Accelerating in a world of chaos

by using Enterprise Architecture with the concept Antifragility

René Bliekendaal

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

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for the degree of Master of Enterprise IT Architecture (MSc)

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

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

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

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

”The only constant is change.”
- Heraclitus

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Author

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

Promotor

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

Co-Promotor

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

Sponsor

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

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

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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 change. 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. If a society or country rejects the change, there is no growth and no progress. The inability to change, progress, or grow can result in stagnation. Stagnation rejects realising ones full potential. Stagnation is not a healthy flowing river; it is an idle and stale pond. (ArapahoeLibraries, 2020; Mark, 2010)

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

Taleb (2012) defines the opposite state of fragile, antifragile as an answer to what Taleb (2008) calls black swan events. These black swan events are also known as X-events (Casti, 2013). Taleb (2012) states that resilient, robust (and company) are states that neither breaks nor improves. Taleb (2012) claims that antifragile is the state that gains and improves. Antifragile is the true opposite of fragile.

In this thesis, the researcher defines the Enterprise Architecture (EA) success factors for contribution to become antifragile. The researcher uses the contextual boundary of the Public Sector Market as his lens.

1.1. Context

The researcher is working as a Chief Architect for an Independent Software Vendor (ISV) specialised in delivering software and services to the local governmental agencies in The Netherlands, such as municipalities, the provinces, the local tax offices, and the regional

water authorities. The researcher, colleagues and local governmental agencies have a common problem with the increasing pace of change.

1.2. Structure of the thesis

In chapter 1, the context of the research is set, the core concepts of EA and antifragility are introduced together with the contextual boundary of the Public Sector Market. This chapter is closed with the problem statement, the belonging research questions, and the substantiation of the relevance of this research.

In chapter 2, the background is given based on literature research. The contextual boundary of the Public Sector market is defined. The concepts of EA, antifragile, and other relevant concepts such as system, organisation, and stressor are researched and defined in detail.

Chapter 3 explains the used methodology and the approach for the research based on the FAIR[1] principles and the research properties of replicability, falsification, independence, and precision as described by Recker (2013).

The researcher will elaborate on the fact that the Public Sector Market suffers from the digital transformation and the increase in the speed of change in chapter 4. The Volatility, Uncertainty, Complexity and Ambiguity (VUCA) world (Bennett & Lemoine, 2014) is used as a lens in this chapter.

1.3. Introduction of the contextual boundary of The Public Sector Market

Remark. Needs a formal introduction.

There is a difference in delivering products and services to the public sector and the private sector. The expected values are different in the public sector than that of the private sector. The top five private sector core values are Profitability, Accountability, Expertise, Reliability, and Effectiveness, while the top five public sector core values are Accountability, Effectiveness, Intercorruptibility, Reliability, and Lawfulness (van der Wal et al., 2008). Profitability is only a value for the private sector. It does not exist as a value for the public sector. The public sector demands or even initiates changes without noticing the needed investments to execute these changes. For more information on the topic public sector and the increasing speed of change see chapter 4.

1.4. Introduction of the concept Enterprise Architecture

Enterprise Architecture (EA) is a discipline for proactively and holistically leading enterprise responses to disruptive forces by identifying and analysing the execution of change toward desired business vision and outcomes. EA delivers value by presenting business

[1] https://www.go-fair.org/fair-principles/

and IT leaders with signature-ready recommendations for adjusting policies and projects to achieve targeted business outcomes that capitalise on relevant business disruptions (Gartner, n.d.-a).

White (2018) states that the organisation's business requirements guide EA — it helps layout how information, business and technology flow together. EA has become a priority for businesses trying to keep up with new technologies such as the cloud, Internet of Things (IoT), machine learning and other emerging trends that will prompt digital transformation.

1.5. Introduction of the concept of antifragility

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

Most people answer that the opposite of fragile is robust, resilient, solid, or something of the sort. However, the resilient, robust (and company) are items that neither break nor improve, so you would not need to write anything on them — have you ever seen a package with robust in thick green letters stamped on it? Logically, the exact opposite of a fragile parcel would be a package on which one has written, please mishandle or please handle carelessly. Its contents would not just be unbreakable but would benefit from shocks and a wide array of trauma (Taleb, 2012).

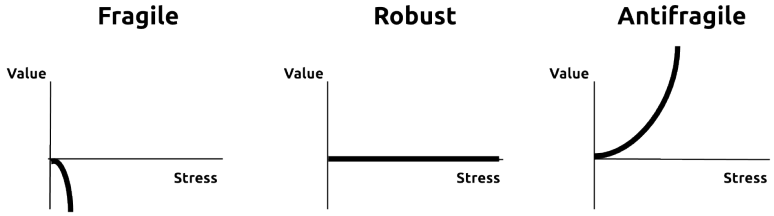

Figure 1.1.: EAAL Triad (Botjes, 2020)

1.6. Problem statement

The concept of antifragility implies that organisations could benefit and strengthen from crises, volatility, errors and uncertainty and could also lead to opportunities for innovation (Kastner, 2017). Enterprise Architecture is a discipline that helps organisations to

reach their goals. As stated by Gartner (n.d.-a) EA is a discipline for proactively and holistically leading enterprise responses to disruptive forces by identifying and analysing the execution of change toward desired business vision and outcomes. One would expect that an organisation uses the discipline of EA to get more towards the state of antifragility. Research has been conducted on aspect architectures such as the application and information architectures but not on EA. The problem is that the Body of Knowledge contains no direct knowledge on how to achieve antifragility with the use of EA.

1.7. The research subject

EA facilitates an organisation in assessing the impact of change and making recommendations for target states that support business objectives. EA guides an organisation in changing. EA can help organisations in changing towards the state of antifragility. However, what are the success factors of EA that contribute in accomplishing antifragility? This is summarised in a conceptual research model.

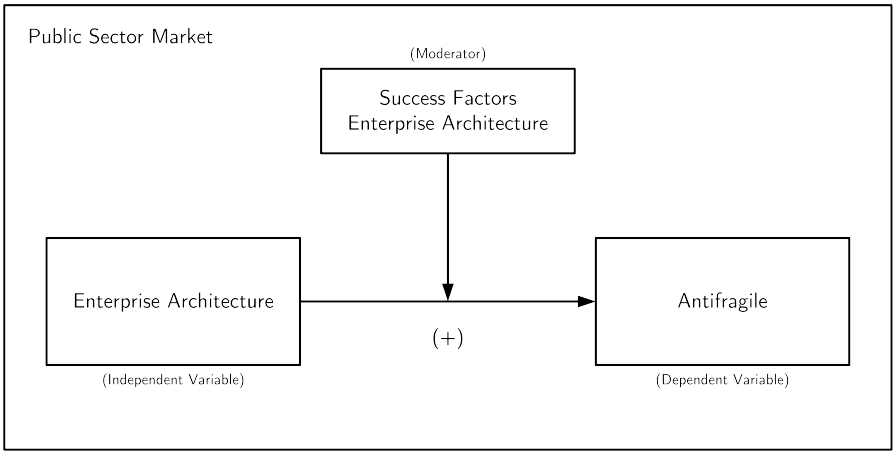

Figure 1.2.: Conceptual Research Model

The hypothesis of the conceptual research model is that, in the context of the public sector market, Enterprise Architecture Success Factors have a positive influence in the contribution of Enterprise Architecture in achieving antifragility. From this conceptual research model the research question can be stated as:

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

To correctly answer this research question the following sub-questions need to be answered:

1. What is literature saying about the Public Sector Market?

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

1.8. Research relevance

Enterprise Architecture (EA) has contributed to being more robust, resilient, and agile. Using EA in pursuing antifragility will add value to companies by accelerating and growing when there is a stressor or black swan event. The antifragile theory is young. Taleb published the theory in his book "Antifragile: Things that gain from disorder." in 2012. Studies conducted on EA with the concept of antifragile are almost non-existence. The conducted studies are primarily about making IT Systems antifragile. Botjes (2020) and Kastner (2017) are exceptions and have researched how to apply antifragile in an organisational context. Nevertheless, both concluded that there is more research needed. The former used the lens of Enterprise Engineering, which is closely related to EA, together with resilience, while the latter used mostly reslience as its lens. There is still no answer to how EA can contribute to becoming antifragile. Organisations use the practice of EA to guide them to achieve their goals. Giving more insights on this subject will contribute to the Body of Knowledge and help others getting closer to antifragility by using EA.

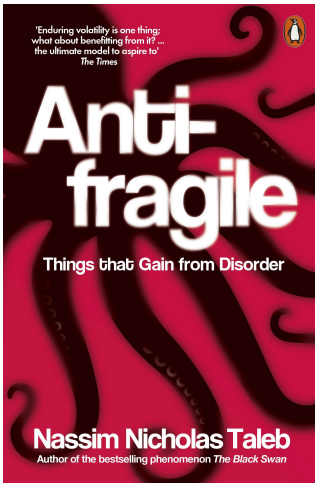

Figure 1.3.: Antifragile: Things that gain from disorder

Because of the digital transformation, the pace of change is increasing rapidly. The increase in pace is not only seen in the private sector but also the public sector. The public sector has another change dimension; elections result in changed regulations and governmental policies. These changes are a result of a new political agenda. In the past, the chosen direction was stable for at least the period until the new elections. With the digital transformation the changes are also taking place in between elections with an increase of pace. Earlier chosen directions often result in the need for a new approach and even new directions. Earlier made investments can be made obsolete because of the new directions that follow out of those policies. The products and services that are delivered are, over time, unpredictable in use and functionality. To overcome this problem, most companies invest a great deal of time and money in being less fragile when the market changes or disruptions occur. This investment is to withstand changes by being more agile, robust, and resilient. By being more agile, robust, or resilient, the company can

only withstand the change or the disruption but does not gain from it. See for more information chapter 4. Governmental agencies and suppliers in the public sector market are searching for methods of dealing with this increased pace and the disruptions that occur. The relevance of this research is not only about the addition to the Body of Knowledge but also to share the outcome with the Public Sector Market.

Remark. These statements will be verified by interviews and the outcome of these interviews are part of 4. This section needs some work!

2. Theoretical background

2.1. What is a system?

Remark. Place standard definitions at this spot of the thesis.

2.1.1. Open vs Closed systems

Complex adaptive system (CAS)

Quote from AMS011: (Turner & Baker, 2019)
"The whole is different from the sum of its parts and their interactions" [61] (p.77) Though emergence, the whole cannot be reduced to the original parts, the whole is considered a new entity or unit. The whole is "qualitatively different from their parts ... The cannot be meaningfully compared-they are different" [61] (system holism)
CAS is going against the second law of thermodynamics.

2.1.2. Linear and non-linear systems

2.1.3. Complexity Theory

Quote from AMS011:
The interactions within organisations are complex and can be explained better through the lens of complexity theory and CAS than by the other theoretical system approaches (Turner & Baker, 2019, p. 15).

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

Remark. Must elaborate more on this.

2.1.4. Viable Systems Model

Viable Systems Model (VSM)

2.1.5. Organisation as a System

2.1.6. To be worked upon

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

2.2. Antifragile

Antifragile loves both randomness and uncertainty.

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

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

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

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

Decentralised Systems, using self organising capabilities might not only survive disruptions but could even psorsper (Brafman & Beckstrom, 2007).The only real difference with Complex Adaptive System and antifragile of Taleb (2012) is that with antifragile stressors, disruptions, errors, volatility, randomness, chaos and uncertainty are seen as

'desired events' in order to strengten and evolve the system (Jaaron & Backhouse, 2014).

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

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

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

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

2.2.1. What is a stressor?

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

2.2.2. Volatile, uncertain, complex, and ambiguous

Volatile, uncertain, complex, and ambiguous.

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

antifragile with fragile, robust, resilient, and agile.

2.2.4. Resilience

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

- **Engineering Resilience.** Bounce back faster after stress, enduring greater stresses, and being disturbed less by a given amount of stress.
- **Systems Resilience.** Maintaining system function in the event of a disturbance. Systems resilience has been applied in governance and management, where it is often called robustness.
- **Resilience in Complex Adaptive Systems.** The ability to withstand, recover from, and reorganise in repsonse 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.

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

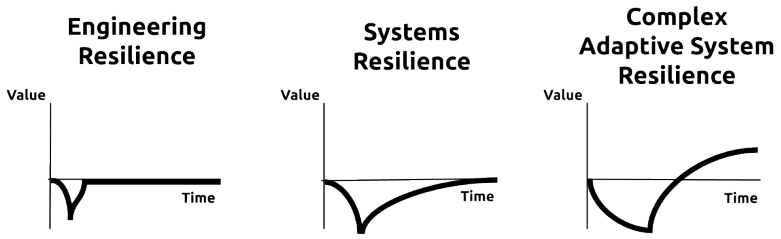

Figure 2.1.: Three types of resilience (Botjes, 2020)

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

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

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

- Maintain a diversity of mechanisms to provide identical functions.
- Make sure networks (social or otherwise) are modular enough so damange or "infection" of one portion does not immediately propogate to all others.
- Maintain or establish feedbacks to, in the simplest case, establish fail0safe mechanisms in case of malfunction.

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

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

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

Remark. add extra references from Kastner to this cite.

2.2.5. Antifragile Systems Design

Antifragile Systems Design (ASD) (O'Reilly, 2019, p. 886-888) requires an organization to move as one toward solving the problem of complexity, which means changing the

perspective from "us vs. them" (IT vs. business) to simply "us" (business). Business leaders, business/ enterprise architects, and software architects all need to engage with the process to make it work. This requires a new approach from both architects and business leaders (O'Reilly, 2019, p. 886).

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

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

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

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

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

The process of ASD constist out of four steps:

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

Remark. Needs some extra explanation per item

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

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

2.2.6. Residuality Theory

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

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

Remark. Barry will be contacted for some elaboration on the subject of the residuality theory.
barry@blacktulip.se
Twitter: https://twitter.com/technologytulip

2.3. Enterprise Architecture

White (2018) states that the organisations business requirements guide enterprise architecture — it helps layout how information, business and technology flow together. Enterprise architecture has become a priority for businesses trying to keep up with new technologies such as the cloud, IoT, machine learning and other emerging trends that will prompt digital transformation. While Gartner (n.d.-a) states that Enterprise Architecture is a discipline for proactively and holistically leading enterprise responses to disruptive forces by identifying and analysing the execution of change toward desired business vision and outcomes. EA delivers value by presenting business and IT leaders with signature-ready recommendations for adjusting policies and projects to achieve targeted business outcomes that capitalise on relevant business disruptions.

2.3.1. Three schools of Enterprise Architecture

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

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

Remark. Use the findings of (Botjes, 2020) to stress the importance of a learning organisation to be antifragile. With this the choice of the three schools is clear. It should be the third school.

2.3.2. Steering mechanisms

2.4. Public Sector market

2.4.1. Differences with the Private Sector Market

3. Research Methodology

3.1. Research Model

The method of Verschuren and Doorewaard (2016) is used for the research model.

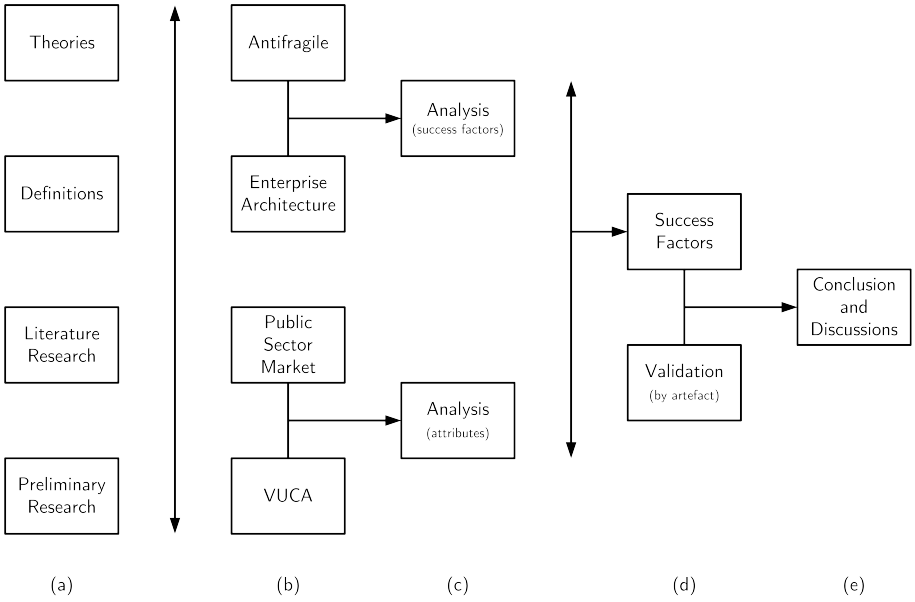

Figure 3.1.: Research Model

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

3.2. Research quality

The researcher uses three frameworks to increase the rigorousness of the research as much as possible.

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

3.2.1. Quality Principles of Recker

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

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

Remark. Howto falsify?

3.2.2. Fair Principles

In 2016, the 'FAIR Guiding Principles for scientific data management and stewardship' were published in Scientific Data. The authors intended to provide guidelines to improve the Findability, Accessibility, Interoperability, and Reuse of digital assets. The research is using the FAIR Principles[1] to increase the quality of the published thesis.

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

[1] https://www.go-fair.org/fair-principles/

- **Accesible.** Once the user finds the required data, she/he/they need to know how can they be accessed. The thesis, research and used datasets are published on GitHub, Zenodo, and Researchgate based on Open Access. The researcher created objects containing a location on where the data can be acquired if it cannot be published because of author rights.

- **Interoperable.** The data usually need to be integrated with other data. In addition, the data need to interoperate with applications or workflows for analysis, storage, and processing. This principle is not relevant for this research. The data are qualitative data sets based on literature, interviews, and questionnaires.

- **Reusable.** The ultimate goal of FAIR is to optimise the reuse of data. To achieve this, metadata and data should be well-described so that they can be replicated and/or combined in different settings. The thesis, research and used datasets are published under the CC-BY-SA 4.0 license. It is allowed that the thesis, research, and datasets are shared and are adapted (even commercially) as long as the original author is attributed and the possible derivate is published under the same license.

3.2.3. The Open Science Framework

One of the starting points of the research is Open Science. The idea behind Open Science is to allow scientific information, data and outputs to be more widely accessible (Open Access) and more reliably harnessed (Open Data) with the active engagement of all the stakeholders (Open to Society) (UNESCO, 2020). The Center for Open Science[1] supports this way of research by supplying guidelines and even a toolkit. For this research the toolkit is used to support Open Access, Open Data and Open to Society. One of the tools in the toolkit is a reference model to select tools for the four main phases of research: Search and Discover, Design Study, Collect and Analyse Data, and Publish Reports. The researcher uses this reference model in section 3.6. Using this framework will help in achieving replicability, precision, and reusability.

3.3. Research approach

What is literature saying about the Public Sector Market? What is literature saying about Enterprise Architecture? What is literature saying about the success factors of Enterprise Architecture? What does literature say about antifragile? How can the success factors of Enterprise Architecture contribute to becoming antifragile?

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

[1] https://www.cos.io/

3.4. Delphi Method

For the Delphi Group participants see appendix D

What about the sample size? Normally Delphi is about 100+. What about this research. How large should the sample size be for a qualitative result? Answer of sample size 12 to 18 (stated by promotor)
The result of the research of Diamond et al. (2014, p. 404) states a median of 75% to determin consensus.

Remark. After email conversation with Hans. I decided on 12 tot 18 participants.

3.5. Literature research

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

- Web of Science
- Research Gate
- Google Scholar

A predefined collection of search strings is used for the search with scientific libraries.

3.5.1. Search strings

The following search strings are used for finding literature with the scientific libraries. Not only the full concept name is used but also the abbreviations (eg. Independent Software Vendor and ISV, Enterprise Architecture and EA).

Enterprise Architecture	
Enterprise Architecture Antifragile	Search String 2
Search String 3	Search String 4
Antifragile	
antifragile robust agile resilient	Search String 2
Search String 3	Search String 4
Independent Software Vendor	
Independent Software Vendor antifragile	Independent Software vendor resilient
Independent Software Vendor Public Sector	Independent Software Vendor Enterprise Architecture

Public Sector

Difference public and private sector	Public Sector antifragile
Public Sector resilient	Search String 4

Enterprise Architeture & Antifragile

Search String 1	Search String 2
Search String 3	Search String 4

Enterprise Architect & Antifragility

Public Sector Market & Independent Software Vendor

3.5.2. Criteria for admission of literature

It is essential that the literature must help to develop the knowledge necessary to conduct the research. But before the literature can be used the quality of the literature must be evaluated. For evaluating the literature on the usability for this research the criteria accuracy, authority, objectivity, currency, and coverage is used[1].

3.6. Research infrastructure and tooling

For selecting the suitable instruments for the research, the Open Science Framework[2] is used. The Open Science Framework consists out of 4 stages in a research project. Those stages are: "Search and Discover, Design Study, Collect and Analyse, and Publish Reports." The Open Science Framework proposes specific infrastructure and tools per stage. The transparency in the used infrastructure and tools increases the quality of the research. It increases the replication factor, findability, accessibility, interoperability, and reusability.

[1] https://libguides.library.cityu.edu.hk/litreview/evaluating-sources/
[2] https://www.cos.io/products/osf

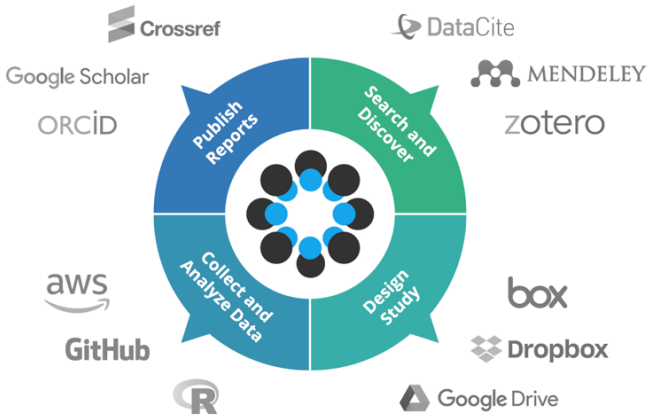

Figure 3.2.: Open Science Framework

3.6.1. Thesis creation

The student used his corporate laptop (Dell Latitude 7200 2-in-1[1]) with Windows 10 Professional installed for creating the thesis. The thesis is created with the markup language LaTeX[2]. The used typesetting environment is TexLive[3] with the document type of "Report" from KOMA-Script[4]. TexStudio[5] is the used LaTeX Editor. It supports syntax-highlighting, has an integrated viewer, reference checking and numerous wizards. For the creation and administration of references BibLaTeX[6] is used with the reference manager JabRef[7] with the citation style of APA 7th Edition[8] and with web browser integration. The files are stored on a personal Dropbox[9] that is used by GitHub Desktop[10] to synchronise with a public GitHub repository[11]. GitHub[12] is used for source control but also for reviewing and discussing the topics with the (Co-)Promotor and the planning of the master thesis project. The thesis source files are copied to an Amazon S3 Blob[13] for backup. The backup rotation is seven versions. Cloudberry Explorer Freeware for Amazon S3[14] is used for backup. Grammarly[15], with the paid subscription service, checks

[1] https://www.dell.com/en-us/work/shop/dell-laptops-and-notebooks/latitude-7200-2-in-1-laptop/spd/latitude-12-7200-2-in-1-laptop
[2] https://www.latex-project.org/
[3] https://www.tug.org/texlive/
[4] https://ctan.org/pkg/koma-script
[5] https://www.texstudio.org/
[6] https://ctan.org/pkg/biblatex/
[7] https://www.jabref.org/
[8] https://apastyle.apa.org/
[9] https://www.dropbox.com/
[10] https://desktop.github.com/
[11] https://github.com/JRBliekendaal/master-thesis
[12] https://github.com/
[13] https://aws.amazon.com/s3/
[14] https://www.msp360.com/explorer/windows/amazon-s3.aspx
[15] https://www.grammarly.com

the thesis for spelling, grammar, style, and plagiarism. The used goals for Grammarly are audience=knowledgeable, formality=formal, and domain=academic. Microsoft Visio Professional[1] is used to create figures. The GitHub repository contains all the sources.

3.6.2. Research administration

The research administration, which includes documentation containing privacy-sensitive information, like the name and contact information of the Delphi Group participants, is stored on a non-public GitHub Repository[2]. The private GitHub Repository is also for staging thesis parts that still need to be anonymised. For taking notes Leuchtturm1917[3] Notebooks are used with mechanical pencils of Faber-Castell[4] and pens from Sakura[5] with long-lasting ink.

3.6.3. Research execution

For the execution of the research, Microsoft Excel[6] is used for the administration of the literature research. For the administration of the literature research, the following headers are used: ID (for a unique ID per item), search terms used, scope, title, subtitle, author(s), year, type, BibLaTeX citation key, title relevance, abstract relevance, content relevance, found at, doi/isbn, url, date found, duplicate, date used, use for, and notes. Researchgate[7], Web of Science[8], and Google Scholar[9] are the main sources for searching for literature. PaperPanda[10] is used for hard to find literature. The literature administration is, together with the publicly available literature, stored in the repository of the master thesis. For non-public available literature, the administration contains the location where the literature is retrievable. All the literature is added to a bibLaTeX file for future reference. For traceability the entries in the bibLaTeX file contain the Unique ID in the notes field. JabRef is used to sort the references by using subgroups to support the workflow. The subgroups used are: "evaluate, rejected, and used." Only the literature in the subgroup used are transferred to the bibliography file of the thesis. This prevents cluttering. For working as paperless as possible all the literature, where possible, is in pdf or in ebook format. For reading Acrobat Reader DC[11] is used for reading the PDF, and an Amazon Kindle Oasis[12] for eBooks. With the Amazon Kindle the highlight feature is used. This is not stored on GitHub since the highlights are under copyright of the author(s).

[1] https://www.microsoft.com/en-ww/microsoft-365/visio/
[2] https://github.com/JRBliekendaal/master-thesis-administration
[3] https://www.leuchtturm1917.us/notebook-classic.html
[4] https://www.fabercastell.com/products/tk-fine-vario-l-mechanical-pencil-10mm-135900
[5] https://www.sakuraofamerica.com/product/pigma-micron/
[6] https://www.microsoft.com/en-us/microsoft-365/excel
[7] https://www.researchgate.net/
[8] https://app.webofknowledge.com/
[9] https://scholar.google.com/
[10] https://paperpanda.app/
[11] https://get.adobe.com/reader/
[12] https://www.amazon.com/dp/B07L5GJD99

For the execution of the Delphi Method, Meetingwizard[1] is used for questionnaires and the analysis of the questionnaires. The license for using Meeting Wizard is supplied by the Antwerp Management School.

[1] https://www.meetingwizard.nl/

4. VUCA and the Public Sector Market

- Idea is take the (notities van de overheid) and distil the plans.
- Take the background information of how the public sector in the Netherlands is organised (freedom of ... per governmental institutes. Law of Municipalities by Thorbecke
- Take a couple of interviews to verify. Three inteviews for triangulation
  - Franc Weerwind. Mayor of Municipality of Almere (Municipality).
  - Nathan Ducastel. Director of VNG Realisatie (Governmental Agency
  - Maarten Hillenaar. Director of Centric Public Sector Solutions (ISV).
- Create conclusion on this part.

Remark. Also take iBestuur into account!!!

Statement of Franc Weerwind Mayor of Municipality of Almere:
Developments are too fast. The governments cannot follow it in this pace. The government needs the private sector to keep up with developments.
This needs certain collaboration instead of customer supplier relationship.
Pace of Stressors is increasing in time!.

Remark. Use the i-Strategy for a summary (Digitaleoverheid, n.d.)

Themes relevant for the government for 2021 until 2025.

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

Remark. Add English translation (not replacement because of citation.)

5. Analysis

6. Artefact

7. Validation

7.1. Delphi Round One

7.2. Delphi Round Two

7.3. Delphi Round Three

7.4. Delphi Round Four

7.5. Delphi Round Five

7.6. Delphi Round Six

7.7. Result of Delphi Rounds

8. Conclusion

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9. Discussion

9.1. Discussion on research

9.1.1. 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.

9.1.2. Is the Public Sector different then the private sector?

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9.2. Discussion on research quality

9.2.1. Size of Delphi Group

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

9.2.2. The composition of the Delphi Group

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

10. Blocks of text that can be used

10.1. Validation through an artefact

Because there is not much known on the applicability of antifragile on Enterprise Architecture, the success factors need to be validated to be true. To validate, the researcher will create an artefact. The Delphi Research Method is used to validate the artefact. By validating the artefact, the researcher can ensure that the success factors are valid with some degree of certainty.

10.2. CAS System Theory/Complexity sciences

Quote from AMS011:
"The whole is different from the sum of its parts and their interactions" [61] (p.77) Though emergence, the whole cannog be reduced to the original parts, the whole is considered a new entity or unit. The whole is "qualitativly different from their parts ... The cannot be meaningfully compared-they are different" [61] (system holism)

10.3. Relevant Laws

- Second Law of Thermodynamics
- Conways Law
- Metcalfe's Law

10.4. Discussion on Frameworks like TOGAF

When the third of the three different schools of Enterprise Architecture, Enterprise Ecological Adaption (Lapalme, 2012), is more suitable for a antifragile enteprise architecture and the residuality theory of O'Reilly (2021, p. 809) is advocating Post-Structuralism, then what is still the added value for frameworks like TOGAF, FEAF, ...

Remark. reference is not oreilly 2020 but 2021!!!

10.5. public sector stressors

Floods, municipal redistricting, redistribution of main tasks between the local and the central government but also change in the information architecture of the Public Sector Market or a new centr

11. Chapter Template

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11.1. section title

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11.1.1. subsection title

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subsubsection title

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

11.2. Building Blocks

11.2.1. table

What	When	Who	Why	How
X	1	1	2	3
Y	2	45	7	9
Z	0	0	1	7

Table 11.1.: Introduction Table

11.2.2. Picture

11.2.3. Glossary

```
\gls{antifragile}␣is␣not␣that␣\gls{fragile}\\
\Gls{antifragile}␣is␣not␣that␣\Gls{fragile}\\
```

Figure 11.1.: Placeholder

```
\gls{fragile} is not that \gls{antifragile}\\
\Gls{fragile} is not that \Gls{antifragile}\\
```

Gives:
antifragile is not that fragile
Antifragile is not that Fragile
fragile is not that antifragile
Fragile is not that Antifragile

11.2.4. Abbreviation

```
\acrfull{vuca}\\
\acrlong{vuca}\\
\acrshort{vuca}\\
```

Gives:
Volatility, Uncertainty, Complexity and Ambiguity (VUCA)
Volatility, Uncertainty, Complexity and Ambiguity
VUCA

11.2.5. Citing

```
\parencite{Bliek2017}
\parencite[p. 20]{Bliek2017}
\citeyear{Bliek2017}
\citeauthor{Bliek2017}
\parencite*{Bliek2017}
\textcite{Bliek2017}
\parencite{Doe2100,Bliek2017}
```

Gives:
(Bliekendaal, 2017)
(Bliekendaal, 2017, p. 20)
2017
Bliekendaal
(2017)
Bliekendaal (2017)
(Bliekendaal, 2017; Doe, 2100)

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Glossary of Terms

agile The ability to adjust before failure happens. 1, 7

ambiguous tbd. 7

antifragile The ability to strive for and evolve under stress. 1–3, 5, 7–9, 14, 28, 35

antifragility The state of being antifragile. 4

complex tbd. 7

Failure Mode Effects Analysis is a Six Sigma technique that helps manage quality in a system by investigating how the system will cope with failure. 9, 35

fragile The quality of being easily broken or destroyed. 1, 3, 7, 28

fragility The state of being fragile. 6

resilient The ability to recover from failure. 1, 3, 7

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

uncertain tbd. 7

volatile tbd. 7

Abbreviations

ASD Antifragile Systems Design. 8, 9

EA Enterprise Architecture. 1–4, 14

EAAL Extended Antifragile Attribute List. 3, 8

FMEA Failure Mode Effects Analysis. 9

IoT Internet of Things. 3

ISV Independent Software Vendor. 1, 2, 4, 10, 11, 15

VSM Viable Systems Model. 6

VUCA Volatility, Uncertainty, Complexity and Ambiguity. iv, 1, 5, 9, 18, 28

Appendices

A. Personal Motivation

Personal story
- Why this subject
- Road to this subject
- Personal motivation
- Personal goals

B. Overview of Laws

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

- 2^{nd} Law of Thermodynamics
- Conways Law
- Metcalfe's Law
- Law of Municipalities

B.1. 2^{nd} Law of Thermodynamics

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

B.2. Conways Law

B.3. Metcalfe's Law

B.4. Law of Municipalities

Thorbeckers Law!

C. Interview Participants

Who	Role	From
Christiaan Konstapel	Lead Enterprise Architect	Mileway
Y	2	tbd
Y	2	tbd

Table C.1.: Interview Participants

D. Delphi Group Participants

Who	Role	From
Jan Ploeg	Enterprise Architect	Centric Netherlands B.V. (ISV)
Y	2	Other ISV
Y	2	Municipality
Y	2	VNG-Realisatie
Y	2	Logius
Z	0	Academic

Table D.1.: Delphi Group Participants

E. Literature Selection

F. Research Log

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

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

Date	What
03/09/21	Research on the ANT conferences and pulled some relevant articles into the research. Administration of Literature study.
04/09/21	Literature study. Read the articles of Barry M. O'Reilly. Shared the articles of Barry M. O'Reilly with colleagues responsible for Software Development and Architecture.
05/09/21	Literature study and structure of thesis. Worked on the introduction and added some new relevant information to the theoretical background.
06/09/21	Literature study.
08/09/21	Administration and preparations for meeting with Promotor and Co-Promotor on the 9th of September at the AMS.
09/09/21	Alignment with Co-Promotor and Promotor at the AMS. Administration on given answers. Requested the sponsor to take his place at the jury.
10/09/11	Literature study.
15/09/21	Visited the iBestuur congress for information on the public sector market and to network for the study/research.
16/09/21	Literature study. Writing on Chapter 1 and 2.
19/09/21	Writing on Chapter 1, 2 and 3. Refine email for sponsor for invitations of delphi group participants. Sponsor accepted his jury position.
20/09/21	Finalising Chapter 1 for 10 pager AMS. Last refinement for Sponsor invitation email after meeting by telephone.
21/09/21	Wrote Barry O'Reilly an email with the request to meet and elaborate on the residuality theory.
22/09/21	Structuring and writing.
23/09/21	Structuring and writing. Created a frozen release on GitHub of this release. Send the same compiled version of the thesis to the sponsor and the second reader.
24/08/21	Master Project Coaching. Status update on Thesis.