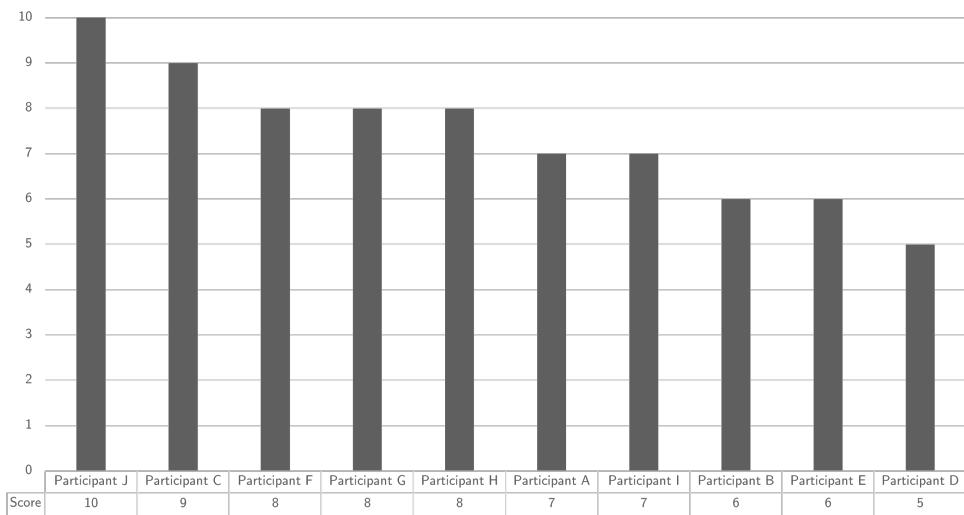


Figure F.7.: Scoring of antifragile attribute Safe working environment

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

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

F.1.8. Naar buiten kijken, samenwerking zoeken

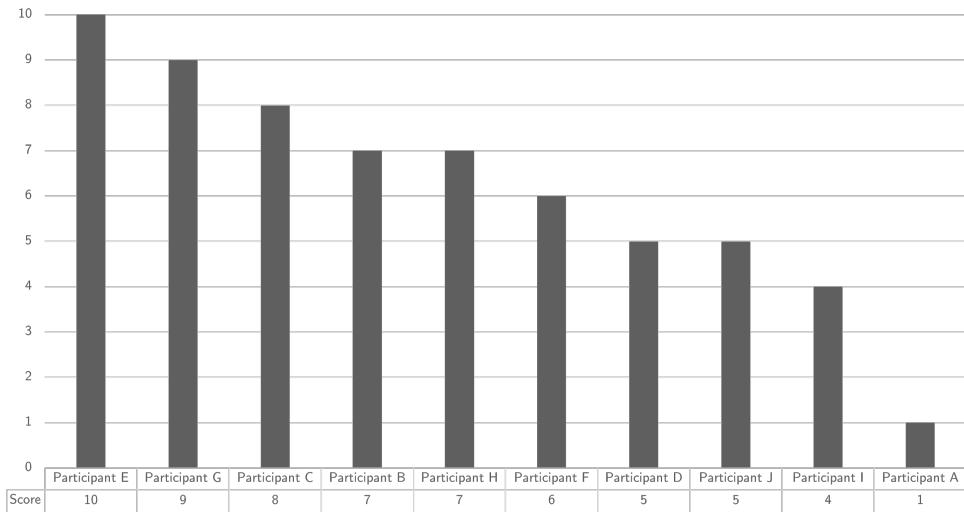


Figure F.8.: Scoring of antifragile attribute Naar buiten kijken

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

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

F.1.9. Data Governance Planes

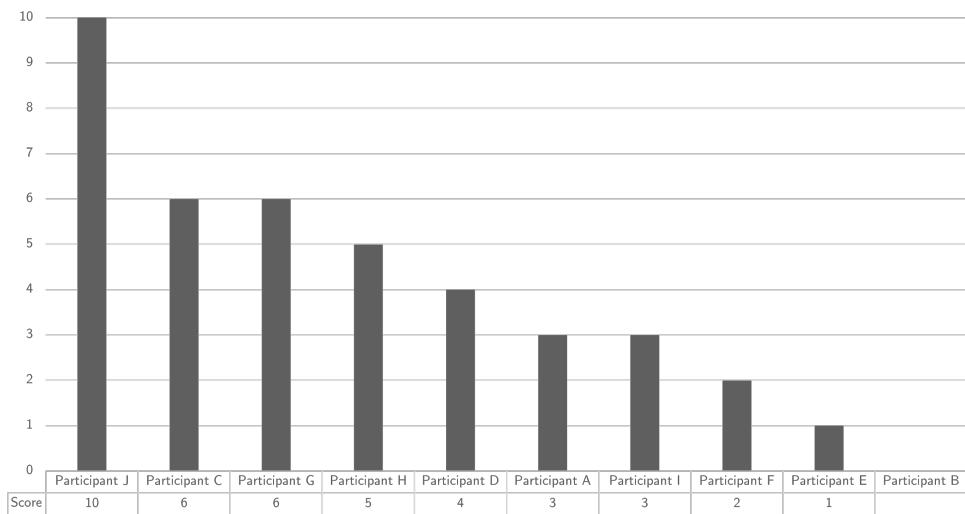


Figure F.9.: Scoring of antifragile attribute Data Governance Planes

Rating	Variability	Abstains
4,4	56%	1

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

F.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 F.10.: Validation of Enterprise Architecture schools of thought

F.2.1. Enterprise IT Architecting

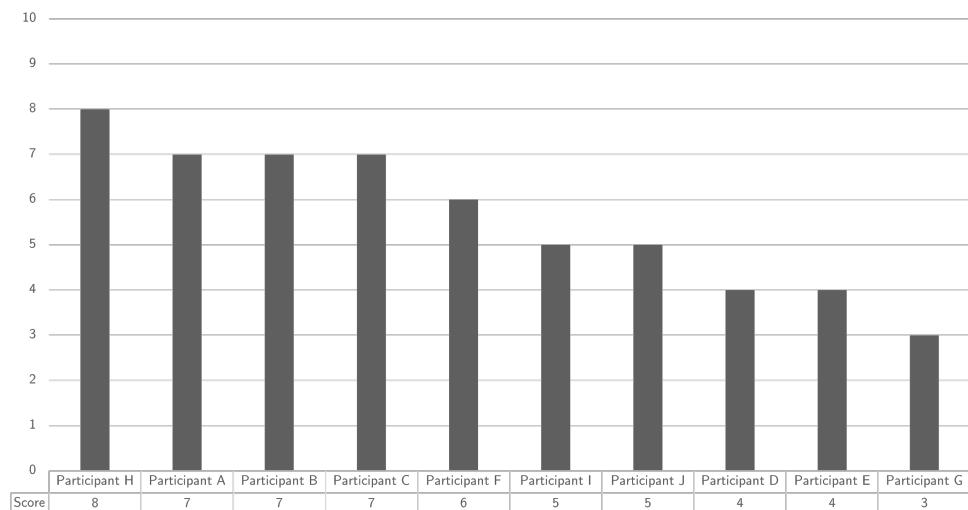


Figure F.10.: Scoring of school of thought Enterprise IT Architecting

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

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

F.2.2. Enterprise Integrating

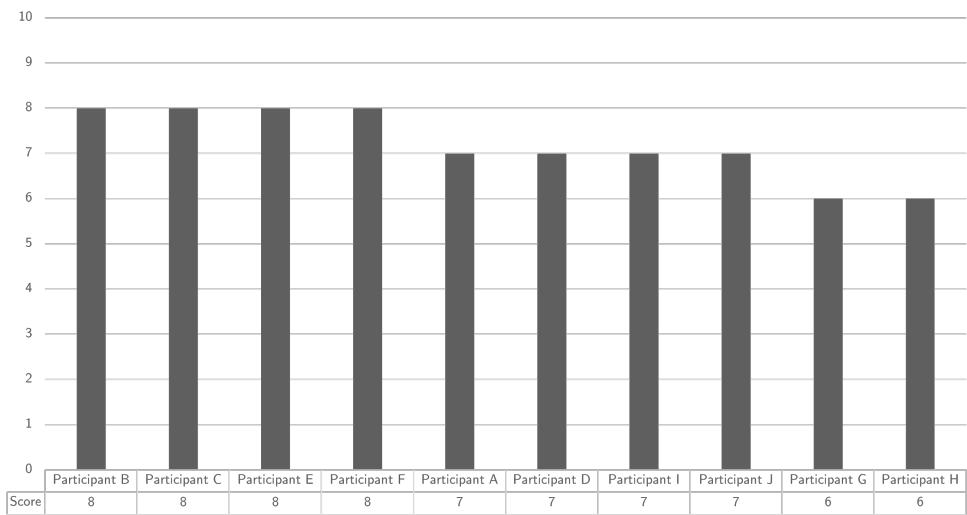


Figure F.11.: Scoring of school of thought Enterprise Integrating

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

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

F.2.3. Enterprise Ecological Adaptation

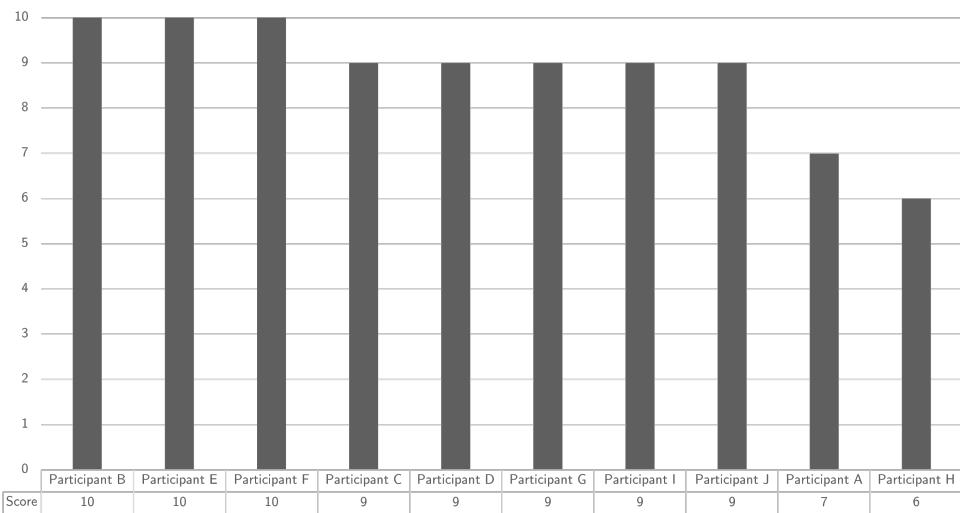


Figure F.12.: Scoring of school of thought Enterprise Ecological Adaptation

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

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

F.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 F.14.: Validation of Enterprise Architecture attributes

F.3.1. Systems-in-Environment thinking

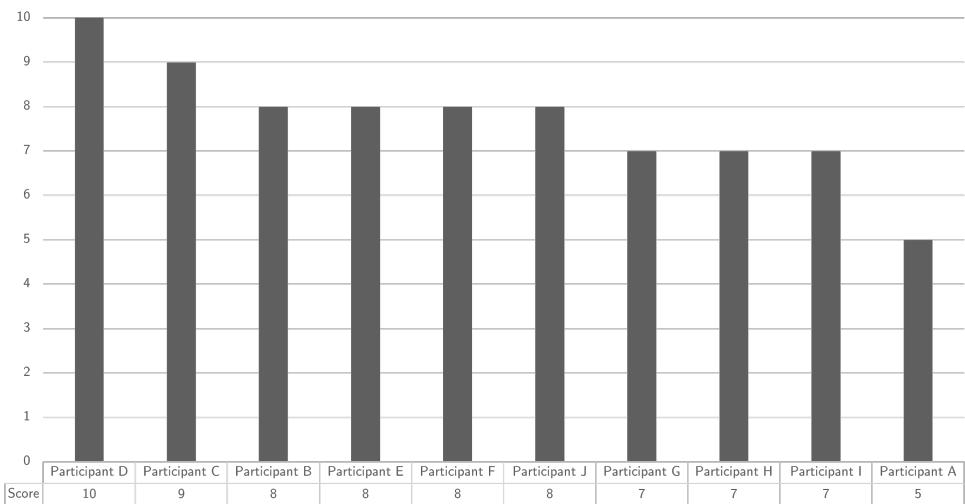


Figure F.13.: Scoring of EA attribute Systems-in-Environment thinking

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

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

F.3.2. Holistic (systemic) stance

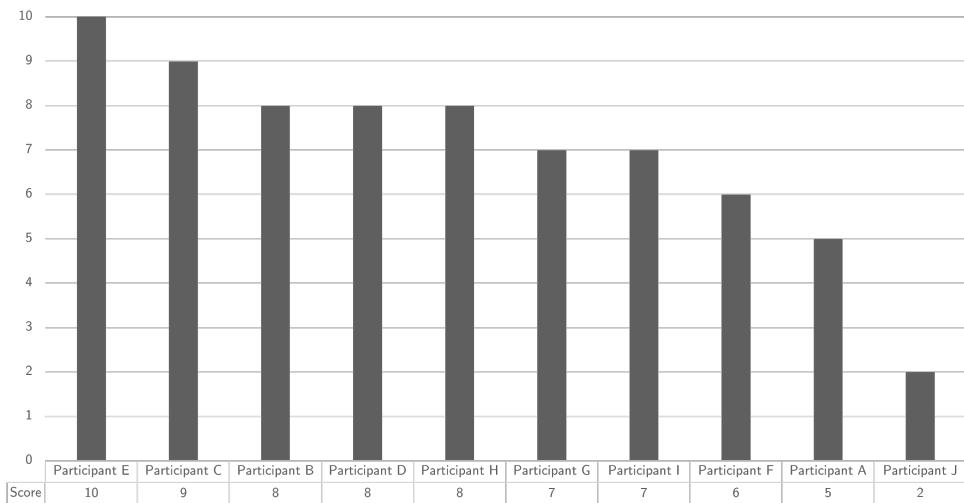


Figure F.14.: Scoring of EA attribute Holistic (systemic) stance

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

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

F.3.3. Organisational learning

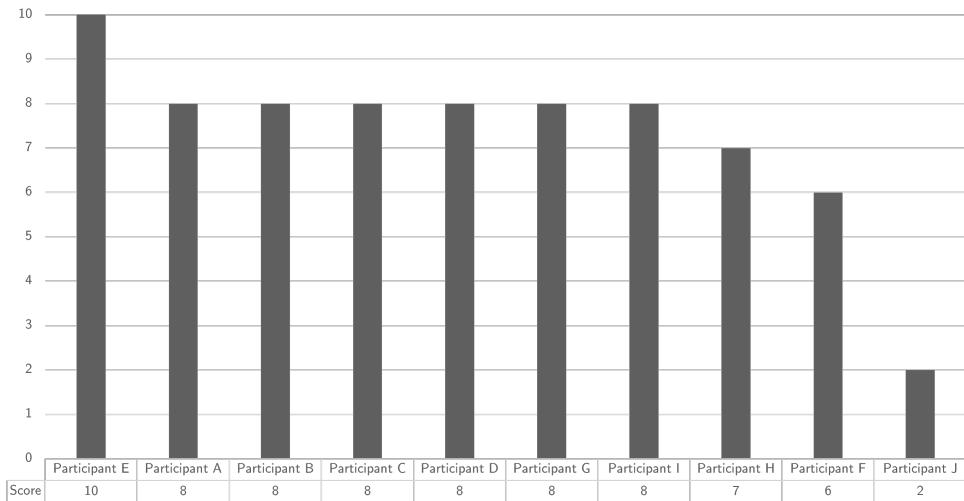


Figure F.15.: Scoring of EA attribute Organisational learning

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

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

F.3.4. Environmental learning

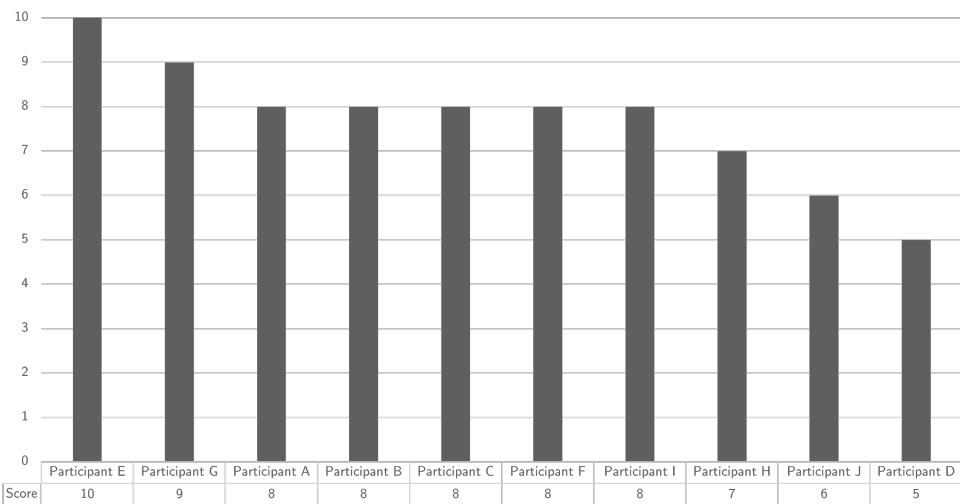


Figure F.16.: Scoring of EA attribute Environmental learning

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

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

F.3.5. Intra-organisational coherency

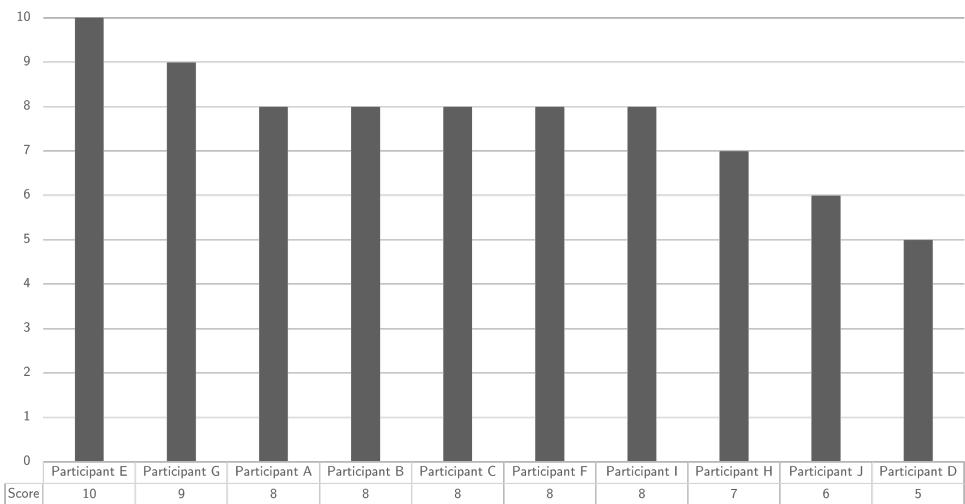


Figure F.17.: Scoring of EA attribute Intra-Organisational coherency

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

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

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

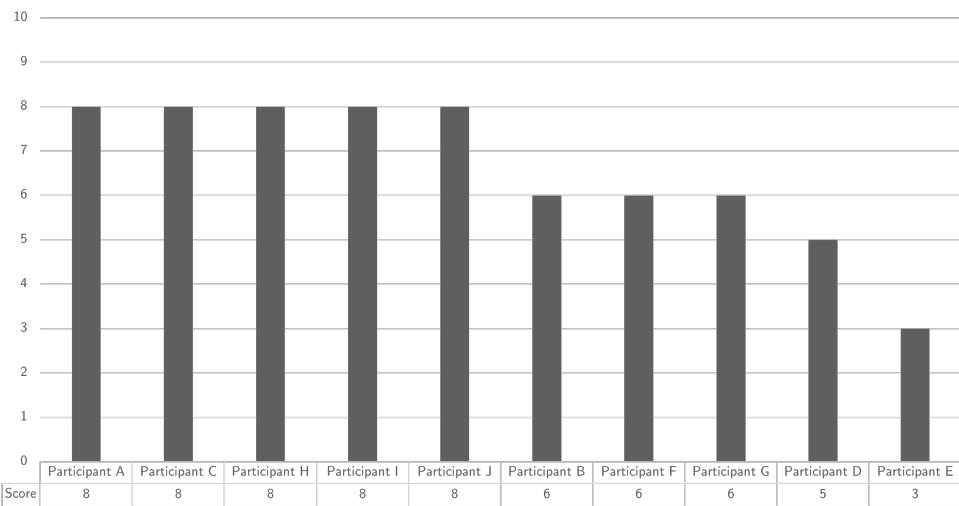


Figure F.18.: Scoring of EA attribute System-in-Environment Co-Evolution learning

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

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

F.3.7. Adapt to business language

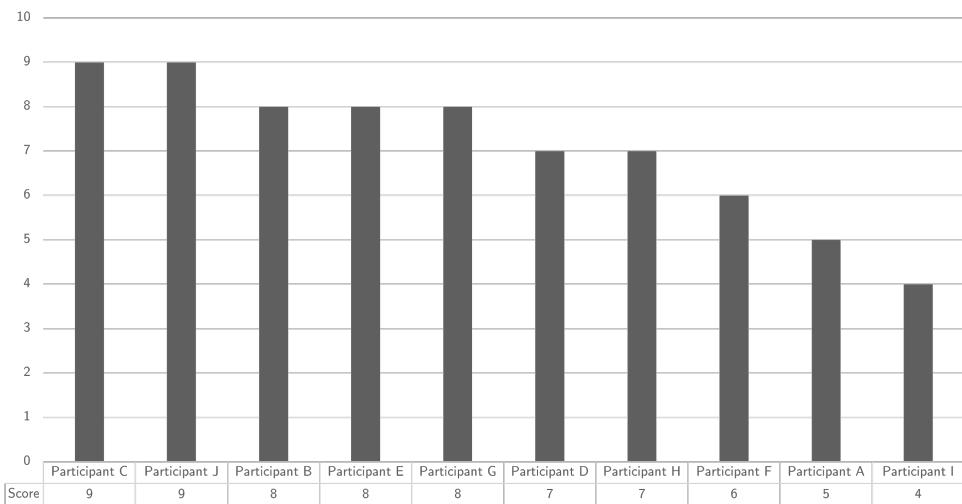


Figure F.19.: Scoring of EA attribute adapt to business language

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

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

F.3.8. Agile Enterprise

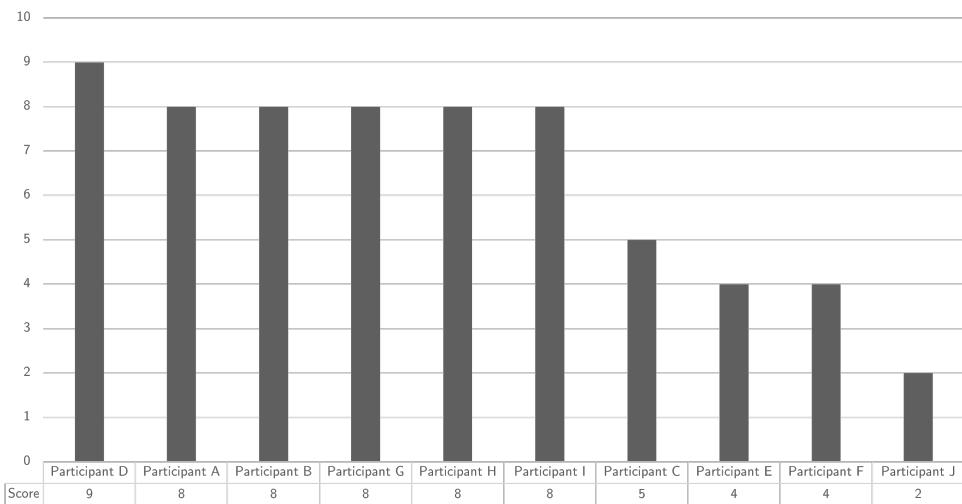


Figure F.20.: Scoring of EA attribute Agile Enterprise

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

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

F.3.9. Real Time Trust

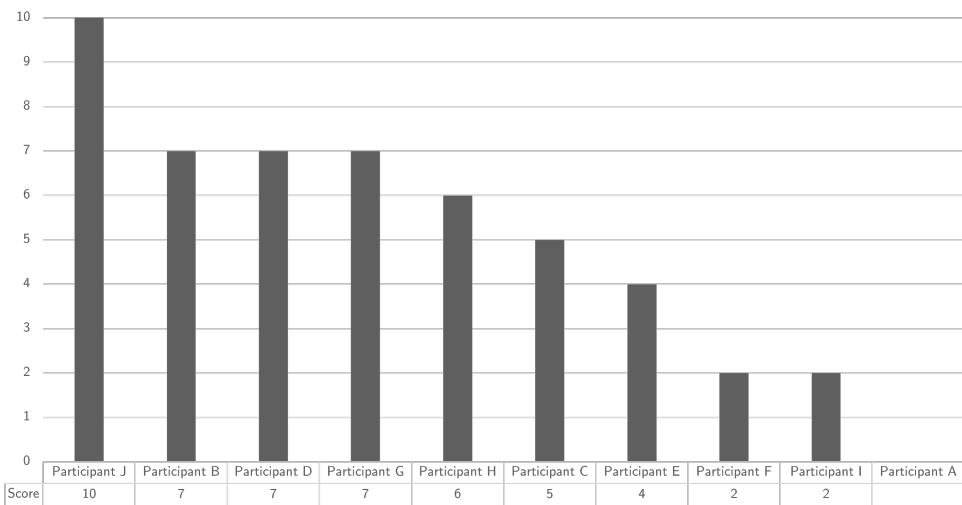


Figure F.21.: Scoring of EA attribute Real Time Trust

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

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

F.3.10. Foster Dialogue

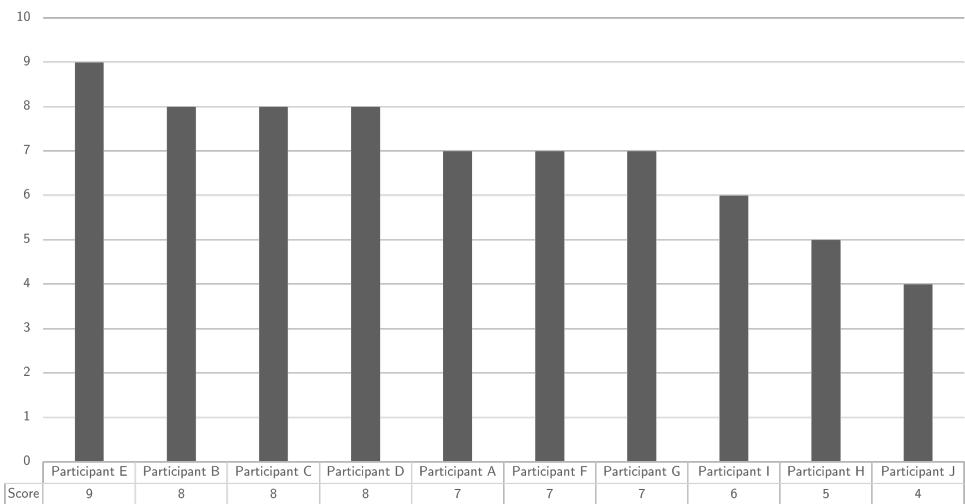


Figure F.22.: Scoring of EA attribute Foster Dialogue

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

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

F.3.11. Validation

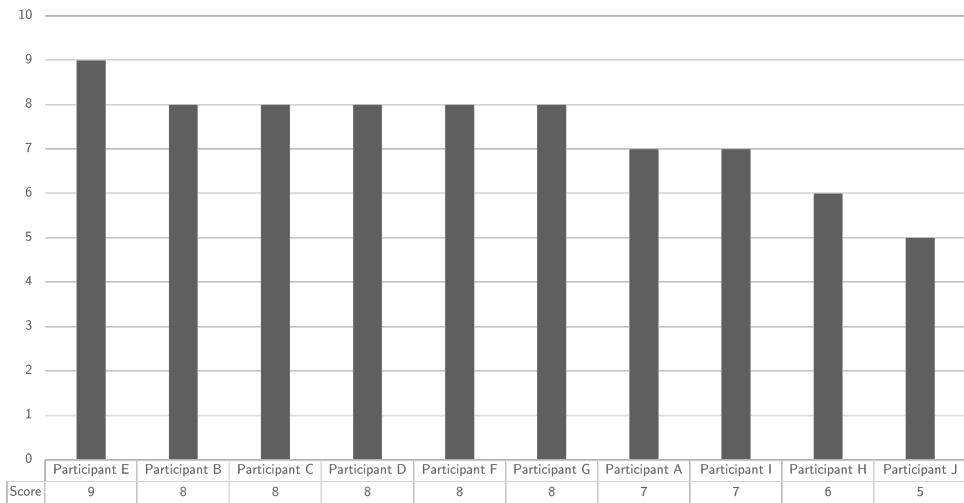


Figure F.23.: Scoring of EA attribute Validation

Attribute	Rating	Variability	Abstains
Validation	7,4	24%	0

Table F.25.: Scoring of EA attribute Validation

F.3.12. Always fitting Enterprise Architecture

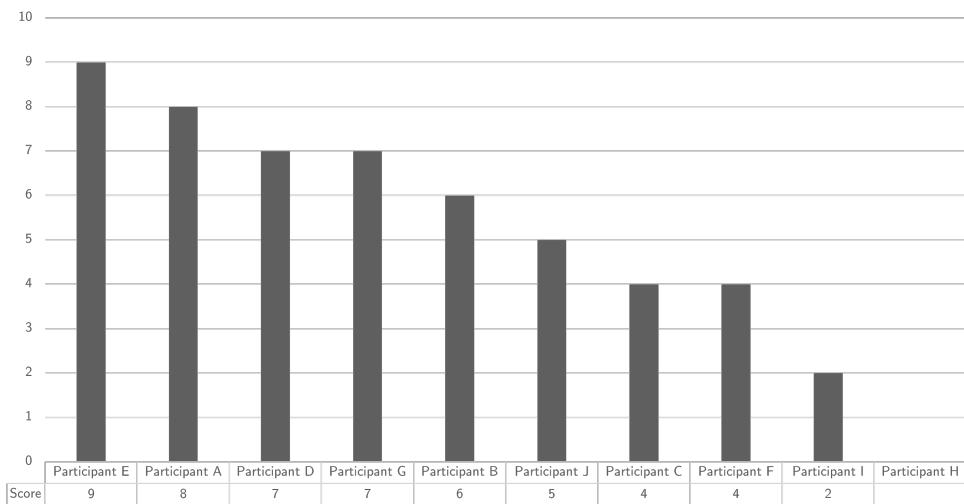


Figure F.24.: Scoring of EA attribute Always fitting EA

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

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

F.4. Closing Survey

F.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 F.27.: Follow-up Survey