Antifragility in strategic management;

Strengthening companies through embracing uncertainty

"An analysis of the application of antifragility in the field of strategic management, focusing on redundancy, optionality, and skin in the game."

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EXECUTIVE SUMMARY

The environment that high-tech companies have to navigate is changing rapidly. To deal with these changes, managers have limited tools, of which many are based on predictive properties. However, as Black Swans and X-events illustrate, the future is inherently unpredictable. As the field of strategic management is primarily involved in dealing with the future, a new approach that does not rely on prediction could be of incredible value. Therefore, the concept of antifragility is introduced in this field as a new approach for management to decide on strategies. Antifragility is a concept that moves away from prediction. It does so by focusing on ways to deal with variation instead of merely aiming to prevent or predict it. It looks at what changes will do to an organisation and how to adapt a system so it can absorb or even benefit from this variation.

Antifragility is a relatively new concept in the field of strategic management and therefore limited research has been conducted. The aim of this research is to analyse the concept through three aspects of antifragility: optionality, redundancy, and skin in the game. Strategies and practices that are related to these aspects are identified and analysed in order to get higher level insights in the mechanisms that increase antifragility through these concepts. The end results are several propositions capturing these mechanisms, which give insight in how companies and organisations can use antifragility to improve their strategic management.

The research is exploratory as the field is relatively unknown and the existing research is not consistent of quality due to the lack of a theoretical framework. The main research question investigated in this thesis is the following: What underlying mechanisms drive antifragility in strategic management through the concepts of redundancy, optionality, and skin in the game?

In order to be able to create propositions with validity in such a new field, the research consisted of three separate parts that delivered separate conclusions. This way, insights and higher-level mechanisms could be triangulated from these parts, creating valid and strong propositions. First a desk research was conducted through literature on antifragility from the fields of strategic management, urban planning, systems dynamics & engineering, and ICT. The literature was analysed to create conclusions on the strategies and practices for implementation of antifragility in strategic management. Furthermore, a comprehensive overview and consolidation in vocabulary on the subject of antifragility in strategic management was made. Second two case studies were executed, respectively about Haier and Zappos. Both companies are known for their innovative management structures and are well documented in scientific literature. This literature was analysed to highlight antifragile strategies and practices employed by the companies and general conclusions were created by comparing overlap between them. Finally, nine semi-structured interviews were conducted with interviewees that employ antifragility or related concepts in their professional career. The results were analysed using a general inductive approach. The resulting categories were discussed. The conclusions of these three aspects combined created higher-level insights into the mechanisms behind optionality, redundancy, and skin in the game and how they contributed to an increase of antifragility for organisations. These insights were captured in several propositions. The resulting proposition highlighted that a greater focus on continuous experimentation, building redundancy and optionality through diversifying and a structure of decentralized decision making can increase the antifragility of a company. Furthermore, that implementing skin in the game from employees can be achieved through either conscious choice or an increase in employee engagement.

The implications of the propositions cover many areas. For the scientific community an overview, consolidation of terminology, and an expansion towards other fields has been made for antifragility in strategic management. This opens up both many new research possibilities and a common ground to start from. For the TU Delft this new view on strategic management can add a new and contrasting view to the curriculum, highlighting biases and assumptions underlying many strategies and theories. For society, a focus on growing organisations in an antifragile manner can promote more adaptability and thus stable economic prosperity.

For management, the implications can be far reaching. This research shows that although the quantitative evidence of the benefits that antifragility can bring are few, the concept holds promise of more control and success in strategic decision making. Using antifragility, they are better able to withstand variations, can benefit from it and it enables them to take an inwards look, focusing their efforts at what companies can influence, instead of trying to influence the un-influenceable. Adjusting to the propositions as stated requires a new view on almost every aspect of the modern company. However, for the concept to become more accepted and applied, future research is necessary, such as quantitative proof of effectivity of antifragility and a better understanding of the limitations of antifragility.

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1. INTRODUCTION

The environment that (high-tech) companies have to chart to become successful players in today's economy is changing at a fast, or even accelerating pace (Ruiz-Martin, Lopez-Paredes, & Wainer, 2018). Company investment in R&D projects, generally the most uncertain aspect of business, have increased steeply during the 20th century (Bakker, 2013) and 90% of start-ups fail primarily due to self-destruction through bad strategic decisions (*Startup Genome Report Extra on Premature Scaling*, 2011). In order to survive or even thrive, new ways are needed to look at the way businesses are managed.

Strategies such as Six-Sigma or Lean seem to provide this, but Näslund (2008) has shown that these share the same fundamental approaches as older techniques such as Total Quality Management and Just In Time. These new techniques are certainly incremental improvements, but to really thrive in the new business environment a radically new lens is needed. A business view that helps management, from start-ups to multi-nationals, embrace the uncertainty of the future and use it to become a better and stronger company.

The field of strategic management is involved with the search for strategies and initiatives to enhance the performance of the company (Nag, Hambrick, & Chen, 2007). The current standard practice of dealing with the future in management is either predicting changes or needs, such as market research, business forecasting and the use of weak signals, or is aimed at trying to minimize these changes by for example implementing six-sigma. But this leaves a blind spot for events we simply cannot predict.

To deal with these so-called unknown unknowns, future outcomes we cannot predict, several approaches have been developed. However, these approaches still aim at reducing the amount of unknown unknowns (Kim, 2017; Ramasesh & Browning, 2014), increasing the ability to predict them (Clark, 2017; DCV, 2019; Raydugin, 2013; York, 2016) or are rather philosophical and broad without clear practices (Kvalnes, 2016; Termeer & van den Brink, 2013).

Unfortunately, until time-traveling is invented, nobody can predict these future events. That is why Nassim Taleb (2012) in his book Antifragile makes a case to shift away our view from predicting the future. Strategic management deals with this future; how to organize the company for the best results, which products to make and research to do. Taleb wants society to change its view towards what the effects are of variations and mitigate these, instead of predicting or preventing these variations. He does this by introducing a new view on the ability systems to not only withstand but also benefit from this variation: Antifragility.

Antifragility is aimed at looking at a system and its workings from a non-predictive standpoint. So instead of working from whether things will change, it focuses on how the system will react when things change. And, in reaction to that, build systems, practices and structures that can withstand variation and even benefit from it.

This new way to look at systems is also useful for companies since they often are ,and operate in, complex systems. Furthermore they are managed with an emphasis on predicting or manipulating the future. Antifragility can help management by creating an environment in which variations and unpredictable events do not hurt the company and may even benefit it. Therefore, the lens of antifragility can theoretically be of much value to the field of strategic management.

1.1 Problem definition

Our business environment is changing rapidly. The internet made the world smaller. Companies expect a crisis to appear every 5 years (Everett & Business Expert Press., 2011). Epidemics as SARS and the current Coronavirus COVID-19 bring great stress to companies.

The techniques and abilities of companies to deal with these unpredictable events are lacking. Literature aimed at unknown unknowns focuses on reducing the amount of unknown unknowns (Kim, 2017; Ramasesh & Browning, 2014), increasing the ability to predict them (Clark, 2017; DCV, 2019; Raydugin, 2013; York, 2016) or are rather philosophical and broad without clear practices (Kvalnes, 2016; Termeer & van den Brink, 2013). This despite the fact that all definitions contain that unknown unknowns are in essence unpredictable.

At the basis of antifragility lies the notion of the Black Swan, a large disrupting event with an incredibly low frequency that can only be predicted in hindsight (Taleb, 2010). Black Swans can be classified as unknown unknowns with an enormous impact. The theory of antifragility is built around this notion that prediction has no true value for the long term and focuses on adaptations to withstand and even benefit from this property.

Antifragility is however a relatively new topic in the scientific community, which is reflected in the low amount of research about it. The concept is not widely accepted, which results in many misunderstandings and as a result many articles are of low quality. Taleb has not written his book as a practical guide, so many articles that are of good quality are aimed at conceptualizing and operationalizing the theory for strategic management. Scarce work is done in related fields such as urban planning, systems engineering, and ICT. These works provide us with excellent examples of correctly implemented instances of antifragility, but also highlight the many misunderstandings of the concept.

Less to no work has been done in strategic management, while this field can benefit a great deal from this new view. As presented before, the field is inherently involved in the future of a business, it's decisions and its continued existence. The business environment for companies is increasingly hard to predict and the stakes are getting higher. Therefore, a lens or framework that can change the focus from predicting the future towards a focus on the company and its decisions itself can create valuable insights and actions a company can take. A company can then structure its strategies in such a way that, up to a certain point, it is unfazed or can even benefit from changes in the environment.

But there is even less research on how to structure a company, for example it's processes and people, in order to achieve a higher antifragility. This research aims to identify practical instances that practitioners and managers in the field can use to increase their antifragility by researching currently accepted practices. And, how they can be viewed through the lens of antifragility and implemented in such a way that the company can become more antifragile. Ultimately this research aims to uncover the higher-level mechanisms that underly these increases in antifragility.

1.2 Research Goal

The goal of this research is to identify higher-level mechanisms that underly the different strategies and practices that companies can implement to increase antifragility, focusing on optionality, redundancy, and skin in the game. The choice for redundancy and optionality is due to the recent popularity to be efficient in operations and strategies, often reducing redundancies. Thus, it shines an interesting light on this idea to look at it from another angle. Second the concept of optionality lies at the heart of antifragility and is thus a great starting point. Lastly the concepts of redundancy and optionality are tightly interwoven as will be described in the chapter about the background of antifragility. The choice for Skin in the game comes from the increase in new management innovations aimed at increasing employee engagement, which can is suspected to be synonymous for the creation of skin in the game.

The research consists of three parts, the first two focusing on secondary sources in the form of literature and the third on primary sources in the form of interviews. The literature part consists of one introductory and one in depth parts. First an introduction and translation of Antifragility in order to understand the terms and concepts is given. Then an overview of antifragility in strategic management and related fields is given, to give a structured summary of work already done and insights that can be incurred from them. In the second part two small case studies highlight strategies in real-life cases and relate them to antifragile concepts. The third part consists of interviews with practitioners from the field that use antifragile practices in their work that ranges from consultants to CEOs.

The aim of this research is to distinguish several propositions, that underpin general insights in how optionality, redundancy, and skin in the game as parts of antifragility are related to strategic management. The three different research approaches will result in several conclusions and insights on the three aspects of antifragility: optionality, redundancy, and skin in the game. The insights from these approaches will be used to find higher level similarities. These will be captured in the concluding propositions.

1.3 Methodology

Exploratory research

The research has been exploratory in nature, making use of both secondary and primary sources. A new concept is coupled to existing research, literature, and in-depth interviews in order to give a comprehensive overview of the academic environment on antifragility and to come to several propositions about the higher-level mechanisms underlying practical applications.

Antifragility in strategic management is not well known yet, the existing research has some serious flaws, is not very extensive and there is not yet enough theory and research to create a complete theoretical framework, which are described as characteristic for topics suited for exploratory research as by Sekaran and Bougie (2016)

The research has been performed using qualitative data obtained from literature and interviews. The units of observation are employees and consultants. The units of analyses are companies or organisations.

In order to achieve sufficient research validity, triangulation has been pursued through decoupling the three methods (desk research, case studies, interviews) and treating them as independent parts. This way overlaps in the conclusions from the three parts provide additional validity to the concepts as they emerge through different sources and methods. In order to have a common vocabulary, the theory as presented in chapter 2.1 Fundamentals of antifragility has been used as a common starting point.

Scope of the research

The research scope during the desk research concerns literature on strategic management and related fields focusing on the concept of antifragility, taking the original papers and books from Taleb as a starting point. The scope of the interviews is focused on redundancy, optionality, and skin in the game in the widest sense to capture different insights from different sectors. These interviews are meant as additional sources of information to connect to the literature, not to collect a representative image of the business environment.

This research that uses the insights of Nassim Taleb and applies them to strategic management in a novel and critical way and is unique in it's kind as it is the first endeavour to translate the antifragility concepts to real life-business strategies and inferring from them the underlying principles for academic purposes. Underlying principles which can act as a basis for future best practices and analysis on strategy fit per company.

The research contributes to the scientific community by pioneering and increasing the knowledge of antifragility in strategic management. It serves as a first step, laying the groundworks for future research. It also aims to provide a starting point of classification and identification of strategies than can be categorized to improve on certain concepts of antifragility. Furthermore, it opens a new avenue of research possibilities into antifragility in strategic management, is a first aim at larger scale research into antifragility, breaking ground with acceptance and methods for future research in the area.

This research contributes to society by developing a new way to look at strategic management of companies. This research aims to result in a first overview of strategies and underlying principles that companies can implement to increase their antifragility on the aspects of redundancy, optionality, and skin in the game. This can result in more robust, resilient, or even antifragile companies, able to withstand the current business environment better and profit from change. This way less businesses fail, and a more stable growth is enabled.

The research is relevant to the curriculum of Management of Technology as it ties together many aspects of the study under a new lens, which can be seen as a new and innovative way for managing companies from start-ups up to multinationals. It relates to the strategic management of many companies but is extra relevant for the field of high-technologic companies as their business environment is more volatile than ever and often are complex. As a young field, the options to pioneer are vast which provides opportunities for the TU Delft to become a leading expert in this field.

Research questions and method

The driving goal of this research is to identify underlying principles or mechanisms of strategies and practices that companies (can) implement to become antifragile, focusing on the concepts of redundancy, optionality, and skin in the game. To guide this endeavour a research question was decided upon and several sub-questions were derived. The main research question is:

"*What underlying mechanisms drive antifragility in strategic management through the concepts of redundancy, optionality and skin in the game?*"

In order to answer this question, the following sub questions need to be answered.

1. *What is already known about antifragility in the field of strategic management and related fields, and what insights can be created by combining them?*
2. *What strategies, practices, and insights for increasing antifragility as a company can be found by analysing the strategies and practices of companies through secondary sources?*
3. *What strategies, practices, and insights for increasing antifragility as a company can be found by analysing the strategies and practices of companies through primary sources?*

In order to answer the above questions several steps were taken.

Sub-question one is answered in chapter 2 Literature. First desk research has been conducted to create an overview of antifragility in relation to strategic management and the related fields of urban planning, system engineering and ICT as they perform in similar environments. Second strategic management strategies and best practices were connected to the concepts of redundancy, optionality, and skin in the game. This results in two chapters, chapter 2.1 Fundamentals of antifragility in which a structured overview of the concept of antifragility is given to establish a common vocabulary and background to understand later discussion, answering the first part of sub-question one. Then, in chapter 2.2 Desk research, an overview of new or adjusted strategies on improving antifragility through redundancy, optionality or skin in the game and the factors influencing the operationalizations of these strategies is presented. This chapter answers the second part of sub-question one.

Sub-question two is answered in chapter 3 Case studies. Through two small case studies the practical applications of the concepts and strategies as presented from the literature studies are described, as well as new insights on strategies and application of the concepts from antifragility. The choice of companies was made by looking at several criteria. First the company's strategies and practices should be well documented, second it should be an established company and third the company should be innovative in their organizational form, preferably showing antifragile motives. Therefore, the choice was made to investigate Haier and Zappos. Haier is an established whitegoods manufacturer from China, known for its progressive management and innovative structuring. Zappos is an online shoe-retailer that is primarily known for implementing Holacracy in an organisation with over 1500 employees. Both are well documented and therefore ideal as subjects to investigate practices and strategies through secondary sources and thus answer sub-question two.

Sub-question three is answered in chapter 4 Interviews, through the conduct and analysis of interviews. Through nine interviews insights from people who practice antifragility, or related subjects, are collected. These are then analysed to collect strategies, practices, and other insights. The interviewees were collected on the basis of their knowledge of antifragility in combination with an active use of it in practice or on being an expert on a clearly related field. Seven of the interviewees were knowledgeable of antifragility and practiced it in their daily lives, ranging from consultants, to independent contractors and CEO's. Two of the interviewees were experts on related fields. As the interviewees are very diverse, a broad set of practices, strategies and other insights is collected, which are analysed to answer sub-question three.

In chapter 5 Discussion the combined answers on sub-questions one, two and three are discussed and put into perspective in the broader field, highlighting new insights and surprising results. Then the sub questions will be used to derive the higher-level mechanisms that underly these strategies in order to answer the main research question.

In chapter 6 Discussion the main research question will be briefly answered, it will be related to the research problem as stated earlier, and the practical as well as scientific applications will be discussed.

1.4 Limitations

Limitations that were known upfront are the lack of sufficient research on the topic of antifragility and the lack of an existing framework on which existing strategies and theories on strategic management are linked to antifragility. This lack of research exhibits itself through a low amount, but also a low quality where many articles showcase a deep misunderstanding of the concepts related to antifragility. Another problem is the lack of unified vocabulary when distinguishing between resilient and antifragile, this will be tackled by this thesis in chapter 2.1 Fundamentals of antifragility.

2. LITERATURE

The literature section aims to answer sub-question one.

1 "*What is already known about antifragility in the field of strategic management and related fields, and what insights can be created by combining them?*"

First the chapter 2.1 Fundamentals of antifragility focuses on structuring current literature and deepening the understanding of antifragility for a business environment. This way a solid basis, collective vocabulary and general level of understanding is created for future research and the remainder of this thesis.

Second, chapter 2.2 Desk research aims to answer sub-question one, by structuring, comparing, relating and analysing antifragility literature on strategic management and relevant fields.

For these parts, articles related to antifragility were collected through Google Scholar and Scopus by using the keyword antifrag*. Results from these searches were filtered on the basis of their quality, field of interest and focus on antifragility. The articles had to focus on the concept of antifragility and not only mention it. Furthermore, they had to focus on strategic management or one of the related fields. These related fields were urban planning, due to the similar environment of deep uncertainty, systems engineering and dynamics, due to their focus on complex adaptive systems and their interrelations, and ICT & Software, due to their focus on complex socio-technical systems containing interconnected paths and autonomous agents. As strategic management also deals with similar systems and environments, insights from these practices can be transposed.

2.1 Fundamentals of antifragility

Fragility, Robustness, Resilience, Antifragility

In short, something is fragile when it does not like variation, it is robust when it does not care, and something is antifragile when it gets better from variation.

To be more precise, something is fragile when the cumulative effects of negative variations have a non-linear effect. That means that ten times a small shock has a smaller impact that one ten-times bigger shock (Taleb, 2012). Compare it to a teacup, being picked up a thousand times won't break it, but falling will or hitting a human with a thousand pebbles, which has less impact than hitting him/her once with a one thousand-kilogram heavy rock. Something robust does not care, and can be compared to an iron cup, picking it up, letting it fall, the cup will stay the same. But the opposite of something that is harmed by more variation is not something that does not care, but something that get's better with more variation. For this Nassim Taleb has coined the term "Antifragile" to indicate a system or property that has increasing beneficial returns to variation. Examples are the aviation industry, where every accident (variation) triggers new measures improving the system or muscles that get bigger when you apply stress (variation) to them.

This triad, as Taleb calls the concepts of fragile, robust and antifragile, can be enhanced with the notion of resilience, a system that can absorb and bounce back from (negative) variations (Jaaron & Backhouse, 2014), in contrast to a robust system that does not change. Important to note is that a resilient system cannot improve from these variations, setting it apart from antifragility. It is imperative to clearly distinguish between the two, as in literature resilience is often preceded by adjectives indicating the ability of the system to also improve in the literature (Blečić & Cecchini, 2019a; Ramezani & Camarinha-Matos, 2020). The limits of scarce research on antifragility are showcased by this lack of unified vocabulary. Resilience with these adjectives is nothing more than a different name for antifragility. Therefore we follow Blečić (2019a) and Ruiz-Martin, Lopez-Paredes and Waine (2018) in categorizing resilience as a limit case of antifragility with the distinguishing feature being optionality; the ability to gain from variations Thus, after addition of resilience to Taleb's triad, the tetrad looks as it is displayed in Figure 1.

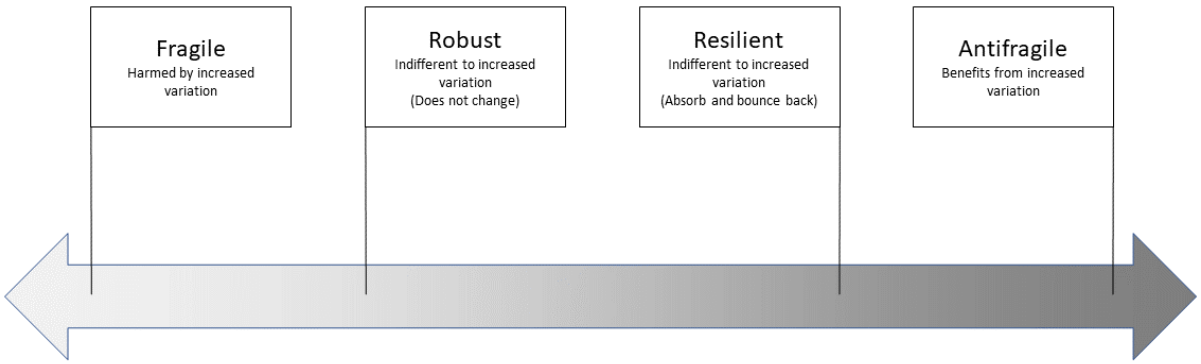
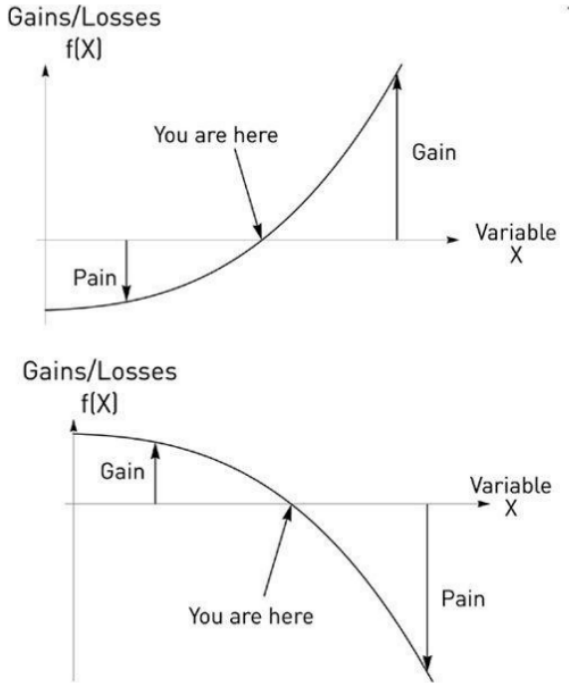


FIGURE 1 VISUALISATION OF THE CONTINUOUS SCALE FROM FRAGILE TO ANTIFRAGILE

Important to note is that this is a continuous scale without discrete categories as displayed in Figure 1. A system N can be anywhere on it as a system can vary from being very harmed by variation (far left) to just a little bit harmed by variation (just left of robustness). This is amplified by the fact that there are many components to an antifragile system and systems can have different maturities on each aspect. The scale from left to right is based on how well a system deals with variation. Another important aspect to note is that robustness, resilience, and antifragility only hold until a certain threshold, above which they will break. Any variation below this threshold will be absorbed or used as a possibility for gain (Babovic, Babovic, & Mijic, 2018).

The different systems can also be described in more mathematical functions. For the complete mathematical groundwork one can refer to the book Antifragile (Taleb, 2012) and the article "Mathematical definition, Mapping and Detection of (Anti)Fragility" (Taleb & Douady, 2014). Below the conclusions of the calculations made in those articles are summarized and simplified.



Fragile systems (below, Figure 2) have a limited amount of (known) gain, for example when taking a medicine you know what gain there is to get from it. But it also has an unlimited amount of (unknown) pain, possible side effects that we cannot know, in a less likely, but still possible situation. This relationship is also non-linear, so twice as much variance (or a twice as small likelihood) has more than twice the impact.

Antifragile systems (above, Figure 2) show an opposite relation between variation and impact. They have a limited amount of (known) pain or loss, such as the amount of money you lose by maintaining a stock of a product. You know that in the worst possible scenario you only lose that money that you have put into the stock. But on the other hand, there is an almost unlimited amount of gain. Again, this relation is non-linear so an increase in variation causes a non-linear increase in gain.

FIGURE 2 PAY OFF GRAPH OF ANTIFRAGILE (ABOVE) AND FRAGILE (BELOW) SYSTEMS. FROM ANTIFRAGILE BY TALEB (2012). VARIABLE X IS A SUBSTITUTE FOR LIKELIHOOD OF AN EVENT HAPPENING. FAR LEFT IS HIGHLY PROBABLE, FAR RIGHT IS NOT VERY PROBABLE. A SYSTEM WITH HIGH VARIATION WILL HAVE MORE EVENTS ON THE RIGHT SIDE, THAN A STABLE SYSTEM.

This non-linear relationship with the open-ended payoffs creates a system that either benefits (more) from variations, antifragile, or is harmed (more) by variations, fragile. The goal of creating situations in which the costs are known upfront and the pay-off is potentially unlimited lies at the heart of antifragility.

Robust systems have no non-linear relationships and are thus not impacted by changes. They remain exactly the same. Resilient systems on the other hand absorb the variation and increase/decrease correspondingly in output, however a resilient system will then recover back to the original state and are able to learn from this. This means that in a future similar situation the harm done is less impactful. This is visualized in Figure 3.

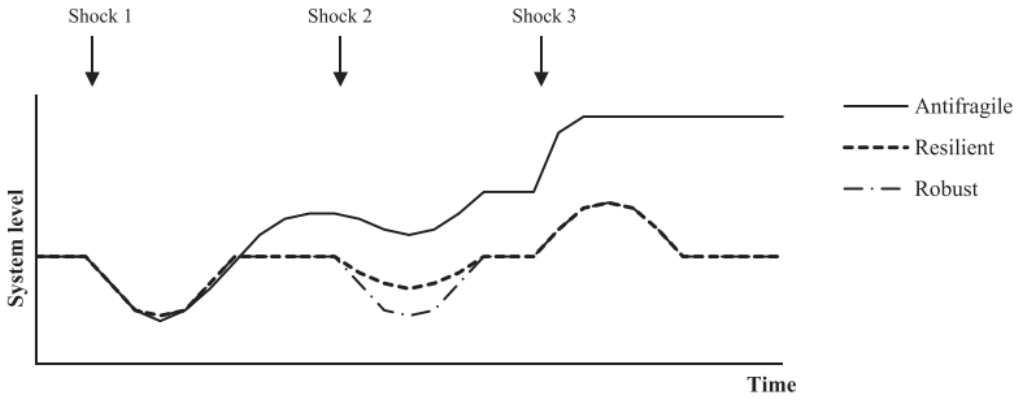


FIGURE 3 IMPACT OF VARIATIONS ON ANTIFRAGILE, RESILIENT AND ROBUST SYSTEMS. FROM DE BRUIJN, GRÖßLER AND VIDEIRA (2019)

In Figure 3 a different aspect of the systems is highlighted, the ability to improve from variations. An antifragile system absorbs a variation (shock 1) and in recovering overcompensates creating redundancies. This creates a stronger system; on this we will later elaborate. The resilient system absorbs the variation (shock 1) and learns from it, so that the impact of shock 2 is less. The robust system absorbs the shock and returns to/ stays in its original form.

Variation and (non-)prediction

Two dominant views on uncertainty exist; the ontological view and the epistemological view on randomness with different mechanisms driving them (Derbyshire & Wright, 2014). The ontological view, which is grounded in quantum mechanics, states that everything is reduceable towards an absolute form of chance and thus cannot be predicted. The epistemological view considers events to be the result of an identifiable cause, but states that our inability to reason and determine the enormous amount and diversity of causes involved in an event is the reason we are not able to predict events (yet). Either way, the effect stays the same, we cannot predict the future. In an effort to solve this problem, the view of antifragility tries to look away from predicting future events and into the effects scenarios would induce. To understand antifragility, several concepts, problems and biases must be clarified, in order to build the argument.

The first important concept is called a Black Swan. This is an event with a very low frequency, extreme impact and that is only predictable in retrospect (Taleb, 2010). These are also called unknown unknowns (Johnson & Gheorghe, 2013) or X-events (Ghasemi & Alizadeh, 2017; Sandler, Coelho, & Sarti, 2019). Because they are inherently unpredictable, they often do not fit, or are not taken into account in models such as in systems engineering (Kennon, Schutte, & Lutters, 2015). This deliberate ignorance of our inability to predict and/or model everything fosters our false confidence that we can predict extraordinarily complex events in detail. This can give rise to wrong decisions with grave consequences, arguing in favour of a view that can do without prediction.

Second is that while simple and regular phenomena are predictable up until a certain point, our society is getting more complicated and is being predicted with models that rely on incorrect assumptions. Taleb (2012) and de Bruijn, Groβler and Videira (2019) highlight the complexity of our world with reinforcing feedback loops that cause fat distribution tails, undermining the assumed Gaussian distribution in many models. Gorgeon (2015) agrees, pointing at power laws that are abundant in real life, but are overlooked in current models. Blečić (2019a) explains this misunderstanding of prediction for urban complexity by highlighting the redoubled complexity due to the large system with many components and autonomous agents making their own decisions. This again shows our inability to predict or indicate the future.

But not only in our models there are flaws, they are also in the way we reason in relation to these predictions. Babovic, Babovic and Mijic (2018, p. 3) explain deep uncertainty in decision making as "*the situation where the parties to a decision do not know – or agree on – the best model for relating actions to consequences or the likelihood of future events* " and "*Under conditions of deep uncertainty, the uncertainty surrounding the future cannot be significantly reduced through intensified data collection as the past is of limited use as an indicator of future conditions*". This belief that more data improves prediction is, as argued, wrong. Also because it assumes that the worst case we can think of is the worst case that can happen. Taleb calls this the Lucretius problem; "*after the Latin poetic philosopher who wrote that the fool believes that the tallest mountain in the world will be equal to the tallest one he has observed*" (Taleb, 2012, p. 42). This is endorsed by Gorgeon (2015, p. 6) who states that: "*The first is that the future is never exactly like the past ... Extrapolation based on past patterns or relationships which may exclude possible extreme events cannot provide accurate predictions*." This ties closely together with several biases we have regarding prediction and the future.

This fourth problem are so called biasing properties. The first bias is anchoring bias, which causes people to pick numbers closer to a base value even when they know it is random. For example people make higher estimates if you ask them whether someone died at age 130 and then to guess the specific age than when you change the number to 35 (Kahneman, 2011; Kennon et al., 2015). Second, predictions make people overestimate their reliability and underestimate risks. In some situations, predictions can thus make people be more reckless as they have a false belief of safety due to the estimates (Gorgeon, 2015). Third, we have a bias to make narratives of

everything we see, strengthening our belief that we can predict anything, if only we have more data. But, as argued above, more data does not equal better predictions (Taleb, 2012). This fallacy is also strengthened by the research of Kahneman (2011) in which he explains the availability heuristic. This heuristic influences estimates and beliefs by favouring things that come to mind easily. Thus, when a situation occurs, the feelings and examples that we are familiar with will have a larger impact, thus favouring a narrative which we can explain instead of accepting that we do not understand what happened.

While the above paragraphs highlight the downsides, such as our inability to recognize the limits of predictions and the effect of biases, there are also some upsides to strategies based on predictions. Predictions can be especially useful in stressful situations in which we need to act fast or cannot access every piece of information, which is why this over time has evolved to be often used by humans. But predictions can also be useful in other scenario's for example when a phenomenon is highly predictable, when variations cause limited harm, or when the system is not that important, as relying on determinism allows for efficiency improvements in these scenario's (Gorgeon, 2015).

Switching to a view not based on prediction has a lot of benefits for people and systems. First, it is easier to identify whether you are fragile by looking at what the impact of a wrong forecast would be, than it is to accurately predict the future. Said differently we can more accurately say what happens when a power outage hits a hospital than predict whether and when this will happen. Second, it is easier to do something about your own organization, system or strategies than it is to control the future (Gorgeon, 2015). Again, taking the hospital idea, it is easier and more secure to implement back-ups for when a power outage occurs, than to completely prevent or predict one. Third, when you are robust, resilient or antifragile, you don't have to worry about predictions and having an accurate comprehension of the world (Taleb, 2012). All you need to worry about is whether you have enough strategies implemented to absorb and exploit variations and a general high-level view of your environment which clears up a lot of work and manpower put into these predictions. Lastly when you are truly antifragile, you benefit from the positive convexity effect, meaning you benefit non-linearly more from positive variations than from negative ones, making your pay-off positive even when the variation is worse than random (Taleb, 2012). Simpler said, since true antifragility benefits non-linearly more from increases in variation, one event twice as "variable" as a normal event will give a pay-off more than twice as big. If we then assume perfect randomness, the pay-off of someone who is truly fragile is higher than 50%.

The biggest problems with adopting an indeterministic view and antifragile strategies are the complexity of the not yet understood components and the short-term costs. Due to the infancy of the field, many components are not yet completely understood in terms of business. This prevents businesses from implementing best-practices but forces them to pioneer, which not every company is determined to do. Additionally, measuring antifragility in one way or another is still very hard and the measurement frameworks that do exist are of low quality, therefore the added value from for example increased redundancy in a company's stock cannot be offset against the direct and opportunity costs as resources cannot be directed otherwise (Derbyshire & Wright, 2014; Ramezani & Camarinha-Matos, 2020). This makes it harder to justify these changes and to come to best practices on for examples these stock ratios.

Many authors of antifragility related papers see the benefit of changing their view, combining the benefits of the antifragility view with avoiding problems of the deterministic view. Derbyshire and Wright (2014) for example operationalize this new lens by combining scenario planning with aspects of antifragility. And Blečić (2017b, 2019a, 2019b) applies antifragility to the concept of urban planning, by looking at what fragilizes for example supply chains in cities and how to de-fragilize them. To understand the studied articles, the use or misuse of antifragility and to detect components of antifragility in the further research, it is important to first summarize the approaches Taleb offers to avoid becoming fragile and becoming more antifragile.

Becoming antifragile (limited downside, unlimited upside)

Antifragility is a concept that many people intuitively understand. Humans constantly use this logic in everyday situations , or as Taleb (Taleb, 2012, p. 192) explains it, we are not interested in the chance a nuclear reactor explodes (small) but at the consequence of it and behave as if it will happen (big), spending millions extra on

additional safety. We are interested in our fragility to a situation happening, not in the true or false of that situation occurring. Thus, it is not surprising that many of the strategies to become antifragile, fit management strategies such as fail-fast-fail-cheap or effectuation. They are all intuitively correct on their own, hence their creation, and can be united under the framework or view of antifragility.

Preventing fragility

The first aspect of becoming more antifragile is reducing fragility, as removing negative effects will always give better results than adding countermeasures. This concept is called Via Negativa. For example, the harmful effects of smoking are similar to the beneficial effects of all medical interventions since WWI (Taleb, 2012). Jaaron and Backhouse (2014) for example use Via Negativa to minimize non-value activities for customers, which decreases the amount of tasks a company has to do and thus decreases the impact variation can have on a company.

It is, next to removing fragilisers, also important to not introduce more. Therefore, it is important to prevent naïve interventionism and iatrogenics. Naïve interventionism is the propensity of humans to solve problems by doing something without analysing whether this act may have more possible negative effects than positive. This is rooted in many of our biases and has seeped into our reward systems; people praise the ones that take action, but never reward an employee that prevented harm by doing nothing (Bridge, 2018; Taleb, 2012).

A related concept is iatrogenics, the name for situations in which the goal of the actor and the person acted upon is different. Medical iatrogenics is a good example. The aim of the patient is to get better; the aim of the doctor is to cure the patient. These two aims do not always overlap, so it increases the chance that naïve interventionism takes place and damage is done (Taleb, 2012). In this specific case the doctor can choose to administer medicine for a speedy recovery, with all the negative side-effects, while the patient may recover just as soon, or slightly later, by just resting.

To prevent naïve interventionism, it is proposed to proportionally tie the outcome of a certain decision directly to the person making it, this is called skin in the game. Think of a pilot who will crash with his plane when making the wrong decision (Gorgeon, 2015; Taleb, 2012), in contrast with a CEO that only has to pay a fine when he is caught committing unethical decisions impacting the health of thousands of employees. Who would sooner take a large, unnecessary risk? This concept is already thousands of years old as for example recorded in the rules of Hammurabi: "*If a builder builds a house and the house collapses and causes the death of the owner of the house—the builder shall be put to death*."(Taleb, 2012, p. 279). As the builder now feels the consequences of his actions, he will choose these with more care and be less tempted to hide imperfections. Skin in the game can also be used in a more positive way in which employees feel engaged and increase their entrepreneurial behaviours due to increased engagement. However, humans generally tend to only get skin-in-the game-like engagement when they completely believe in the company as it is, or when companies are (or feel) smaller due to a more direct relationship between actions and results (Taleb, 2012).

Hormesis, overcompensation and redundancy

The central aspect of antifragile systems is that they can gain from variation. At the heart of this lie hormesis, overcompensation, and redundancy. Hormesis is when a small dose of harmful substance is beneficial for an organism. Within the antifragile lens, it relates to adding (or not removing) low levels of stress to an environment to make it better at resisting it. Having this variation alone is not enough, the system needs to react and overcompensate to these stressors. Much like strength training, where the body overcompensates to be able to withstand heavier loads in the future (Tomov, 2019) and like our immune system benefits from small injections with pathogens (Monperrus, 2017), it implies at an organizational level a certain process of evolution (Derbyshire & Wright, 2014). Hormesis and overcompensation together create and maintain redundancies; extra buffers of resources, time or different tangible and intangible items that help absorb variation. This overcompensation results in a greater ability to resist the same category of harm in the future, making it beneficial in the long run, but not in the short term (Derbyshire & Wright, 2014).

Optimization and reducing variation threaten these beneficial effects of hormesis and overcompensation and make the organization more fragile. Processes like six-sigma aim to reduce buffers and optimize the use of resources (Näslund, 2008). However, reducing variation prevents the system from improving without breaking, and thus

increasing the chance it breaks once large variation occurs (Taleb, 2012). Although there are instances in which optimization benefits outweigh the higher risk, it is often not beneficial for a company in the long run (Blečić & Cecchini, 2019a), primarily because of the inherent unpredictability of black swans.

Redundancy should not only be practiced with resources but also in project planning and abilities of employees. In project planning, sufficient redundancy in time prevents tight coupling, in which the work of one employee relies heavily on the work of another. In the case of a delay, a ripple of inertia can spread through the company (Johnson & Gheorghe, 2013; Sandler et al., 2019). With abilities, high specialization of employees fragilize the system in the long run when projects get dependent on one person (Blečić & Cecchini, 2017b). In software this is called the bus factor; if a developer gets hit by a bus, will that stop the entire project (Monperrus, 2017)? However, redundancy is not only able to mitigate the negative effects of black swans, it can also be used as an option in the case of a positive black swan.

Optionality

Optionality refers to situations in which the downside is known and limited, and the upside is potentially unlimited. It's the mechanism through which antifragile systems can benefit from variations. Renting a house is an option; you have the right, but not the obligation to live there under fairly stable conditions, the landlord can only raise the rent incrementally. Whenever the area's rent price drops, you do not have the obligation to rent your current house and could move (Derbyshire & Wright, 2014). Optionality is well known in financial fields, but the concept of real options is new and slowly gaining traction (Babovic et al., 2018). A real option is investing small amounts of funds into projects to see where it will go, via for example a stage-gate approach (Gorgeon, 2015), by expanding capabilities of employees so they have more optionality within the company (Blečić & Cecchini, 2019a) or when a buffer of material can be sold off when the price is high, a case where redundancy turns into optionality (Taleb, 2012). Options are commonly intuitively understood under the names of long-term investments, small scale experimentation (Babovic et al., 2018; Jaaron & Backhouse, 2014), fail fast, fail early, lean start-up or design thinking (Bridge, 2018) or collaborating with companies to spread risks and enhance optionality (Blečić & Cecchini, 2019a).

Transference of fragility

Fragility is also something than can be transferred from a larger group towards individuals. In other words, if the individual parts of a system are fragile, it creates antifragility for the system. An example of this can be found in evolution. As a population exists the individuals, rabbits for example, are fragile, but the rabbit population is antifragile. As more variation occurs, for example by foxes becoming better at hunting, individual rabbits are fragile to this; they have a higher chance of being eaten. But the population as a whole will survive and will even become better "adapted" as only the fastest rabbits survive, improving the qualities of the population (Taleb, 2012). In a business sense you could look at the sector of pizza restaurants in Amsterdam. When a recession hits, individual pizza joints will go bankrupt, but the system as a whole will be antifragile because the parts are fragile, even benefiting by the new higher standard.

This concept can also be applied within a company. If a company works on different projects, and these projects are fragile, then the company is antifragile. When a project doesn't work, it is cancelled and the whole system is not or only limited impacted by this. A problem in modern day workplaces is the inability and aversion of terminating projects (Yemini et al., 2018). This makes a company fragile as one bad project can drain all resources and eventually bankrupt a company. Another variation of this, is operating in different sectors, preferably sectors that rely as little as possible on the same resources and market segments (Taleb, 2012).

Relation of antifragility to other concepts dealing with uncertainty

Real options theory

Real options theory (ROT) is the theory that has taken the financial option towards strategy decision making. In essence it works the same as a financial option where for a fixed price you have the right, but not the obligation to take a specific action (Trigeorgis & Reuer, 2017). But in contrast to financial options, in ROT real options are seen as "*opportunities to purchase real assets on possibly favourable terms*" (Myers, 1977, p. 163). Regarding real assets, Trigeorgis & Reuer (2017, p. 5) give the following examples "*incremental cash flows that are tied to*

the construction or scale up of a plant, the development of a product in an R&D program or the exploitation of a patent, and so forth".

ROT has many similarities, but also some differences from antifragility. ROT can be seen as a way to look at the optionality aspect of antifragility, and as such, antifragility encompasses a larger and more holistic approach than ROT. However, as this field is already very established it can provide many useful insights on the reasoning and decision-making processes about options. Especially the stream of real options reasoning overlaps with the philosophy of antifragility as it recognizes the difficulty of quantifying values with uncertainty and it aims to both create options with limited downsides and unlimited upsides as well as recognizes the benefit of delaying choices (Trigeorgis & Reuer, 2017).

Unfortunately, there are also some problems with ROT compared to antifragility as it still leans heavy on prediction of future events. Two other thought-streams, Real options valuation (ROV) and Behavioural perspective on ROT have more focus on the modelling and prediction of values to be given to different options to maximize efficiency. Also, at the basis of all ROT streams is the basic process which encompasses the following stages: Problem structuring, Valuation and modelling and Implementation planning. Stage 2 is problematic if looked at through an antifragile lens, since Valuation and modelling relies on predictions, which again are never fully trustworthy (Trigeorgis & Reuer, 2017).

Real options theory could be a useful field to look at when doing more in-depth research into optionality related to antifragility, as it could give guidance on operationalizing strategies to become antifragile. However, one needs to consider the inherent assumptions within ROT that value prediction.

Effectuation

In 2001 Saras D. Sarasvathy published a paper describing the concept of effectuation as opposed to causation, especially in the approach that business can take in new venture development. Causation, which focuses on deciding what effect one want to achieve and then searching for the means to get there, was up until then the major maxim in strategic decision making. However, Sarasvathy described a different approach called effectuation. In effectuation one starts with the means one has and then evaluates which effects one might achieve using those means (Sarasvathy, 2001). Effectuation is particularly useful in uncertain situations (Chandler, DeTienne, McKelvie, & Mumford, 2011)

Effectuation and antifragility share many commonalities. Effectuation focuses on affordable loss rather than expected returns, just as in antifragility one focuses on creating situations with a capped downside. Furthermore, in effectuations one tries to exploit contingencies rather than exploit pre-existing knowledge, which could be seen as similar to concepts of antifragility that evade prediction and that benefit from variation. And last, one core concept of effectuation is to focus on controlling an unpredictable future, rather than predicting an uncertain one. (Sarasvathy, 2001)

However, there are some slight differences. First, antifragility focuses not on controlling an unpredictable future, but it focuses on building systems than can withstand and benefit from these futures. It is in that sense inwards looking and not outwards looking. This stems from the fundamental believe that nothing can be predicted, or influenced in the long term in that sense, within antifragility. Second antifragility again ranges wider than effectuation. Effectuation can be used in the experimentation and optionality aspects of antifragility, but they are focused on decision making, with a focus on new venture development. They do not support businesses in making their already existing business more robust, resilient or antifragile.

Effectuation thus has a lot of useful insights that can be incorporated in the optionality and experimentation aspects of antifragility. However, the concept is lacking in width when compared to the entire concept of antifragility.

2.2 Desk research

Antifragility in strategic management and related fields

Taleb's book Antifragile was written in the socio-economic context of our society, not as a handbook to make companies more antifragile (Ghasemi & Alizadeh, 2017). Although some aspects are easily translatable to the business environment, others are not or lack scientific proof. This chapter covers the first endeavours in several fields to conceptualize and operationalize antifragile concepts to real-life business situations. This chapter will list, review, and critique the ways in which this is done to answer sub-question one, *what is already known about antifragility in the field of strategic management and related fields, and what insights can be created by combining them?*

To answer this, the chapter will cover the fields of strategic management, urban planning, systems engineering & dynamics, and ICT/software, and their relation to antifragility. The literature of these other fields is included because the body of literature in strategic management alone is so small, that it would be hard to derive conclusions with it alone. The three additional fields have been chosen because they have overlapping strategies and environments and therefore can be put parallel to strategic management. Urban planning deals with the same kind of structural challenges as strategic management and with the same kind of (redoubled) uncertainty (Blečić & Cecchini, 2019a). Systems engineering deals with complex adaptive systems, of which companies are perfect examples (Johnson & Gheorghe, 2013). ICT/Software deals with a complex socio-technical environment and has been an incubator for innovative management practices in the past (Gorgeon, 2015; Näslund, 2008).

In the following chapters the relation with antifragility of each of the fields will be discussed and evaluated. After that the insights from the different fields will be combined in the conclusions to reach concrete strategies to increase antifragility through the three focal areas of redundancy, optionality, and skin in the game.

Strategic management

The simplest model regarding antifragility in organizations is presented by Ruiz-Martin et al (2018) placing an organization's "resilience" on a scale from fragile to antifragile. The article makes a distinction between resilience and antifragility on the basis of benefiting from variation just as Blečić and Cecchini (2019a), but despite this continues to focus on fragile features such as predicting future trends, which makes many of the recommendations unusable for antifragile aims.

In the field of strategic management, the article of Derbyshire and Wright (2014) can be seen as one of the most influential. It first criticizes the most used method of scenario planning, Intuitive logics (IL), which relies heavily on determinism and narratives. They state that relying on these predictions is inherently flawed while increasing misplaced trust in potentially harmful decisions. They propose to improve a company's strategic direction to make companies more antifragile by creating an overview of all strategies and investments, categorizing them on the continuum from fragile to antifragile and creating mitigating policies for the fragile strategies.

Mitigations fall into five categories. The first is creating optionality. Bridge (2018) proposes Lean start-up, design thinking, or effectuation in order to achieve this. The second is a barbell strategy, consisting of taking extremely low risk in the majority of your strategies (minimizing losses) and taking high risks in the minority (unlimited upside). Small scale experimentation (Jaaron & Backhouse, 2014) and learning-by-doing at the forefront (Ramezani & Camarinha-Matos, 2020) exemplify combining a barbell strategy with hormesis. Third and fourth are redundancy and hormesis that combined strengthen the system over time by allowing for trial and error (Bridge, 2018) and by benefitting from positive black swans (Taleb, 2012). The fifth is bricolage, which focuses on creating acceptable losses by adaptive cycles improving the system in small steps, or in other words, tinkering (Ramezani & Camarinha-Matos, 2020).

Jaaron and Backhouse (2014) incorporate antifragility in strategic management through the Vanguard Method, via analysis, planning and implementation of solutions focused on minimizing wasteful activities (Via Negativa) and distributing decision power to hands-on employees increasing small scale experimentation (optionality). Ramezani and Camarinha-Matos (2020) highlight a similar organizational design called Holacracy, which in addition focuses on increasing employee responsibility to react on variations at the forefront. Although the article

of Jaaron and Backhouse (2014) links antifragility in a questionable way to the vanguard method, stating that the work of Taleb from 2012 inspired the method which originates in 2003, it correctly combines the theory with practice.

Unfortunately, not all articles use the principles of antifragility in a correct way. Meissner and Wulf (2015) propose an improved scenario planning method by supplementing IL with backward logic and antifragility. Their approach only covers the strategic focus of antifragility and focuses further on fragile strategies such as risk assessment and predictions, completely overlooking benefitting from variation. Similar misunderstanding can be found by Ramezani (2020), where a clear distinction between resilience and antifragility is missing. This can be seen in the categorization of redundancy as resilient where it is also a source of optionality and thus antifragile. Also, strategies that increase fragility (focus on efficiency) and antifragility (redundancy) are proposed in one sentence, misrepresenting the underlying logic. This supports the claim that more research is needed in this area.

Urban planning

Urban planning deals with deep uncertainty which cannot be significantly reduced through data collection since the past is of limited use as an indicator of the future (Babovic et al., 2018). Blečić and Cecchini (2019a, 2019b) present the redoubled complexity of urban planning from being a large system with a lot of interdependencies and a social system with autonomous agents. Urban planning and strategic management thus deal with similar uncertainty. One could argue that the public nature of urban planning cannot be reconciled with the private goals of strategic management. However since this study only aims at handling uncertainty, strategies can be transposed between the two fields. Below these applications of antifragile strategies that relate to organisational challenges are discussed.

Babovic et al (2018) present a fuzzy definition of antifragility, building on ecological resilience, which effectively is the same as antifragility in this scenario. However, the applications exhibit useful properties for strategic management, focusing on a barbell strategy. To mitigate the impact of negative black swans, they focus on minimizing speed, size, and concentration of activities. This is done by decentralizing (critical) systems and processes, introducing redundancy of important resources, and preventing optimization. On the other hand, positive black swans are exploited via optionality through real options, which incur a small increase in capital cost but increase the operational flexibility and stimulates a wide area of experiments. A last valuable insight is to prevent the increase in data-collecting methods to increase predictions, by making data less fine-grained and using it for detecting fragilities rather than predicting future trends.

Blečić and Cecchini (2017a, 2019a, 2019b) provide us with the strict definition of antifragility as opposed to resilience as presented before. Furthermore, they hypothesize that an antifragile planning creates antifragile projects. This is supported by Monperrus (2017) calling it Conway's law; organizations are constrained to produce designs that are copies of their structures. Thus, creating antifragile structures gives rise to antifragile strategies. Blečić and Cecchini (2019a) introduce reduced inclusion as a fragiliser, as it creates a lack of accountability, which increases iatrogenics. They also promote simplification and standardization. Standardization is a peculiar suggestion, since it aims to reduce variation which creates fragility (Taleb, 2012). Therefore, we do not transpose it to strategic management. Three strategies are proposed to increase antifragility. First, working from proscriptive instead of prescriptive rules, limiting actions that fragilize (Via Negativa). Second, that while strategies cannot be based upon prediction, prediction is a useful tool for creating shared visions focusing on capabilities, which increases optionality and streamlines efforts. Third, uniting these two strategies in a project space where experimentation and variation advance the shared vision within the constraints of the proscriptive rules. This is similar to creating an organizational environment with a lot of individual freedom, such as Holacracy, as mentioned by Ramezani and Camarinha-Matos (2020), which also increases the aforementioned inclusion.

The last important aspect is the question of what system must be antifragile to what extent. Antifragility of a system can be composed of the fragility of its parts. In the case of projects this is not a problem, but with employees this becomes an ethical problem. For example, you could state that a company can become antifragile by transferring the fragility to its employees, firing them, or lowering wages when times are rough. Blečić and Cecchini (2019a) resolve this by stating that the intention of Taleb was not to create a feasible political theory and that in turn, antifragility does not have to be fundamentally incorporated. The aim of a company can be to pursue

antifragility for valuable systems as long as acceptable trade-offs are made with regard to individual fragility (Blečić & Cecchini, 2019a).

Systems engineering/dynamics

Systems engineering and dynamics is concerned with complex adaptive systems and their interrelations (Johnson & Gheorghe, 2013). As companies are prime examples of such systems, insights from this field can be used in making strategic decisions. One useful insight comes from de Bruijn et al (2019), who modelled a system with antifragile characteristics. Tests indicate that it creates better outcomes than systems aimed at robustness, supporting the proposition that the antifragile approach is beneficial. Although the article wrongly categorizes redundancies as solely a resilient trait, it does point out that in practical applications the redundancy – efficiency ratio needs to be investigated more since the short-term cost can fragilize the system; something that is endorsed by Sandler, Coelho and Sarti (2019). It also points out that for a company to go from a robust to an antifragile mindset, a solid comprehension of the mechanisms behind antifragility and an active mindset on benefitting from black swans and raising redundancy afterwards is necessary.

Many other articles aim to operationalize antifragile mechanisms and make them measurable via frameworks and tools. Unfortunately, the observation that the inherent unpredictability of black swans seems to be incompatible with the field of system dynamics and engineering from Kennon, Schutte, and Lutters (2015) might be correct, since the current frameworks exhibit a grave misunderstanding of the mechanisms behind antifragility. Even though articles explicitly express the need for less focus on prediction (Johnson & Gheorghe, 2013; Sandler et al., 2019) many chosen variables are related to predictions and reducing variation and even recommendations in conclusions rely on this. For example, Johnson and Georghe (2013) use entropy as a variable arguing that more complex systems create more black swans, while mentioning earlier their inherent unpredictability. They also uncouple concepts, such as preventing stress starvation and non-monotonicity (the ability to learn from variation), as do Ghasemi and Alizadeh (2017). But this renders outcomes useless as only a combination of the factors creates an antifragile characteristic. Concepts are also measured multiple times (redundancy is separated into reducing tight-coupling, efficiency vs. risk and absorption) causing certain mechanisms to be more important without argumentation (Ghasemi & Alizadeh, 2017; Johnson & Gheorghe, 2013). Sandler et al (2019) shows a misunderstanding of the mechanisms behind antifragility. A telling example is the choice of the variable “Being shareholder of other banks” for the category redundancy when determining the antifragility of banks. Since relying on the same aspect on two different income streams (your own activities and how well others are doing) is very fragile to variations as impact is doubled. Contrarily not having them does not enhance antifragility, as shares you hold can still be influenced by similar aspects as your primary income.

ICT & software

Information systems are complex socio-technical systems containing interconnected parts and autonomous agents (Gorgeon, 2015) and software engineering is often a breeding ground for management and process innovations such as agile and lean (Näslund, 2008; Tomov, 2019). Therefore, looking at this field can provide valuable information for the field of strategic management.

Within the field of ICT many similar basic implementations are discussed to increase antifragility. Optionality is implemented by using real options (Gorgeon, 2015), ensuring projects are fragile (Tomov, 2019), and building fault tolerance into applications (Tseitlin, 2013). Injecting randomness to benefit from hormesis and build up redundancy is done by continuous testing (Monperrus, 2017) or randomly assigning people to meetings (Gorgeon, 2015). To prevent naïve interventionism and iatrogenics, continuous testing is integrated with skin in the game via ownership, culminating in DevOps functions (Monperrus, 2017). Decentralization of services and governance, and the prevention of single-points-of-failure aim to increase redundancy (Gorgeon, 2015; Monperrus, 2017). Netflix combines multiple measures through their simian army strategy; autonomous applications that disrupt a part of the system, from single connections up until entire distribution centres. This urges DevOps who have to fix their own applications to have enough redundancy or build extra relays for decentralization (Tseitlin, 2013). It also shows that in order for this to work decisionmakers need to have ownership and a failure accepting culture.

Gorgeon (2015) states that using ICT systems to provide simplicity in workflows will increase antifragility throughout companies and that standardization will support this. However, standardization reduces variation and

experimentation, fragilizing the system in the long run (Taleb, 2012). Thus, simplicity should be enabled without standardization to benefit optimally.

Tomov (2019) also misapplies antifragility by using the concept on qualities instead of systems, where many of the conditions do not hold. This also causes many of the solutions offered not to represent antifragility correctly. However, he is one of few to correctly point out that project size should be reduced in order to increase antifragility. In time-related instances, variation has limited positive and unlimited negative effects; when flying you rarely arrive 20 minutes early, but often hours late (delay) and sometimes not at all (cancellation). The positive variation is capped at what physically is possible (Derbyshire & Wright, 2014). The larger the project the higher the possibility of a delay. To solve this, you can either split-up projects (Tomov, 2019) or build sufficient redundancy in the form of extra time (Taleb, 2012).

2.3 Conclusion

Strategic management aims to find the best strategies to enhance performance (Nag et al., 2007). The antifragility lens can be used as a new way of organizing companies and strategies to survive and thrive in the changing business environment. Within strategic management, several valuable frameworks already exist that discuss measures to improve antifragility (Derbyshire & Wright, 2014; Jaaron & Backhouse, 2014). The field of urban planning gives rise to insights on barbell strategies, correct usage of collected data (Babovic et al., 2018), a framework based on Via Negativa and a shared vision, and the relationship between antifragile structures and strategies (Blečić & Cecchini, 2019b, 2019a). Systems engineering cautions us that thorough understanding of mechanisms behind antifragility is necessary (Sandler et al., 2019) and the field of ICT gives practical examples for implementation of antifragility at an employee level.

This chapter aimed to answer sub question one; "*What is already known about antifragility in the field of strategic management and related fields, and what insights can be created by combining them?"* The first part has been answered by creating an overview of the current literature on antifragility in strategic management and highlighting lessons and measures that have been developed in related fields.

To answer the second part of sub-question one, an overview has been made to create a comprehensive image of antifragility in strategic management. For this the research on antifragility in strategic management has been discussed and enriched with research on antifragility from other related fields. This way the amount of useful literature has been enlarged and it was possible to derive valid conclusions and strategies. Furthermore, there has been a critique on the validity of some papers and on the terminology used in different articles, unclarities have been consolidated accordingly and as such have been presented in chapter 2.1 Fundamentals of antifragilityto understand the subsequent chapters.

From this broad perspective of antifragility in strategic management and related fields, several strategies can be deduced that can be incorporated to increase optionality, redundancy, and skin in the game in order to answer the second part of sub question one. These will be discussed below per category.

Optionality

Short feedback loops and trial & error

The first strategy for increasing optionality revolves around creating small experiments to get direct feedback. This way companies can adapt fast to the ever-changing environment. Several strategies already exist for this, such as Lean, Agile, design thinking and effectuation strategies (Bridge, 2018). Important factors for this strategy are that projects need to be fragile (Tomov, 2019) and that there needs to be a failure accepting or even loving culture in order to motivate employees to engage in trial and error (Monperrus, 2017).

Real options

The second strategy is to focus on real options. Looking at projects through the lens of real options can shift companies thinking towards what they are able to do, instead of what they need to do (Gorgeon, 2015). Furthermore, looking at new projects as options ensures that companies realize that they have the possibility but not the obligation to carry on with projects (Babovic et al., 2018) ensuring that projects remain fragile. A variant of this strategy is the stage-gate approach (Cooper, 1990) in which with every step, a new option can be "bought". With every step a new evaluation is done, with the possibility to stop, or invest (again) a limited amount of money in a project with possible unlimited upside.

Expanding skills and capabilities

The last strategy for increasing optionality is aimed at employees and their optionality for the company. By expanding the skills and capabilities of employees and departments, companies increase the options that people have in different parts of the company, as well as the possibility that these skills enable a company to act on changes in the business environment, similar to what Blečić & Cecchini (2019a) described with regard to capabilities of buildings in cities. An important factor is that companies need to maintain a good balance between directed capability expanding, as it is preferable to have high chances of possible use for the new skills and giving employees enough freedom to maintain motivation and variation throughout the company.

Redundancy

Tinkering and overreacting

The first strategy to increase redundancy is to constantly experiment, tinker and then overreact when something goes wrong. This is similar to what your body does when building muscles (Taleb, 2012). This calls for an environment that accepts failure (Tseitlin, 2013) and where there is motivation and space for trial and error (Blečić & Cecchini, 2019b; Bridge, 2018). One of the goals of this strategy is the prevention of single-points-of-failure (Gorgeon, 2015; Monperrus, 2017). One example of this is for example the Simean army strategy of Netflix that ensures that developers build in enough fault tolerance so their service will not break. And when it does break, they will build in more redundancies (Tseitlin, 2013).

Project Management strategy adjustments

A second redundancy strategy relates to project management. Due to the time properties of variation, we systematically underestimate project time. Therefore several articles advise on simply increasing the timescale of projects (Taleb, 2012) or decreasing the size of projects, thereby increasing the amount of redundancy there is to absorb setbacks (Tomov, 2019). One example of project management in small cycles is agile (Tomov, 2019).

Decentralization

Decentralization is a strategy that increases redundancy in several manners. With decentralization of decision power, there is no single-point-of-failure. With decentralization into smaller autonomous teams there is redundancy in skill and in income streams (Babovic et al., 2018). An important factor remains that decentralized units must be fragile.

Redundancy- Efficiency ratio

Something that is difficult to calculate is the ratio between redundancy in for example money and other resources, and efficient use of it. Since there are no definite ways to measure an increase in antifragility yet and thus no way to quantify the additional value of a strategy, it is a challenge for businesses to decide the ratio of redundancy and efficiency as these redundancies can carry significant costs (de Bruijn et al., 2019). And when they carry too much costs one could argue that it fragilizes the system as variation in income can then not be absorbed (Sandler et al., 2019).

Skin in the game

Responsibility and freedom

Employees are more engaged when they have a feeling of autonomy and responsibility. Higher employee engagement means more skin-in-the-game for these employees as they are personally impacted when the company suffers. Several factors influence this. The first factor is the distribution of decision power, because employees are more engaged when they have ownership of their work (Jaaron & Backhouse, 2014). This ties directly together with the second aspect, accountability, which is having responsibility over a certain aspect and being the one who needs to deliver (Ramezani & Camarinha-Matos, 2020). Thirdly, individual freedom and the possibility to explore and exploit personal skills and talents also support this phenomenon. This can be done by expanding skill-sets, having room for experimentation and by working on projects that employees are interested in (Monperrus, 2017; Ramezani & Camarinha-Matos, 2020).

Tying the work to the person.

Another strategy is by tying the results of ones work to the individual. That can be done in different ways. For example, the DevOps function has been created so that developers are responsible for both building and maintaining their products. This incentivizes developers to make it easy to debug and update as failing to do so will become their problem in the long run (Monperrus, 2017). Especially if combined with a concept as the Simean army, developers have skin in the game of delivering qualitative and easy manageable products which benefit everyone (Tseitlin, 2013). Another strategy is that of tying the compensation or disciplinary action of a result to the person responsible (Taleb, 2012). An important factor here is the identification of the correct value that must be delivered and tying that to the outcome of the work to prevent employees to take shortcuts.

3. CASE STUDIES

In chapter three, sub-question two is answered.

"*What strategies, practices and insights for increasing antifragility as a company can be found by analysing the strategies and practices of companies through secondary sources?*"

In order to answer this question, two case studies were performed. In order to showcase the practical applications of the concepts and strategies of redundancy, optionality, and skin in the game more than twenty-five articles and interviews were collected that illustrated the strategies, workings and culture of Haier and Zappos in relation to antifragility. As motivated under Methodology, Haier and Zappos were fit for this case study due to the extensive literature about them and their characteristics hinting at antifragile tendencies. With Zappos these antifragile tendencies show in their organizational form, Holacracy, and with Haier in their aim on extreme decentralization, Rendanheyi. The result is an overview of practices and strategies implemented at these two companies that increase their antifragility, thereby answering sub-question two.

The case studies have been performed by using google and Scopus to collect literature on Haier and Zappos. Papers and interviews were then scanned to decide on their relevance to the companies' strategic management and the relevant articles were then read in full. Duplicate information was removed, and the resulting articles were then used to write the case description as seen below. First Haier will be discussed, touching upon their view on organisational forms supporting entrepreneurship. Next Zappos is discussed, mainly surrounding their organisational form Holacracy, that increases decentralization and employee engagement. After that the similarities and differences of the two companies in relation to redundancy, optionality and skin in the game will be discussed and conclusions will be drawn to answer sub-question two; "*What strategies, practices and insights for increasing antifragility as a company can be found by analysing the strategies and practices of companies through secondary sources?*"

3.1 Haier

The first case study to showcase the way the antifragility lens can help understand strategic management practices is the case of Haier. Haier is a whitegoods manufacturer that has been founded in 1920 and has been under management of Zhang Ruinin since 1984. At that time, the company performed very poorly, which Zhang had to turn around. One famous act of Zhang in his efforts to improve the quality of Haier's products is the symbolic destruction of seventeen faulty refrigerators with a sledgehammer in the middle of the workplace in order to drive home the new course of action for Haier: Quality without compromise. Since then the company has evolved multiple times into being one of the largest whitegoods manufacturers in the world (Kwan & Yu, 2014). What is especially interesting is the application of practices that improved "Skin-in-the-game" of the employees and it's more recent radical shift into a networked- or platform-organization that embodies many of the aspects of an antifragile strategy, among them redundancy and optionality.

Continuous change

An important aspect of this is the continuous change that Haier has shown. Many companies do major overhauls and set new courses in an effort to avert market loss. However, very often this does not work due to the stress, fear and lack of resources (Crainer, 2015). Haier has turned this around; they have accepted that business models do not last forever, but that they have to change, and sometimes cannibalize on their own products as an effect (Smith, 2007). Haier changes from a position of strength, in which morale is high and, more importantly, resources are abundant (Crainer, 2015). This can be viewed from an antifragile perspective, in which your redundant resources give you the ability to absorb variation, in this case the changes your company is going through. You have the space to experiment and build better systems/programmes/routines by allowing for this continuous variation which can be done due to the redundancy a company maintains. In such a case, the abundant resources are not even just redundant, but form an option. Maintaining an amount of resources has an opportunity cost (Stephen Palmer & James Raftery, 1999), but enables a company to invest in such a reorganization with possibly unlimited upside.

Diversification

After the first major shift of the company towards focussing on quality, the second step was undertaken. This step focused on diversification through mergers and acquisitions. For this, Haier had a special technique called eating shocked fish (Zhang, 2016). The company solely took over companies with good resources and machinery, but with bad management. After the take-over, the only thing Haier would do is share their management model and organizational practices in order to improve the company. No lay-offs were instigated, nor were key-positions taken over by Haier employees: the company stayed the same. This way Haier has acquired many other companies, turning them all profitable in short periods of time (Iñiguez De Onzoño & Ichijo, 2018). This again is a showcase of an option if observed through the antifragility lens. The upfront known, limited costs are only the acquisition costs because the strategy was to only share and export their knowledge and thus additional costs would not be made. The upside on the other hand was unlimited as companies could grow to be large departments in the Haier group. This is in fact a nice example of combining an antifragile mindset with smart business thinking, by profiting from the non-linear pay-off of an option, combined with smart decisions maximising the likelihood a company could be turned profitable.

A second aspect of the mergers is that the diversification of Haier also made it more antifragile, as now there were multiple income streams and markets. This way variation in one of many markets would have less impact on Haier than when they relied on only one. And in an even more extreme version, the bankruptcy of one aspect of Haier would not mean the end of the company, as examined earlier. This is of course only when Haier makes sure that individual projects or departments can fail, an antifragile mindset which many companies and project leaders struggle with (Yemini et al., 2018).

Big company disease

After a ten year period of growth, Haier began suffering from what Zhang describes as Big Company Disease (BCD); the situation in which employees and departments start playing (power) games with each other in which they can damage the interests of the company or colleagues in order to maximize their own interest (Iñiguez De Onzoño & Ichijo, 2018). In antifragile terms, you get a principal agent problem in which the person who is

performing the action has interests that are not aligned with the interests of the receiving party, in this case the employee or company.

To fix this, Haier implemented the individual-goal combination in which employees were expected to set their own goals in terms of developing new products or services, market orders and added customer value and where compensation is tied to these goals (Iñiguez De Onzoño & Ichijo, 2018). It's essentially an incentive system, based on the concept of Skin in the game; now the interests of the company and the employee are aligned, as the best course of action for the employee is to set ambitious but possible targets and then to achieve them. An important factor is the identification of correct targets and how to decide on compensation, as people might take shortcuts to reach targets (Taleb, 2012). Therefore, Haier has tied the compensation system primarily to created customer value (Iñiguez De Onzoño & Ichijo, 2018). From this, we can learn that it is important to identify your most important interest and tie this to the targets and compensation to effectively combat the principal agent problem or BCD.

Rendanheyi 1.0: ZZJYT

Another aspect of big companies is that they get inflexible, they lose their agility. Zhang recognized this and started using innovative management practices to combat this, with a focus on an entrepreneurial spirit and user orientation.

The combination of different strategies that was used by Zhang was called Rendanheyi and it aimed to create "zero distance to the customer". It ought to do so via creating entrepreneurial autonomy within the company through the use of micro-enterprises, performance-based pay, a network strategy, and a focus on experimentation (Frynas, Mol, & Mellahi, 2018)

At first Haier established so called zi zhu jing ying ti's (ZZJYT's), small, self-managed, (virtual) teams. These teams had autonomy over all aspects, from recruiting to compensation and strategic direction (Frynas et al., 2018). The teams were in turn supported by the overall structure of Haier and its management (Smith, 2007). Compensation was, again, tied to individually set-goals that aligned with the interests of the company, mainly outgoing sales (to customers) and created customer value (Smith, 2007). This method created a more decentralized structure, as every ZZJYT had a lot of autonomy. They could for example renegotiate relations with distributors or contact new ones. An important aspect with this, that comes back in many of Haier's practices, is the use of local employees to benefit from distributed knowledge (Guo & Zheng, 2019). For example, for the US expansion of Haier, they hired only local people to overcome any cultural barrier and benefit from local knowledge, network, and insight in preferences. In a sense, Haier America was built by Americans (Kwan & Yu, 2014).

This new set-up also inspired a learning culture to blossom, as ZZYJT's were encouraged to experiment, adjust to local preferences and to nurture their entrepreneurial spirit. Employees were urged to think like they were CEO's in order to overcome obstacles they identified (Iñiguez De Onzoño & Ichijo, 2018). A nice anecdote illustrating this, was an instance in which a local distributor went to repair a washing machine of a customer. Upon arriving he learned that the customer had used the machine to wash sweet potatoes and that the extra grime and soil had damaged the washing machine. Instead of teaching the customer not to do this, Haier took the opportunity to create an extra sturdy washing machine, especially for washing potatoes (Chen, 2016), which is an excellent example of antifragile thinking. Instead of predicting or moulding the future, you experiment and find out what works or not continuously.

The small scale, self-managed team structure again has additional benefits that can be explained through the lens of antifragility. First, the compensation of the self-managed teams is still tied to their performance, which is based on the interest of the company, thereby creating Skin in the game for the employees. Second the creation of small-scale teams can transfer the fragility from the company towards these micro-enterprises in a responsible way by allowing ZZJYT's to fail and bringing the employees under in new ZZJYT's. Third the use of local talent, knowledge, and experimentation created an environment with a lot of volatility, a lot of small experimentations with differing outcomes. Every small experimentation and new innovating ZZJYT, can increase the strength of

the system by creating an option and enforcing it if it seems to be worth something, just as the washing machine for potatoes was created and then became a success (Chen, 2016).

Rendanheyi 2.0: Xiaowei

Zhang realised that the reorganization was not radical enough yet to reap all the benefits as described above: the teams were often not fully autonomous yet, the payment structure still had a basic salary, and the "natural selection" of ideas was still not optimal (Crainer, 2015; Frynas et al., 2018).

Therefore in 2014 the system was reorganized, creating a network of independent micro-enterprises called Xiaowei. Each Xiaowei is around 8 people and the CEO of each Xiaowei is exactly that; a CEO with complete autonomy, decision making authority and a small ownership stake (Frynas et al., 2018). It is a functional hybrid of a start-up within a company-network in which a Xiaowei can be outward facing, for example in rolling out new white good products or inward facing, providing HR or legal services, although some basic features are also provided by the Haier Headquarters. Xiaowei are expected to push back at the company to acquire funding and resources both from within the company as well as outside (Frynas et al., 2018; Smith, 2007). This causes a market effect within the platform.

Not only can Xiaowei's use external funding for their endeavours, they are also not obliged to work with internal services or suppliers. If they think working with outside partners is more beneficial to the company, they do. This strengthens the competitive environment within Haier even more and creates an environment similar to what a start-up experiences (Frynas et al., 2018). As Smith (2007, p. 5) summarizes*; "... Haier appears to have accepted market fragmentation and adapted to it by radically decentralizing into a team- based organization rather than maintaining a centralized organizational structure as most Western firms prefer to do*."

When teams do not reach their targets consistently, they will be disbanded, securing the fragility of the individual teams, but when teams perform well, they can even spin-out (Smith, 2007). For example, the Xiaowei "Goodaymart", one of the logistics teams of Haier, has spun out to become one of China's leading companies (Crainer, 2015). Another example is ICS, it's delivery department, which now also distributes parcels from many western companies to the rural areas of China (Smith, 2007). In this way, Haier is acting like a venture capitalist platform, incubating, guiding and growing companies as a core capability (Crainer, 2015) with initiatives, experimentation and adaptation coming from bottom-up rather than top-down.

Looked through the antifragility lens, the evolution of rendanheyi 1.0 to 2.0 adds again aspects to the system that are highly antifragile. Where the incentive system allows for skin in the game for the employees, rendanheyi 2.0 takes it one step further by adding ownership and the possibility of spinning out, essentially creating the same incentive system as when creating a start-up. Furthermore the platform structure maximizes the optionality and redundancy aspects. Optionality through continuous small experimentation with micro-enterprises trying new ideas, competing with each other and the outside market. The damage from one micro-enterprise failing is very small but the potential benefits are unlimited. The ability of Xiaoweis to fail is maintained, transferring fragility from the system to the micro-enterprises. The system also allows for a lot of redundancy. Since people are not specialized into specific jobs or roles, gaps in the system will be filled up when there is enough profit to be made, as Xiaowei can form and disband as they want.

Fragile parts

Rendanheyi is not built on the idea of antifragility and nowhere does it become apparent that Zhang has used it to decide on his management strategies. This again strengthens the notion that many of these ideas for antifragility, especially in networks, come naturally due to the inherent logic of them.

Several aspects of the Haier strategy are very fragile. One part of Haier's strategy is to keep inventory small and as efficient as possible (Smith, 2007), a strategy that is very fragile to variations as the system is only designed to run smoothly under the assumed conditions. Second the company, especially in the early days, has adopted measures that introduced fragility such as six-sigma (Crainer, 2015), as this is aimed at increasing efficiency, which as explained before only works within pre-defined boundaries.

Three aspects are less fragilizing, but also need discussion. First, tying the salary of people completely to performance is something that cannot be taken lightly. Many countries have minimum wages and as a company having so many employees you are responsible for their well-being. This has caused the Rendanheyi 2.0 to be modified or not implemented at all in countries such as Russia or the USA, as the system does not comply with worker protection laws as well as with the focus on quarterly results (Frynas et al., 2018).

Second the ownership structure of Haier and its micro-enterprises is shrouded in secrecy as the company is officially state-owned. Furthermore as described by Frynas et al. (2018) employees receive no dividends and the main company's strategic power still comes from a top-down position. Where on the one hand this is perceived to fragilize a company, on the other hand the reorganizations as done by Haier would probably have never occurred bottom-up.

Lastly a critical view on the future is important. Since the company has changed into a network, it has lost a lot of its directing power and thus faces a challenge on whether it needs to guide the company to create coherence, or if it needs to let go of control and go where the efforts of their Xiaowei take them (Frynas et al., 2018).

3.2 Zappos

The second case study regards Zappos. Zappos is an online shoe-retailer that was founded around 1999 by Nick Swinmurn but has been transformed and made more antifragile by Tony Hsieh. The concept is quite simple, buying shoes through the internet, but was revolutionary when the idea came to fruition. After a long search for investors, Swinmurn convinced Hsieh to invest in Zappos. This eventually snowballed into him joining the company as CEO in 2004 (Eng, 2012). Since then the company has had some major transformations with an almost fanatical focus on customer service and adoption of a hierarchy free organizational structure called Holacracy (De Smet & Gagnon, 2017). Once again this focuses on the increase of employee engagement, or skin-in-the-game, and shows an organizational structure that fosters innovation and rapid adaption through self-organising. This in turn increases redundancy and optionality within the company.

Holacracy

The implementation of Holacracy has had different results in different companies with some embracing the new organizational form, such as Zappos, but some reverting back to old ways several years after implementation, such as Medium or the Lausanne Business School (Frynas et al., 2018; Kumar S & Mukherjee, 2018). One thing that strikes as important is the necessity to already have a culture of highly engaged employees that value autonomy, risk-taking and creativity. This is backed by existing research that organizational culture is an essential part of a company's strategic resources that create sustainable competitive advantage (Kumar S & Mukherjee, 2018). Zappos has implemented an incredibly strict hiring and training process already way before the implementation of Holacracy. Not only does Zappos hire exclusively on culture-fit, they also offer new employees after an intensive training programme the possibility to receive an amount of money for them to quit there on the spot (Kao, 2018; Perschel, 2010). The idea is that only fully committed employees will refuse the offer, which strengthens the culture. Both these instances portray excellent examples of how skin in the game can be created through cohesion and employee engagement. If a company takes good care of its employees, these employees are likely to return that favour. And when an employee feels like he or she belongs in the company, they will try their best to preserve that workspace (Kao, 2018).

Around 2014 Zappos decided to take the radical step of implementing Holacracy. Holacracy works from a different kind of perspective, in which there is only a formal, elected hierarchy, but people at the frontline have decision rights. The organizational form is built up from teams called circles. Each circle has its own purpose, its goal. Some companies use old-fashioned terms such as marketing, HR, while others use more trendy names like academy or people management. Each circle exists of roles that people can fill. One employee can fill roles in several circles and there can exist circles within circles if certain roles become so big, that they need to be broken down into smaller pieces. These circles are then called sub-circles. All circles eventually are connected through the highest circle which is called the super circle. In this circle, representatives of all major circles, called lead-links, together decide on the general strategy, direction, and communicate with each other on general topics. For reference look at the schematic provided in Figure 4. The role of lead link is a chosen one, as well as the role of facilitator which functions as a manager in individual circles. A facilitator is not a traditional manager in the sense that he or she

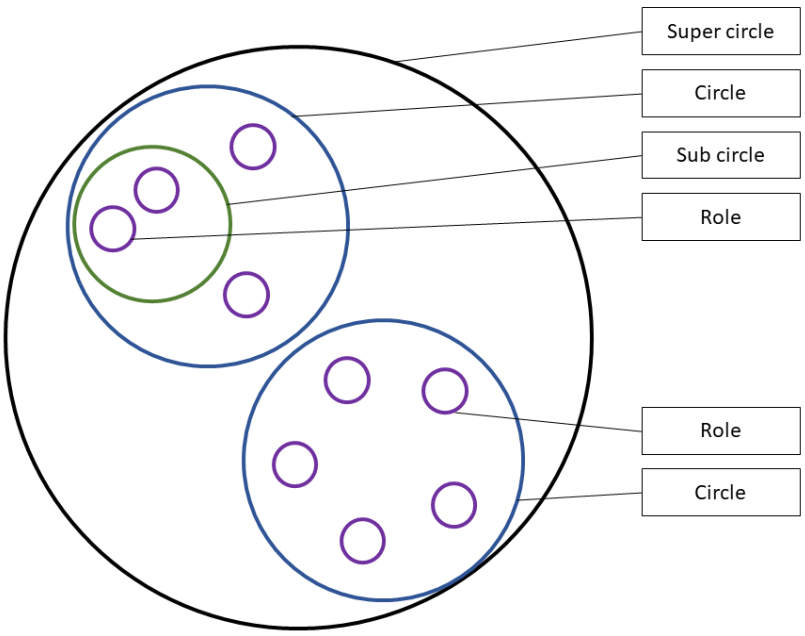


FIGURE 4 SCHEMATIC OF HOLCRACY ORGANISATION STRUCTURE

decides what happens, but coordinates the efforts and makes sure all efforts are directed at fulfilling that circles purpose (Kumar S & Mukherjee, 2018; Robertson, 2013)

The main strength lies in the accountability structure of roles. If one fulfils a certain role, this person gets a set of accountabilities, which grant him complete responsibility and power over those decisions. Other people can give advice, or comment, but ultimately it is the fulfiller of the role who has authority to decide. The only rule is that if a decision influences other people's accountability they need to agree to it. This creates a system in which frontline employees have the authority to take the necessary decisions. In other words, authority and decision-making power are transferred from the top to the bottom of the organization (Robertson, 2013). This increases the antifragility by definition, as there is more redundancy in decision making by having no single-point-of-failure as there is with a single CEO/manager (De Smet & Gagnon, 2017). Also, having decision making authority lower in the organization makes for more variation in decisions and thus increases experimentation and redundancy as a result. This also creates increased value since front-line employees often know the best response to what happens (Perschel, 2010). Furthermore, due to a high level of accountability, employees are more engaged in their work as they own their roles, which increases their skin in the game.

Effects of Holacracy implementation

The implementation of Holacracy caused around 18% of the employee base to quit Zappos, further instilling that only people that are completely bought into the company remained, strengthening the culture and thus skin in the game (Kumar S & Mukherjee, 2018). The self-organizing nature of the structure promoted an entrepreneurial mindset which increased experimentation and rapid adaptation, heightening the level of redundancy and optionality within the company (De Smet & Gagnon, 2017). In a sense, as Hsieh explained in an interview with McKinsey, every employee now works as a sensor. Just as in an aircraft every one of these sensors is taken seriously and will be seen or heard when it sounds the alarm (for a problem or an opportunity). They will not be ignored as in traditional organizational structures, partly because they have the authority to act on their observations (De Smet & Gagnon, 2017). As he also explains, this helps to adapt to the fast-changing environment. As Hsieh says in the article of De Smet and Gagnon (2017, p. 8): "*There's a quote attributed to Charles Darwin—it may be misattributed—but it's something like, "It's not the fastest or strongest or most intelligent of species that survives. It's the one most adaptable to change." The world's moving faster and faster. Technology is enabling things to happen more and more quickly, and information flows much more quickly than it did 20 to 30 years ago. It's really going from a mind-set of, "How do we try to predict, plan, and control and execute on a specific plan?" to a mind-set that's more about, "How can we get fast feedback loops? How do we constantly sense and respond and build the organization around adaptability and resilience and longevity?" versus the more traditional mind-set of efficiency*." This focus on adaptability, resilience and fast feedback loops are in essence small options that are created with low inputs that will be enacted upon when they seem promising, building new practices, routines, and redundancies into the company. It also showcases the companies 180 degree turn from the traditional method of plan, predict, and control towards benefitting and moving along with change.

Values and purpose

The self-organisation does have to be directed in some form. Hsieh himself compares it with being a groundskeeper or architect of the greenhouse enabling others to work (De Smet & Gagnon, 2017). An important factor in Zappos' approach is the use of values and purpose. Values that regard the complete company and align them with each other. And purposes that are tailored to each circle, eventually leading up to the super-circles purpose. This all builds upon creating buy-in of the employees at their respective roles and again adds to the skin in the game of these employees (De Smet & Gagnon, 2017). Next to that, the company also implements policies and ties bonuses to behaviour that reflect the values (De Smet & Gagnon, 2017; Lawton, 2005). They also share profits with employees in good years, which all also benefit the level of skin in the game.

Redundancy through training

Every employee gets a basic training of 200 hours in the first 18 months of their employment. This way every employee has a basic skill set that can be used. Everyone that gets hired gets the same training as call centre representators do independent of their primary function. This way the company has created redundancy in skills in a way that when a peak in volume of calls is experienced, or a large part of the company is unable to work,

employees can be shifted from their normal workplace to the call centre (Perschel, 2010). Secondly employees get payed based on certifications in 25 different skill set's in which employees are authorized to create their own learning path. This way the company creates more skills, redundancy and skin in the game by allowing employees to pursue skills that fit their interest and talents, creating heterogeneity among them (Kumar S & Mukherjee, 2018; Perschel, 2010).

Internal Market Mechanism

Zappos also tries to use an internal market mechanism, which breaks up monopolies of service providers (such as one central HR department) and have different internal teams to be customers of each other. This pushes for effectiveness and experimentation. They also experiment with crowdsourced participation, in which people can contribute when they think a certain project will create more value than where their time is currently spent (De Smet & Gagnon, 2017). All of this is to increase the entrepreneurial mind-set of all employees in order to stimulate experimentation, adaption and to benefit from the collective intelligence of all employees (De Smet & Gagnon, 2017). In this continuous cycle of experimentation and adaption, they take a very antifragile approach as showcased by Hsieh's remark that; "*It's not, "Oh, I need to go invent X, and so all I have to do is steps one through ten, and then, all of a sudden, we come up with this random invention*." *I think people fool themselves into thinking things can be predicted and, therefore, controlled. And so, at Zappos, the bar is: Is it safe enough to try? It doesn't matter if other employees think it's a bad idea. I can take that input. But is it safe enough to try?"*(De Smet & Gagnon, 2017, p. 10). By allowing for experimentations with limited downside, that the company can bear, experiments are really done. These experiments can fail, and the costs are payed, but when the experiment succeeds, the benefits are potentially unlimited. This strategy also reverberates in the findings of Kumar & Mukherjee (2018) that states that companies should not wait for crucial events to force change, but start change from a position of strength when there are enough buffers to absorb shock. In other words, when you change from a position with enough redundancies, those redundancies can become options.

Fragile practices

Also, at Zappos there are some aspects that fragilize the company. First the depth of inventory is kept low (Kumar S & Mukherjee, 2018), which is solved by taking the product offline the moment it is sold out. However this merely makes the company robust, as it cannot benefit from a sudden surge in interest. Secondly, Zappos has reverted to mass lay-offs in the past with an 8% lay-off round in 2008 (Hsieh, 2010). Mass lay-offs like this decrease the trust of employees and increase the chance of self-protecting behaviour like hoarding important information. This is detrimental for the level of skin in the game of employees and eventually the created value for the company.

3.3 Conclusions

The cases of Haier and Zappos show similar and different practices that increase the antifragility of the companies. In the previous parts the ways they operate have been described and related to antifragility. The similarities and differences are discussed below, resulting in insights and strategies that can be used to answer sub question two, "*What strategies, practices and insights for increasing antifragility as a company can be found by analysing the strategies and practices of companies through secondary sources."* The insights of this chapter can then be compared to the insights from the other parts in order to achieve validity of the final conclusions.

Continuous change

Something both cases showcase is the continuous focus on change and an aversion of stagnation. Often companies have an aversion for change as it incurs costs or can cause cannibalization on their own cash flows (Frynas et al., 2018; Smith, 2007). Additionally, oftentimes there are no incentives for change and companies will only initiate change in times of crisis, with fear running high and resources running low (Crainer, 2015). Haier and Zappos work exactly the other way around; they initiate (continuous) change from a position of strength (Crainer, 2015; De Smet & Gagnon, 2017). This proves to be an especially important factor in whether this strategy is successful or not. This way their redundant resources enable them to partake in these changes as if they are taking a real option. They utilize fast feedback loops to probe the environment and adjust in real-time. Haier utilizes these via the many small projects and new teams that are set up (Frynas et al., 2018), Zappos does this through enabling people at the forefront to take decisions of which they gather the feedback themselves (De Smet & Gagnon, 2017). This way Zappos uses the collective intelligence of the company just as Haier uses this with their internal marketplace (Crainer, 2015; De Smet & Gagnon, 2017).

Internal Marketplaces

Implementing some sort of internal marketplace is also a strategy implemented by both companies. In Zappos this is explicitly done to benefit from the collective intelligence of the entire company seeing each employee as a sensor to adjust strategies on the fly. Also they want to expand on this by enabling people to crowdsource work-time for people to pursue new projects (De Smet & Gagnon, 2017). This way fast-feedback loops are created and skin in the game is improved due to the freedom to commit oneself to a project of choice, increasing intrinsic motivation (Tomov, 2019). Haier implements the internal marketplace in a more literal sense, in which employees can start and join micro-enterprises that can offer services to each other and outsiders. In that sense Haier creates a platform in which all participants are part of start-ups (Crainer, 2015). An important aspect of these marketplaces is that they create a situation in which projects can fail and these decisions are made decentralized through a market mechanism. Another factor is that projects must be able to fail and thus are fragile, which increases the antifragility of the complete company. Second these marketplaces create redundancy through having multiple small entities in which many of the same skills are needed. Therefore, when one enterprise or project fails, its employees can go on and fill places in other places. And the other way around, when one micro-enterprise grows quickly, they can get employees from different places to fill their ranks fast. An important factor for this is that there are many employees with different skills. Third these marketplaces are full of optionality, as they have limited downside (initial investment) and unlimited upside. For example, a micro-enterprise that outgrows Haier will deliver unlimited upside. A last important factor of this internal marketplace is that it works best when one has an organizational model using small self-managed teams, as this enables projects to change, scale and pivot fast.

Small scale, self-managed teams

Not only do the self-managed teams enable an environment in which redundancy and optionality are increased, they also increase skin in the game for employees. Haier achieves this through tying the compensation of company workers to the performance of the teams, mimicking the environment of someone working in a start-up (Crainer, 2015). Zappos achieves this differently, by ensuring that employees have a perfect culture fit so they become part of the "tribe" of Zappos. This enables them to take accountability for their work and related decision through Holacracy (De Smet & Gagnon, 2017; Hsieh, 2010). As such, Haier takes a more material manner of increasing employee engagement and thus skin in the game, whereas Zappos takes a more emotional route. However, both are built upon accountability and ownership, which seem to be the two most important factors in making self-managed small teams a success.

Redundancy in workplace skills

A fourth aspect is redundancy in skills. In Zappos this is apparent through the fact that every employee receives the same basic call-centre training. Zappos has identified that their most important aspect is the call-centre and that it would impact the company the most when it would have insufficient capacity. Therefore, they create redundancy in the skills required so they can quickly create extra call-centre employees (Perschel, 2010). Second the pay-raise method using standardized skills increases redundancy as they create distinct overlaps in different people throughout the company (Perschel, 2010). A critical note there is that this standardization decreases variation in worker skills as they all specialize in the same aspects, which decreases antifragility in the long run. Haier creates redundancy of skill in a less organized way by allowing the micro-enterprises to also employ people from outside of the company. This way the redundancy is built by opening up the company to an inflow of skilled people (Frynas et al., 2018), especially attracting ones that have a great affinity with start-ups which now compromise the core of what Haier has become. Important in this implementation is to identify where your greatest need for redundant skills is located and to adjust your strategy to fit this need.

Diversification

Diversification creates antifragility by creating redundancies, for example by creating multiple income streams. It also creates room for optionality if you approach diversifications as real options. But the most important thing about diversification lies in transferring fragility from the whole towards the parts. Haier is a prime example of this, by having lots of different micro-enterprises that serve many different needs and target groups. The company also has mechanisms to ensure that projects are fragile and can fail (Crainer, 2015; Frynas et al., 2018). Zappos is still in an earlier stage, but is increasingly diversifying by offering more than just shoes, and opening diversification projects through the earlier mentioned time-crowdsourced projects. They treat these as options, thereby increasing the antifragility of the operations (De Smet & Gagnon, 2017). The single most important factor for diversification is that there is acceptance of the fact that parts must be able to fail to preserve the whole. And that this can be both the new segment and the old. Second, to minimize possible downsides, the diversification should be seen as an option and thus be tested against the same criteria as such.

Holacracy

Holacracy is an organizational structure that enables a lot of practices and processes to be antifragile. It eliminates the single-point-of-failure in strategic direction that is often found with CEO's and boards (De Smet & Gagnon, 2017). This creates layers of redundancy in an efficient manner that can be scaled up and down per the companies needs. It also incorporates that single units must be fragile for the whole to be antifragile. Because the company is built around circles and many people enact roles in different circles, it is easy to disband or simplify a circle when that is better for the company (Robertson, 2013). The accountability structure with a high level of trust and autonomy creates a high level of employee engagement. This in turn increases the skin in the game for the employees in a positive way because they are personally and emotionally involved in the well-being of the company. Last the accountability structure increases the adaptability of the company, because there are fast feedback loops (De Smet & Gagnon, 2017). This can increase the amount of experimentation and adaption on the front lines of a company, increasing the antifragility of the company. An important factor for this is a culture that accepts failures and wants to learn from them, to stimulate and allow for experimentation.

Fragile aspects

Haier and Zappos also implement policies that fragilize the company. Both keep a very small inventory, or said differently, have a very little amount of redundancy in inventory. This is fragile as they cannot deal with a sudden shortage of produce which prevents them from benefitting from optionality when the demand rises suddenly. Haier has implemented practices such as six-sigma before, that aim to reduce variations, which as explained before creates fragilities. Another interesting fragiliser is the lay-off policy of Zappos, since a large part of the policies is implemented in order to create intense, almost cult-like employee engagement (skin in the game). As already mentioned, they decided to lay off 8% of staff in 2008. For a company that focuses on creating a great environment for employees, having sudden lay-offs can give that safe environment quite a hit, as it causes employees to be less open, hoard information and in general hurt the company (Minnaar & De Morree, 2020). Practices that would have been more in line with their approach to create skin in the game would have applied principles such as open communication about the hard decision, having the strongest shoulders bear the heaviest loads, and a call for

collective sacrifice. This has proven to be a very good method to dealing with crises before, often resulting in an even higher employee engagement after the crises (Minnaar, 2020).

4. INTERVIEWS

The aim of chapter three is to answer sub-question three.

"*What strategies, practices and insights for increasing antifragility as a company can be found by analysing the strategies and practices of companies through primary sources?*"

In order to answer this question nine interviews were conducted, which were analysed using Atlas.TI. Categories were then created that guided the conclusions, tying together the insights from the different interviews into a list of strategies, practices, and insights in chapter 4.4 Results. This shows how the interviewees used redundancy, optionality, and skin in the game to increase antifragility, thus answering sub-question three.

Important to note is that the interviews departed from the common ground as presented in chapter 2.1 Fundamentals of antifragility, but did not include questions related to conclusions answering sub-question one and two. As explained, this has been done in order to create a higher validity of results when the three separate instances raise similar strategies and practices. The full questionnaire can be found in Appendix A.

4.1 Interviewee pool

In order to get a wide view on the use of antifragility in real life and as such collect suitable information for the exploratory nature of this thesis, a diverse group of interviewees was collected.

The criteria for selection were the following:
A potential interviewee needed to be familiar with the concepts of antifragility and practice them in his/her (daily) professional life.
Or
A potential interviewee needed to be an expert on a different subject that had noticeably clear connection to the field of antifragility.

The interviewees were collected through the network of the author and through online searches. Special focus was applied on antifragility mentioned on LinkedIn as it is a professional platform and as such people who mention it there will be involved in the concept professionally. Furthermore, a snowballing approach has been taken with several of the interviewees recommending further potential candidates. One of the interviewees does not fit this description but caught attention after he wrote about networked organizations, which overlapped so much with antifragility it raised the curiosity of the author.

The interviewees are from many different backgrounds, from clinical psychology or IT to drop-outs from university, and from entrepreneurs straight out of school to ex-McKinsey consultants and even lifelong IBM managers. Several trends in the interviewees can be seen. Many work in the training or consultancy business, using antifragility to advise or help others better. Several others use antifragility in order to steer and guide the companies they have founded. The interviewees have many different nationalities and are spread globally. The majority is Dutch, but interviewees are also from Belgium, Poland, Swiss and Australia. This was not a pre-requisite, but the consequence of the low density of antifragile professionals.

One difficult aspect is that there are not many to no real experts on the area of antifragility in the area of strategic management. However, the interviewees collected represent a very knowledgeable group and come as close to key experts as one might aim for in a field this young. Interviewees are respected members of different communities, of which many have published (multiple) books, are regular writers in management journals, are, have been, or have trained C-level executives, or have been active in applying antifragility in their respective field of work since the concept and book were released. Therefore, although the interviewee pool is not a complete representation of the experts on antifragility in strategic management, the group as such is more than sufficiently equipped for the interviews to be viewed as valid.

Seven out of the nine interviewees had prior knowledge on antifragility and made active use of this in his/her professional life. Interviewing these people was suspected to shine a light on everyday implementations of antifragility. Two of them were not previously known with the subject. One of these was recommended through a colleague at the same firm, as this person was an expert and coach on Holacracy and employee engagement, two aspects we have observed in the desk research phase to be potential drivers of antifragility. The second person owns a training company that is completely built on networks and partnership and has written extensively about this phenomenon. After reading an article describing the positive effects of this networked set-up during the recent coronavirus crisis, it occurred that the similarities of this system with an antifragile one were remarkable. Therefore, these two people were also selected to be interviewed. The average time people knew about antifragility and/or used it in their professional life (the two unknowledgeable excluded) was 6 years.

Interviewees were completely free to answer any question and follow up question without steering and to ask for clarifications. In the case of misunderstandings, the interviewer clarified or reiterated the questions. With the interviewees who were less familiar with the concept each part of the interview was started with a small introduction on the concept and how it related to their field of expertise. This approach, the outcomes of the interviews, the extensive experience with antifragility and related concepts, and the expertise of the interviewees validates that the interviewees and their answers give a relevant and valid insight into the practical applications of antifragility.

4.2 Coding method

Several semi-structured interviews took place that were centred around companies and consultants that have implemented or are trying to implement antifragile strategies.

Interviews were centred around the motivation for implementing antifragile strategies, the how, the type of implementations, the strategies involved in this implementation, and the perceived effects. This is all performed with a focus on redundancy, optionality, and skin in the game. The outline of the questionnaire can be found in Appendix A.

Interviews were recorded, transcribed, reviewed, and coded using ATLAS.ti software to correlate, connect and observe patterns in the different interviews. As we are working from an exploratory research here, with little known research, the coding has been done using a general inductive approach as described by Thomas (2003) and Sekaran and Bougie (2016). The steps were followed, with the following adjustments.

1) Prepared all interviews for a first coding on paper by printing.
2) Close reading: here the first coding was done using the three categories of Redundancy, Optionality and Skin in the game, as well as the category Communication about how to communicate about antifragile strategies and Future research to highlight potential follow-up research.
3) Categories were created by grouping subjects of the highlighted texts together into themes. Several themes were then grouped into categories. These codes again were grouped under sub-concepts and concepts.
4) Overlapping codes and uncoded texts were solved by recoding the entire texts in Atlas.TI using the coding scheme that was produced in step 3.
5) After completion, the codes were revised by repeating the grouping of themes into sub-concepts. When incongruent, changes were made and applied to Atlas.TI, until none were left.

The reliability of the coding is based on triangulation between the background theory and input from multiple interviews. From these codes, categories emerged that are discussed to determine their relevant effect on the concepts of antifragility and the opposing and similar opinions on them. This resulted in several strategies, practices and factors that influence the antifragility of a company.

4.3 Category Definitions

An overview of the different concepts and their relationships can be seen in Figure 5, of which a larger copy can be found in Appendix B.

A table with all codes, and indications of mention by the interviewees can be found in Appendix C.

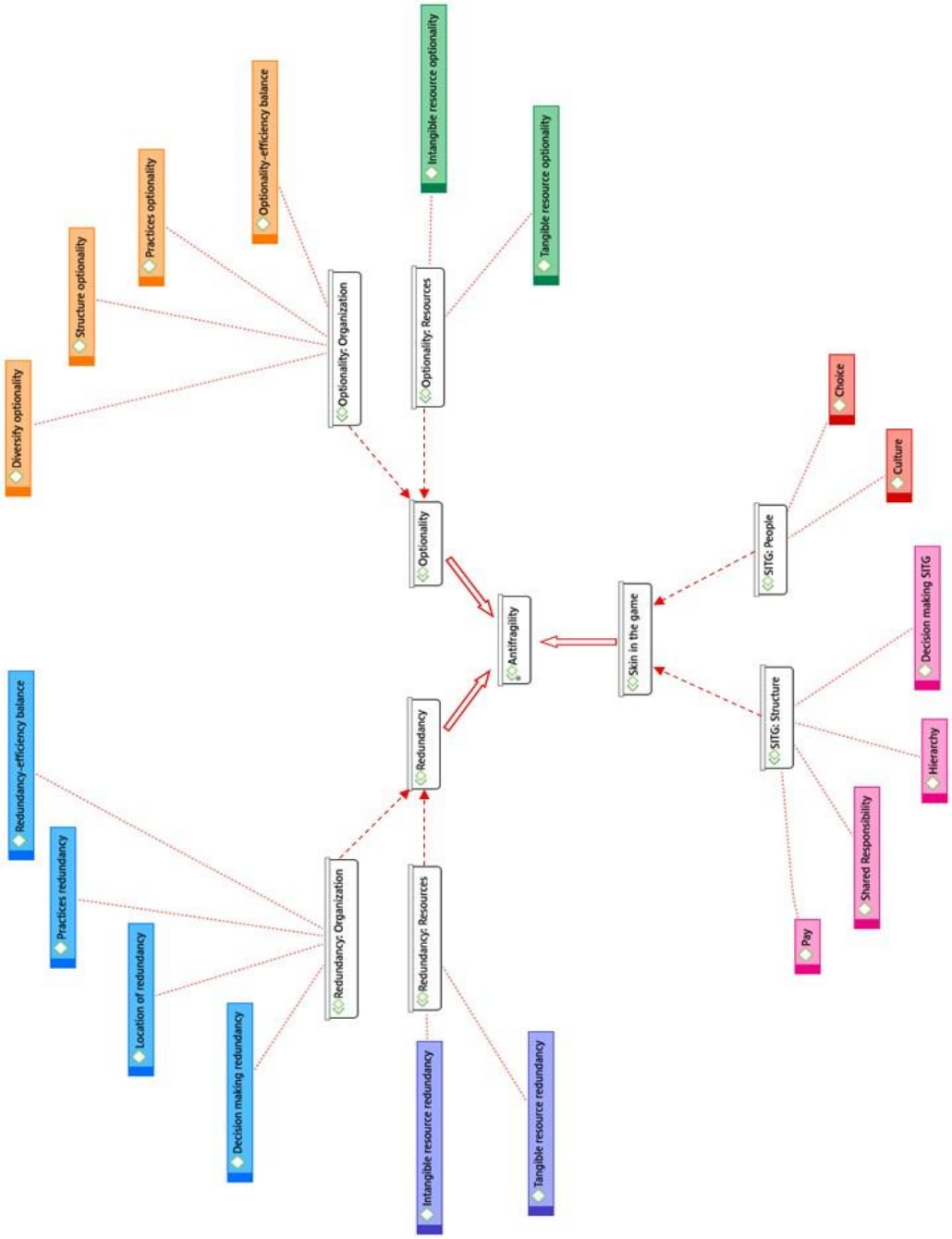


FIGURE 5 RELATIONSHIP BETWEEN THE CODES AND CONCEPTS

Redundancy

Redundancy - efficiency balance: strategies related to balancing redundancy with efficiency.

Decision making Redundancy: strategies to make a company more antifragile by creating redundancy in the decision-making process.

Location of redundancy: Strategies related to the placement and location of redundancy in organisations.

Practices Redundancy: Strategies and practices that companies or employees can engage in to create more redundancy.

Tangible resource redundancy: Tangible resources in which redundancy (strategies) can be integrated.

Intangible resource redundancy: Intangible resources in which redundancy (strategies) can be integrated.

Optionality

Diversify optionality: Strategies focused on diversifying to increase optionality.

Optionality-efficiency balance: Strategies relating to balancing optionality and efficiency.

Practices optionality: Practices and strategies that companies or employees can engage in to create more optionality.

Structure optionality: Strategies relating to building optionality into the structure of an organization.

Tangible resource optionality: Tangible resources in which optionality (strategies) can be integrated.

Intangible resource optionality: Intangible resources in which optionality (strategies) can be integrated.

Skin in the game

Decision making power SITG: Strategies related to creating more skin in the game by altering the decision-making process.

Shared Responsibility: Strategies related to sharing responsibilities in order to create more skin in the game.

Hierarchy: Strategies addressing hierarchy problems or opportunities.

Pay: Strategies related to pay and bonuses.

Choice: Strategies and practices related to the autonomy of people regarding skin in the game

Culture: Strategies aimed at altering or maintaining the culture of a company.

Communication

Remarks related to the communications surrounding antifragility in their professional careers.

Other

Other remarks aimed at increasing antifragility in companies, but not related to optionality, redundancy, or skin in the game.

4.4 Results

Guided by the codes that were derived from the inductive coding process, the different findings will now be discussed in this chapter in order to answer sub question three; "*What strategies, practices and insights for increasing antifragility as a company can be found by analysing the strategies and practices of companies through primary sources?*"

Due to the fact that some interviews were conducted in Dutch, several of the quotes used to illustrate the conclusions in this chapter, have been translated.

Let us first look at some general statistics of the results. In Table 1 an overview is given of some raw data in a schematic overview that shows the amount of times a certain code has been appointed to the interview of a certain interviewee. In the discussion below we will disregard the category "future research" as it was not a significant part of the interviews.

TABLE 1 TABLE REPRESENTATION OF THE AMOUNT OF TIMES A CERTAIN CODE WAS APPOINTED TO THE INTERVIEW OF A CERTAIN INTERVIEWEE. GR STANDS FOR THE NUMBER OF QUOTATIONS FALL IN THAT CATEGORY / INTERVIEWEE. GS STANDS FOR THE NUMBER OF CATEGORIES FALL UNDER THAT CONCEPT

Interviewee / Category / Code	**1** Gr=38	**2** Gr=29	**3** Gr=39	**4** Gr=43	**5** Gr=48	**6** Gr=20	**7** Gr=42	**8** Gr=45	**9** Gr=33	**Total**
GR = # of quotations GS = # of categories										
Redundancy Gr=0; GS=2										**140**
Redundancy: Organization Gr=84; GS=4	12	8	9	10	17	8	7	5	8	**84**
• **Redundancy-efficiency balance** Gr=34	7	5	3	2	8	3	3	2	1	**34**
• **Decision making redundancy** Gr=13	3	1	0	0	5	1	1	0	2	**13**
• **Location of redundancy** Gr=17	2	1	3	4	1	2	1	2	1	**17**
• **Practices redundancy** Gr=28	2	1	3	4	5	4	2	2	5	**28**
Redundancy: Resources Gr=56; GS=2	5	3	11	6	8	5	7	8	3	**56**
• **Tangible resource redundancy** Gr=14	0	0	2	4	0	0	5	2	1	**14**
• **Intangible resource redundancy** Gr=45	5	3	9	3	8	5	4	6	2	**45**
Optionality Gr=0; GS=2										**144**

Optionality: Organization Gr=100; GS=4	12	7	7	10	17	5	14	17	11	**100**
● **Diversify optionality** Gr=24	1	0	1	4	7	2	2	6	1	**24**
● **Optionality-efficiency balance** Gr=28	5	1	4	5	1	0	6	5	1	**28**
● **Practices optionality** Gr=18	5	2	1	2	1	1	1	2	3	**18**
● **Structure optionality** Gr=39	2	4	3	0	9	3	6	5	7	**39**
Optionality: Resources Gr=44; GS=2	2	3	5	7	5	1	7	9	5	**44**
● **Tangible resource optionality** Gr=29	1	3	2	6	2	0	6	4	5	**29**
● **Intangible resource optionality** Gr=17	1	0	3	2	3	1	1	6	0	**17**
Skin in the game Gr=0; GS=2										**104**
SITG: Structure Gr=46; GS=4	5	3	3	5	9	3	1	10	7	**46**
● **Decision making SITG** Gr=11	1	0	0	0	5	0	1	1	3	**11**
● **Shared Responsibility** Gr=16	2	1	2	2	2	1	0	3	3	**16**
● **Hierarchy** Gr=7	1	0	0	0	2	1	0	3	0	**7**
● **Pay** Gr=14	1	2	1	3	2	1	0	3	1	**14**
SITG: People Gr=60; GS=2	2	6	8	5	7	6	8	4	14	**60**
● **Choice** Gr=22	0	3	5	4	1	2	6	1	0	**22**
● **Culture** Gr=41	2	3	3	2	6	4	4	3	14	**41**
Other Gr=24; GS=2	6	2	2	9	0	0	4	1	0	**24**
● **Other** Gr=17	3	0	1	8	0	0	4	1	0	**17**
● **Communication** Gr=7	3	2	1	1	0	0	0	0	0	**7**
Future research Gr=10; GS=2	2	2	2	2	1	0	1	0	0	**10**

● **Biggest problem in antifragility adoption** Gr=4	1	2	0	1	0	0	0	0	0	**4**
● **Most useful new research** Gr=6	1	0	2	1	1	0	1	0	0	**6**
Totals	**95**	**68**	**96**	**112**	**133**	**59**	**103**	**111**	**98**	**875**

We can conclude several things from this data. First both optionality and redundancy were mentioned a similar amount of times, around 140 “mentions”, while skin in the game only has around 100. The spread between the categories is somewhat larger, with the lowest being seven and the highest 45. But each of the relevant categories is at least represented in four different interviews, which regarding the variety of backgrounds of the interviewees is an acceptable minimum to work with as it shows that the concept or category is noticed by multiple experts. There is also a noticeable difference between the number of quotes per interviewee ranging from 20 to 45, and the amount of codes attributed per interviewee ranging between 59 and 133. However, as the processed interview lengths ranged from approximately 3000 to 10.000 words, these differences are explainable. Furthermore, the attribution of codes seems to be spread evenly, with sometimes a distinguishable focus of an interview on a certain code (e.g. interviewee 9 has fourteen attributions of culture), which is expected of experts with their own focus area. Having concluded that there are no outliers or unexplainable trends, in the next chapters the interviews and the resulting practices and strategies will be discussed following the codes.

Redundancy: organization

In the sub concept organization of redundancy four categories were discussed. The first is the balance between redundancy and efficiency, discussing how to find that balance and whether we can even speak of a balance. Second redundancy in decision making processes will be elaborated upon. The third category encompasses the placement of redundancy in an organization. And lastly, practices that increase redundancy in an organisation are discussed.

Redundancy – Efficiency balance

The first aspect is the balance between redundancy and efficiency. A company cannot be completely redundant, as the accompanying costs of that would be way too high in many cases, but having no redundancy results in a very low antifragility. The interviewees now see too much redundancy in the wrong places in companies. As interviewee 1 remarks, "*this surplus of unnecessary redundancy, it clouds the discussion*". And as many of this surplus redundancy is located at the wrong places, thus in places where redundancy doesn't increase antifragility, it incurs large costs to the companies and should be seen as waste. The first step is thus to make the organization leaner, or as interviewee 5 said, "*when you have a clear image of the company, you begin with trimming down*". This is of course a sensitive balance, because "*when you become too lean you remove a piece of your redundancy*" according to interviewee 2.

After trimming down, it is important to add redundancy in the right places. One possible method of doing that is via the strategic goals of a company as interviewee 5 remarked, "*and from there, the context of the company will show where and how to create useful redundancy*".

There are several ways in which companies can find this balance. Multiple interviewees emphasized the importance of small and continuous experimentation to find the right balance, to constantly carry out small experiments and establish feedback loops in order to guide the creation of redundancy. And as interviewee 5 emphasizes, you need to focus on experiment driven change and not on (temporary) transformations, because those assume that there is an end point;" *You shouldn't be afraid of setting up experiments. You have a certain hypothesis and you go out of your way to prove or disprove it*". This is emphasized by interviewee 1, "*As an organization you never want to stop and adhere to the status quo*". The interviewees also advise on several ways to implement this kind of experimentation into your company. Interviewee 1 proposes the practice of Canary-releases, rolling out updates to small amounts of employees which act as your guinea pigs for problems before rolling out to the entire company. Or allocating time specifically for experimentation to "*make sure that work really gets done and to prevent delaying it until you have spare time. Because you never have spare time*." Next to constantly adjusting to the new situation using "small iterations" and "feedback loops", another positive effect is that "*it's much safer due to the smaller steps, your losses are minimal when things don't work out*", as interviewee 9 remarks.

Another way to look at this is at a more meta-level of the company. As interviewee 2 puts it, "*it's a very difficult balance, due to the abstractness of the discussion ...Eventually it really matters whether you can look at your organization on a meta-level*." Several similar suggestions were made by other interviewees, for example by looking at flow-efficiency and value stream mapping. When looking at flow efficiency, you evaluate work on the basis of total time to completion divided by total time explicitly worked on, or in other words making sure the project is finished as soon as possible. This causes more slack in time which increases redundancy, opposed to resources efficiency, which is focused at having people working at all times. "*When using this with knowledge work, you have to visualize it. You need to look at the flow of the work and protect your capacity. When work proceeds slow you know you have not enough slack and you need to limit your active work*" (Interviewee 3). The other technique is value stream mapping, finding out how value moves through your company and making sure that there is enough redundancy in all aspects supporting this value stream.

But the interviewees do not always agree about the balance. As interviewee 4 puts it, "*There is no simple answer. There is no formula. There is some rule of thumb for each and every company that they have to decide on themselves.*" Or they are of the opinion that a balance is not possible or necessary. "*I don't think you can decide on a balance upfront ...I think it becomes more of a mindset, which would be awfully hard to sell at public*

companies, where shareholders don't have skin in the game ...I think one should completely let go of efficiency" (Interviewee 7). Others remark that it is more about efficacy than efficiency: as long as your production is better than that of your competitors, then efficiency doesn't matter. However this that gives rise to its own set of challenges as interviewee 8 emphasizes: "*Effectivity however is also very hard to measure*"

Decision making Redundancy

Redundancy can also be particularly useful in decision making. Having many different eyes on a decision can help with looking at things from different angles and seeing things they you otherwise miss. One of the most mentioned ways of increasing redundancy is by decentralising decision making, either by engaging with more people or pushing decision making authority down to lower levels. "*Decentralise decision making, especially decisions not belonging to your core-activity*", emphasizes interviewee 5. This way you create more time and slack at higher levels, while at the same time decreasing the size of the impact of decisions. Having more people at lower levels taking everyday decisions decreases the impact of decisions and thus increases the chance that a company can recover from faults. A practical application is for example, as interviewee 9 illustrates, "*in Holacracy authority is given to roles, not people*". And when you empower the right people, you also make sure people have the best interest to take the right decision, which will be elaborated upon later.

Including more people in a decision also increases redundancy. Both through providing new insights and the extra effect that "*people begin to understand what is necessary to run a company ...not only the people, but also contacts, processes and how these are formed*", as interviewee 7 puts it. This increase in viewpoints improves decision making processes and it increases the knowledge about the company of the employees, increasing redundancy in information. A last aspect of this is that including more people slows down decision making, which has as a positive effect that one looks more at possible consequences, both known and unknown. But as interviewee 2 puts it *"...it asks for slowing down tremendously. And organisations are often programmed to act, so that's an interesting paradox that arises*".

Another aspect is to keep decision making units small, "*It is easier to control a city-state than a country*" (Interviewee 1). Small teams can be more agile and "*you can have multiple teams on an assignment, scaling up and down the number as seen fit.*" (Interviewee 5). This increases your redundancy through the amount of slack you have. Examples come from micro-services, for example Interviewee 5 points at "*loosely coupled tight cohesion structures, which is a micro-service architecture I try to apply to teams*". This technique enables redundancy by having multiple units that can work on different aspects. If one fails, it is contained and absorbed by the other units.

Location of redundancy

But where in the organization is it important to build in redundancy? One thing all interviewees agree upon is that you should avoid single points of failure. Within technology this is general knowledge, but with processes and people this is less known. "*Single points of failure often occur in Taylorian organisations"* mentions interviewee 1, meaning the single point of failure in decision making when one manager is responsible for all decisions. Another form of a single point of failure in humans are specialists: "*In the past you had one big bottleneck, the specialist. The more specialists you have in your organization, the slower things move*" (Interviewee 3). When only one person is able to do a job, this poses large risks for the continuity of a business and a limit on how much capacity a company has.

With Interviewee 4, we came to a rather interesting conclusion. He explained: "*For manufacturing their big buzzwords is lean management and they have their lean consultants that are about stripping everything*" but "*they also had a lot of redundancy around it, an extra electricity network, they have a helicopter available to get materials as leather if necessary. As their redundancy is money and redundancy around this line to not make it stop*". Furthermore "*The assembly line is blue collar work and I can understand that there can be no redundancy in worker capacity and there it is money, but when it comes to white collar there can be some redundancy in their capacity*." This shows a possible pattern, that is elaborated upon in the following idea. When an asset is flexible such as white-collar employees, you should build redundancy in it. When an asset is inflexible, such as an assembly line, you built redundancies around them. Because flexible assets can also be used in other places as the situation prescribes, but inflexible assets are stuck to their initial purpose.

Whether redundancy is better aimed at your core business or somewhere else has proven to be a hard question. Some, such as Interviewee 3 say; "*You need redundancy in your core business. In non-crucial activities that's not necessary. You can work from an efficiency view there*." Others, such as Interviewee 2, say it is a little more complicated than that, highlighting that you should not only look at your core processes and redundant processes, but also at "*processes that keep your culture alive ...to know whether you need more redundancy is also dependent on your culture and what you want to achieve with that*". However, others have a complete opposite view, because no core capacity lasts forever, or as Interviewee 8 said, "*If you don't invest in the future and only have one product, you know one thing for sure; that you won't survive the next wave of innovations."* That's why some, like interviewee 7, say that *"small experiments should be your core activity*".

A last location where redundancy can be implemented is in partnerships and networks. This improves redundancy by having resources and skills that are not directly yours to tap into. This way you "*build an ecosystem, which is a more antifragile way than building a large company*" (Interviewee 3). For example, Interviewee 6 describes that "*when it is not convenient for her, she gets someone else in the network to do it*", thus a sudden increase in work can be absorbed by the network.

Practices Redundancy

Last, we focus on practices that organisations can implement to increase redundancy. As mentioned before, the best way to increase redundancy is by small and continuous experimentations and deployment. Continuously experimenting is for example done via Holacracy as interviewee 9 states; "*Holacracy is peppered with learning and improving in small steps*." Another important aspect in this is to continuously deploy. This is both to "*step for step build a product that is exactly what people want*" (Interviewee 9) and to generate practices and skills that equip employees to deal with variation, which helps employees when they need to find new solutions. One Interviewee told that you can either write standard how-to pages, but people do not learn from that, but if they go out and look online or ask, people will learn. "*That process of discovering, that should also become redundant*" (Interviewee 7), in order to be able to deal with uncertain situations later. Another example is fully educating all your employees by yourself, so you gain the skill to educate new employees from various backgrounds, independent of their initial skill, such as Interviewee 9 stated. Or to quote Interviewee 1 it will become "*a non-issue because you have done it so often*."

Another practice to increase redundancy is to "*move away from the narrow definition of a job description*" (Interviewee 2) and towards roles. Roles in this context mean small responsibilities and tasks, instead of one large job description. An example that was given was that you could either have the job description of a marketing manager, or a handful of roles such as SEO optimization and Social media manager. "*Within our structure, we purposively kept those roles small*" explained interviewee 9. This provides redundancy because there will be more people in a company that would have the skill to take over a small role such as social media manager, than to take over the entire job description. Thus, by creating roles, you create more flexibility in who fulfils it and thus more redundancy.

One of the most important practices that kept coming up time and again is diversification. As Interviewee 1 put it, "*Things just change. You need to acknowledge that and when you want to be antifragile, you can't put all your eggs in one basket*". "*You need to have different options to be flexible and thus antifragile*" stated Interviewee 3 and related this to hedging, "*You want to optimise over projects, not each project separately*". There are several aspects on which an organization can diversify. They can *"widen their skillset*" as Interviewee 3 mentioned. But it's also important to have "*more than one business, one strategy or client. One idea how to make money*" (Interviewee 4). When you don't have that then "*company is basically the slave or prisoner of the other*." But there are more angles to look at this. For example, Interviewee 7 highlighted "*capital redundancy, having your money in different places ...so you are not dependent on one*."

Two insights from Interviewee 6 are from the perspective of a networked organization and are not that easily translated to a normal organisation. However, these were so interesting they are highlighted here. The first is his reaction when asked about how to decide on the balance between redundancy and efficiency, "*That assumes that the leader or the management group is funding that redundancy. And again, I am sorry to be awkward for you, but we don't fund that. The players fund it, and that's what is happening at Haier too. They are funding it with*

their time and money and judgement. And their collaborations." So, finding a way to let employees fund redundancy in a responsible way might be a great strategy for organizations. The second remark is closely related but is slightly different. It was the notion that the employees were responsible for creating their own business. Since they were in a networked organization, they were essentially entrepreneurs. That is why the redundancy could also be funded through them. As mentioned by Interviewee 6, Haier has implemented some interesting new organizational structures and practices that may make this possible for more traditional organisations.

Redundancy: Resources

Next, we discuss the different resources that the interviewees suggested were fit to focus on when adding redundancy to an organization. These are split up in tangible resources and intangible resources because each requires a different approach. Important to acknowledge, is that redundancy in these resources is, as Interviewee 4 remarked, "*that it is not only to address problems, but also to address opportunities*", which we discuss more at length with optionality.

Tangible resource redundancy

Two tangible resources were mentioned the most often: money and people. These were preferred above something like raw materials or similar things due to the flexibility of these two resources. With enough of either, you can solve almost every problem according to the interviewees.

With people, it's also important how you use them. Putting two people on a specific task or project increases redundancy immensely. At the company of Interviewee 3 "*presentations and trainings are always given by two employees*". This way when something happens to either, the presentation can continue, and it increases homogeneity in the presentations. Furthermore, the staffing of roles can be doubled, as happens at the company of interviewee 8 and 9; "*Every role is filled by two employees. One lead and one backup. The backup is often not a specialist in the role but is able to pick up the role if necessary*".

Money is said to be a pretty obvious choice, as this can solve almost any problem a company runs into. It is therefore advisable for a company that wants to become antifragile to have a significant cash reserve. But redundant money can also be made more antifragile by making sure that the location and even form of this money is diversified, as mentioned before. Having capital in brick and mortar and over several banks for example, decreases the impact bankruptcy of one bank can have on a company's cash reserve.

Additionally, Interviewee 7 also mentioned "*systems and IT-systems*" as good places for redundancy, especially for companies that rely heavily on technology for their business, which in today's economy is a large part. And in light of the current corona crisis, enabling your employees to have redundancy in the place they can work at, for example by providing them with enough electronics and having IT-systems in place, can also save tons of money for companies.

Intangible resource redundancy

Regarding intangible resources, four themes arose: time, skills, information, and income streams.

Skills were identified as the most useful to create redundancy and were mentioned by almost every interviewee. To prevent confusion, within redundancy skills are categorized as intangible, while people and their skills are categorized as tangible under optionality. This is because with redundancy the focus lies on the particular skill; if only one person can do something you have a problem when that person falls away. In order to create redundancy, it is important to have a second person with the same (kind of) skill. What kind of person or whom it is, is unimportant. The main focus is the skill itself. With optionality the focus lies more on having employees with multiple or different skillsets, thus the tangible person and the categorization under tangible resources.

Something that was discussed a lot were the concepts of T-shaped profiles, generalists, and jack-of-all-trades. In order for a company to be redundant in terms of skillsets, it is important to have employees that have a basic understanding of many skills and preferably a specialty in some. Not only does this create redundancy for when people fall out, it also makes it easier to "*organise project teams with less people*" (Interviewee 1). Not only a person can become T-shaped, but a company too, as Interviewee 8 puts it; "*Because we have many different people, we can become T-shaped as a company*". Another aspect is the cross-functionality of teams, so having redundancy of skillsets in different teams also creates redundancy as Interviewee 5 stated or creating certainty with experienced employees to offset inexperienced ones as mentioned by interviewee 8.

So, a good way for companies to increase their redundancy is "*not through hiring, but by spreading knowledge*", proposed interviewee 5, "*for example through a teacher-teacher principle*". This is not an easy task and takes a long time according to Interviewee 3, "*with knowledge workers you are not talking about weeks, but months at*

minimum." An important aspect is to "*make employees develop these skills without micromanagement. It is important they discover it themselves*" (Interviewee 1). One important skill to learn is how to learn better, suggests interviewee 2; "*I think the most important part to have redundancy in is in the ability to learn new things inside your organisation*."

The second most mentioned intangible resource is time. Or in other words "*Redundancy in time, time can do everything, it can generate money, knowledge*" (Interviewee 5). There are two main aspects of redundancy in time. Slack in time can be used to give space for new opportunities, such as "*having ten minutes before and after every meeting enables me to prepare for the meeting and to check what is happening within teams. Or to listen what is being talked about around the watercooler. Those 10 minutes are priceless*." Or one can use that time to be creative and come up with new ideas. The second aspect is time to compensate for delays and similar events." *A robust system can become fragile when there is too little time to recover*" (Interviewee 2). Software projects are actually a very inefficient way to organise the writing of code, interviewee 1 stated, "*it does not have economies, but diseconomies of scale*". A planning should be easily adjustable by everyone according to interviewee 5, "*We do that to retain as many options as possible and to adjust quickly to changes and new information*".

The third intangible resource is information. There are two main aspects to redundancy in information. The first one is internally by "*sharing way more information than necessary ...whenever something needs to be taken over, I can do that without briefing*" (Interviewee 5). Redundancy in information not only makes taking over projects easier, it also helps people to have a full picture and understanding of what is happening in the company. As Interviewee 7 described it, "*people get a better understanding of what is necessary to run this company*". The second aspect is focused on having diversity in information, vision, and backgrounds to be able to make decisions based on multiple views. For example, transferring information across domains can help with, says interviewee 4, which is endorsed by Interviewee 8; "*often the people that see crisis coming, are people from other disciplines*". Interviewee 8 also states that zooming out is often a good strategy "*to get a clearer view of situations, look at other countries*". Last, a diverse organization is beneficial. This way when you communicate, different worldviews can shine different lights at problems, uncovering facts that were otherwise overlooked state interviewees 3, 6 and 8.

The last intangible resource is a company's income stream. It has a lot of overlap with the aspect of diversifying. Interviewee 3 described that at their company they "*try to prevent biolocking. So, we don't want to work with all 10 at one client, because then they have so much power over us, they can do what they want*." But spreading your income streams also protects you from variations in economies and seasons, as Interviewee 6 describes; "*Generally when you have a worldwide thing, well not at the moment but normally, if Thailand has a problem with politics or the value of the baht, China might be doing well for us. And usually that's been the case. Because of the variety in the sources of business, usually that evens out okay*."

Optionality: Organization

Within the subcategory organization within optionality, the focus lies on four aspects to consider when implementing optionality into an organization. The first one is diversifying, which focuses on spreading your risks and your chances. Then we move on to the optionality – efficiency balance and how an organisation can find that balance. Third are practices organisations can adopt to increase their optionality and last the structural components of optionality are discussed. One might notice a lot of similarities between optionality and redundancy, which is because they are closely related and often stem from the same resource or practice. There are however distinct differences. Whereas redundancy is primarily used to create a robust or resilient company, optionality lies at the heart of an antifragile system, by enabling the ability to benefit from variation and is thus especially important. Or as Interviewee 5 puts it; "*You got to have options, options, and more options. And you shouldn't be afraid to choose an option*."

Diversify optionality

The first part is about diversifying within an organisation, or "*having diversify as your motto*" (Interviewee 4). The first aspect of this, again, is not putting all your eggs in one basket. As said before, change is imminent and "*you need options to be flexible, without options you are stuck*" (Interviewee 3). The reason for this is twofold. The first is that with several options, just as with redundancy, you have different cashflows, different options to pursue. Both for freedom and, to quote interviewee 8 again, "*If you don't invest in the future and only have one product, you know one thing for sure; that you won't survive the next wave of innovations*". The second is that having several different options also has some very positive aspects. Having different options increases your chance of working on something that will grow out to be a huge opportunity even in the face of huge uncertainty. "*If you look at it this way, you have three playgrounds in which you can experiment with different methods*", illustrates interviewee 5 for a situation in which you have three teams. Important in this situation is to have several "*cross-functional teams, that are capable of working on projects separately*" (Interviewee 5). To illustrate, as Interviewee 8 said, "*currently the wisdom in management is specialisation and selling of everything else … but when that goes wrong, you have a big problem ... I would rather take an example of Unilever. As Unilever you wouldn't suddenly sell everything off and focus on only selling butter!"*

An important factor in this, and a beneficial side effect of having many small options is the ability to absorb failed options. In taking options, it's important to constantly "*consider, would I be able to back off from that*" (Interviewee 4). Many interviewees wanted to provide as little as possible rules or guidelines for taking options, but on this many agreed; "*make sure the possible downside is small enough that you can take it*" (interviewee 5), "*Make sure you can close things off in an okay manner ...maybe if you go and look at guidelines then don't take risks that could bankrupt the company. That's it*" (Interviewee 7) and "*You should not take options that are larger than what you can afford financially or with resources*" (Interviewee 8).

The beneficial effect of this is that having multiple options, especially taking the above into account, increases your flexibility and thus chance on finding the right answer or project. Or as Interviewee 5 puts it "*By betting on multiple horses, when the costs are manageable in the bigger scheme of things, they increase their chance of success.*" For example, spreading your options over different countries allows you to be less affected by local fluctuations as described by interviewee 6 and experimenting with decentral structures also benefits from this property as suggested by Interviewee 8.

Optionality-efficiency balance

Companies also need to balance the amount of options they take with their own resources, efficiency goals and risk appetite. Especially the risk appetite, since the balance between efficiency and optionality is "*always a mix, it is also a very subjective something*" (interviewee 9). With this risk appetite, there are no right or wrong answers and it is often "*basically a rule of thumb decision that mostly depends on the gut feeling*" according to interviewee 4. However, there are two things to consider. The first, again, is "*introduce in your selection criteria, would I be able to back off from this?*" (Interviewee 4), so take no risks bigger than what your company can handle. Second, whatever your risk appetite, it's always a good idea to have a little slack in capacity in order to capitalize on new opportunities when they arise.

Strategies that could help with finding this balance is looking at literature from the innovation dilemma or blue ocean strategies according to Interviewee 1, or for example a model such as the 3-horizon framework from McKinsey as proposed by Interviewee 8. But interviewee 8 and 7 also claim that these small options should be your core business, and as such, there is no balance. "*The fact that something works for you now, doesn't mean it will stay that way*" (Interviewee 8). For insights on how to deal with that, Interviewee 8 points at the pharmaceutical industry; "*the pharma branch has experience there, since patents expire*".

How to decide when to keep an option alive and when to pull the plug on them? Several strategies were presented. The first was to work with feed-forward. "*Continuously formulate upfront what you expect from a process and what you expect to see when things work, and when it doesn't*." (Interviewee 2). Others were more in favour of a lean start up approach. "*Basically, when you are a start-up, I would say optionality is bullshit. Your whole company is one big bet*", stated interviewee 4, and that is exactly the reason why start up strategies are useful to guide optionality. By "*making sure you have the right insights, you can already pivot at 5 or 10 percent of a project, so you never throw away your efforts*" (Interviewee 5), so work with a minimal viable product or idea. Another view on this is quite similar; options do not need clear cut endings; they will bleed out eventually and sometimes putting something on a shelf is the best method. "*We don't force people to complete products or to maintain them. It's just that at a certain point they bleed to death*", Interviewee 7 said. And interviewee 8 claims that "*as long as you don't need them these options can still become an advantage ...you can also be aware of the T-shaped profile this gives you. Don't burn all your bridges right away*." To conclude he said, "*when you stop projects, its more often than not because something better came along*".

Practices optionality

The practices within an organization can also increase optionality of a company. Again, the most important things here are experimentation and continuous deployment. As discussed in the redundancy practices chapter, experimentation gives flexibility and lets an organisation figure out what works and what not. For example, Holacracy has many practices that make sure changes are realized through continuous small changes. And again, here too, by making experimentation and deployment or similar practices continuous, "*they become a non-issue, since you do it so often*" (Interviewee 1).

More interesting are some of the practical applications of this that improve optionality. Something interviewee 1 illustrates is the institutional yes, "*like at Amazon, that when you have a good idea, you should work it out. And you have a yes by default, the institutional yes. And the only way to stop you is if someone else can prove it's a bad idea*." A similar practice is present in Holacracy, where someone fulfilling a role has the autonomy to change almost anything and people are only allowed to object when they think it would hurt the company (Robertson, 2013). Another practice that can be observed at a company which interviewee 5 described is "*every 4 years they change positions within the company*". This incurs costs of course, but also enables new and cross-domain insights. Essentially, they take the option with the (limited) costs that are incurred because of the reorganisation and benefit from the unlimited upsides that are created. Other examples of options were leasing stuff instead of buying it, "*you can just adjust your needs on the go*" (Interviewee 4) and the use of virtual offices. These virtual offices as described by Interviewee 8 and 9, work in the same spirit as leasing and entail that one hires office space in a co-working space in order to try and see whether the market is attractive and starting to build identity in that market without the immediate costs of an office.

A last thing that can help create optionality is to refrain from linear planning and go for more flexible ones. As described before, projects can get in trouble due to tight schedules and as such, companies should build in redundancy in them. But this can also create optionality, as this extra time is also available to pick up extra opportunities when they arise.

Structure optionality

Several suggestions and ways were discussed on how to build optionality into the structure of an organization. The first was to build many small feedback-loops in every aspect of the company. For example via the earlier explained canary release of Interviewee 1, but also in how people are functioning, as Interviewee 9 said, "*so when in that little amount of time do you process and evaluate your functioning in order to get right back on track?*". This of course also relates back to the pivoting you can make in projects when the results of the feedback loops

are negative, or less than expected. And by making the steps small and incremental, you can "*build, step by step, a product that meets customer demand one on one.*" (Interviewee 9).

What is important in order for these feedback loops and experimentations to be successful is to create a fault-tolerating or even promoting culture. "*It is good to emphasize to people that it is okay to make mistakes ...or rather, to go make mistakes"* (Interviewee 7). Interviewee 9 emphasizes this further, "*that happens very often in companies, that they prevent people from experiencing change and how to react to that. To try and think of new ways, without the risks of losing money from it.*" So, it is important as Interviewee 3 put it, "*you need to create psychological freedom, for people to really tell what they think.*"

Another important aspect is to realize that you first need to be robust before becoming antifragile, because "*optionality invites fragility*" according to interview 2, "*It took me a long time to realise that antifragility is robustness with a small layer of fragility, a layer in which you allow things to break.*" And this robustness first is important, says Interviewee 1, "*because when you are just fragile, there is a big chance that a negative outlier will make you go bankrupt. You first want to limit your fragility ...and then when you experiment, the outliers you come across are more often positive.*"

A different way to create optionality is by creating and joining networks and partnerships. As interviewee 1 already mentioned earlier, an ecosystem is more antifragile than an organization. So, it is better to build "*a networked organization*" (Interviewee 6). This ecosystem can not only bring you redundancy, as shown before by the quote from Interviewee 6 "*when it is not convenient for her, she gets someone else in the network to do it*". When you are that organization or that person who gets this opportunity from someone, the network works acts as an option. So, in the words of Interviewee 6, "*having a network is like having one big option*".

There were also several remarks on optionality and the impact of decision making on it. One of the advises was to delay decision making. "*One of the things I maybe highlight too little, is to delay decisions when you can. Only make one when necessary*", said Interviewee 5, sometimes delaying decisions costs you money or resources. But more often than not when you decide to delay a decision, the benefit or the chance of making the right decision increases. In other instances the decision solves itself, such as the example by interviewee 7, "*so because we were so busy with other things, we did not focus on product X, which in hindsight was the best outcome. It would have been the right decision to do nothing*." This also translates to making "*decisions with as little downside as possible, in which I have the maximum amount of flexibility later*" (interviewee 5). This can be incredibly challenging for companies, because as Interviewee 2 commented, "*organisations are made to do things, so doing nothing as a goal creates a big paradox."*

Another aspect of optionality in decision making is the decentralisation of decision making. The general wisdom behind this is that when autonomy and decision power are distributed, more people will be able to conduct tiny variations and experiments to improve the business. So, you spread risks, and when you "*create empowerment at the right level*" (Interviewee 5), oftentimes the people in charge of making these small changes know more about the processes than in centralised decision making. A concrete method to do that is by letting go of job descriptions and adopting roles as described before. Holacracy works from this principle. Furthermore "*in Holacracy you give authority to roles, not people"* as Interviewee 9 told, this way authority is also easily transferred and if implemented correct creates empowerment at the right position.

A last theme that arose revolved around minimising the number of guidelines and rules, because of the inherent unpredictability of things. As Interviewee 7 put it; "*actually it already goes wrong with trying to structure an unpredictable process ...I have a double pendulum in my windowsill. It is quite simple, two sticks, two hinges, mathematically speaking it cannot be simpler ...theoretically you could predict exactly how it should move. But even the slightest imbalance, fractions of millimetre will make the calculations useless after 5 to 10 rotations ...and society or a company is something with an infinite number of hinges ...so to say something concrete about that is impossible.*" And in addition to that, "*every action or rule also has a lot of side effects. If I for example say that projects can only be done by 1 developer ...you disregard too the positive side effects of working with multiple people ...I think you need to look at every case individually*." Interviewee 9 agrees, "*you need to remove everything that lock people in, or guide them to a certain path, in order to really remove all barriers for people*." "*Reduce to*

the max", emphasized Interviewee 8, "*Our golden rule is, treat others as you want to be treated, use your common sense and when you still don't know it ask your colleagues. So, you almost want no rules at all."*

Optionality: Resources

Optionality can also be stimulated through the (in)tangible resources a company possesses. Many of the subsequent conclusions have overlap with the ones from redundancy, as having redundancy in something enables the possibility to use that redundancy for unpredicted possibilities, or as Interviewee 4 said; "*the important thing about redundancy is that it's not only to address problems, but also to address opportunities.*"

Tangible resource optionality

We start with the tangible resources of a company. The most mentioned tangible resource are the employees of a company and the skills they possess. As Interviewee 2 put it; "*I think optionality is typically a human factor. The robustness aspect of antifragility requires solidness in structures and not too much optionality ...for example in a factory, there are certain structures to ensure that robustness. And the human factor creates the optionality there. How do we handle the safety, how do we handle the failures, how do we improve this*"? One way to really make sure these employees make the most of this optionality is to work from a "*people first strategy, so your own employees are the most important. Even more important than customers and shareholders*" (Interviewee 9). That entire package of investment you put into your employees can be seen as one big option, as the potential downsides are capped, but the potential upside of each motivated employee is potentially unlimited.

The second aspect of the optionality of people is in their skills. As explained in the redundancy piece on skills, having a t-shaped profile or generalists in your company allows you to be flexible in assigning your workforce. This does not only help you absorb variation, it also enables you to act upon new chances. So, having a varied workforce with multiple skills can bring a company quite some optionality. And companies can increase that skillset themselves, as Interviewee 7 illustrated; "*a good example is when an employee wants to follow a new course. The potential downsides are that the employee leaves soon and the investment is gone, but that is often very manageable. The potential upside however, the person becomes happy in his job, learns skills we suddenly need very hard in the future or attracts new employees through this course.*" And since you cannot predict what kind of skills you will need in the future, maybe job interviews are useless in the format they are performed in now. In line with that idea, it is better to do an intake conversation to estimate the fit of the person with the company and then try how it goes for the next 6 months. "*Some time ago another entrepreneur came to me and said, we reject 80% of the people who apply, how about you? And I answered, yeah, we basically accept everyone that applies*", interviewee 7 told.

The second resource is money, because "*when an organization has enough money in reserve to invest, the world is practically at its feet*" (Interviewee 1). Having enough reserves that you can invest in opportunities that arise, enables you to react on positive variations in your environment. And enough money in reserve also enables you to take these options in a responsible manner. Having different cash-flows also gives optionality as you "*bet on different horses*" and thus on the one hand you have hedged your income for when one income stream falls away and on the other you have spread your chances of benefitting from positive variations.

A third strategy to improve optionality in resources is to lease. As mentioned before, leasing products enables you to upscale and downscale as the situation requires, giving you both redundancy and optionality. Examples are leasing cars instead of owning them so you don't have costs when times are rough, and you can upscale when you land a big project. Another example is leasing a virtual office "*which is actually in a shared workspace building, where we hire the possibility to make use of a meeting room.*" (interviewee 9).

The last example was offered by interviewee 8 and 9, which is to expand up- or downstream into the value chain. While this does not fit a diversifying strategy, expanding does give you more optionality as you are less reliant on other companies, giving you more optionality in your processes. When another company can do it cheaper you can outsource it, but having your own production line for example enables you to switch back when prices rise. Furthermore "*it's clearly harder for competitors to arise when you own upstream production as a competitor cannot call that producer and say they want the same product*" (Interviewee 8).

Intangible resource optionality

With intangible resources the main recommendation was time. By creating slack in your timeline, you enable yourself to create optionality and to act upon options as they come along. While on the one hand slack in time

makes sure you have space for failure and setbacks, it also enables you to have time to explore new opportunities. For example, as Interviewee 5 said; "*exactly through that slack in time we are going to create optionality, because those people can go and be creative*". Apart from just increasing the time people have using double occupation of roles, as described by interviewees 8 and 9, one can also create this extra time in which one occupant can work on the daily tasks and the other on being creative within the role.

A second aspect is to create diversity. "*You want to have as much diversity in profiles working together as possible, otherwise you are in silo's ...it's not necessary to have many different ideas, but you need different profiles*" states interviewee 3, which is confirmed by interviewee 8, "*you want to have a diverse team instead of a mono-culture with people that have the same thought process ...people who see things ahead of time are often people from outside the discipline*". Thus, having diversity enables you to recognize optionality better and is in itself an option. But also, diverse skillsets and cross-functionality in teams enables optionality through having multiple teams that can work on different solutions simultaneously.

Two other intangible resources of optionality are events and media. Events are classic examples of optionality where there are "*fixed costs upfront and unlimited upside*" (interviewee 6). And media attention, as described by interviewee 8; "*Another option we take is through media. We are doing a lot of interviews in English and articles in Germany and Switzerland ...the long-term strategy is to become an international company ...so when we want to expand to these countries someday, we already have a solid reputation that helps opening up that market.*"

Skin in the game: Structure

The next parts are about skin in the game and how to structure an organization in order to stimulate it. Four aspects will be discussed below, how to organise decision power, how to create shared responsibility, how to organize hierarchy and the pay of your employees. Again, many solutions have touch points or overlap, as the beneficial aspects of one measure often have spill over to others. What is important to note on the chapters about skin in the game is that there was a focus on humane implementations. Inhumane examples and examples that do not fit labour laws of many a country are easy to come by but are less interesting and unpractical. For example the tale of Hammurabi (Taleb, 2012) or tying an employee's complete salary to its output. Therefore, in the interviews there was more focus on innovative ways to increase skin in the game.

Decision making power SITG

Two aspects are important according to the interviewees in organising decision-making power. Decentralization and autonomy. Decentralization of decision power has multiple positive effects. "*Decentralise decision making, especially on subjects not related to core activities*" interviewee 5 answered, because this frees up space, but also ensures that people who are responsible for those activities really have ownership of them. People who have ownership of something are also oftentimes the people with the best interest of making the best choices, because the effects influence their lives the most. So "*the mandate to decide should lay with the people who have the best interest in making sure a choice turns out correct*", interviewee 5 continued, "*and make sure you empower people at the right level."* An important factor here, he continues, is to *"make sure there is balance between shared knowledge and decentralized decision making*", because empowering employees to make decision without sharing the necessary knowledge with them will lead to faulty decisions. Holacracy does a good job of decentralising decision-making power, "*in Holacracy authority is given to roles not people*" illustrated interviewee 9, and since often the roles on the frontlines have the most authority, this is automatically implemented on the right level. Another positive aspect of decentralization is that more people have an image of where the company is, what it is doing and where it is going. This creates a shared understanding, which can improve skin in the game.

This autonomy is crucial in making this decentralized decision-making work. As interviewee 9 put it; "*it's about not being in a difficult hierarchical structure, where even if you have these roles, you have this unnecessary delay in decision making because you need to account for your actions to a manager ...A lot of companies, when you start working, break down intrinsic motivation by difficult performance programmes, hierarchical structures and managers that need to show their opinion matters, causing you to have no authority to decide about the thing you applied for."* So, employees need to have autonomy in the decisions they make, otherwise this greatly reduces skin in the game and general employee happiness.

Shared Responsibility

The second aspect is to stimulate and create (a feeling of) shared responsibility within the organisation. The primary method to do that is by getting the support and involvement of everyone involved in decisions. As interviewee 3 put it; "*you want to have as much support as possible from all involved parties, at the same time, with the same information*." This way employees "*feel ownership of what they do ...what do our advisors think if it? People first, we also want to keep working fun*" (Interviewee 9). A method for doing that is for example soundings, as interviewee 6 described; "*Generally we do that by taking soundings. Say in Singapore we have maybe 4 or 5 people, we would talk to them and say look since employee X retired, or has become a grandmother once again, we could use somebody extra. Or alternatively we would say there is a sector of the market which we are missing out on, say, we have nobody for the high-tech. Are you okay with taking someone new in. That is the way we do that*." Additionally, the consent method, or the use of a decision-making protocol involving amendments such as in Holacracy create a shared base of support for decisions.

Other methods increasing skin in the game focus on the hiring and feedback process. "*Hiring new employees together is next to a form of redundancy ...also a form of skin in the game*", interviewee 8 told, "*you hired someone together and thus you are all responsible for the functioning*." This also relates back to what interviewee 9 said, feedback should not come from "*managers or HR, but from the colleagues you work with. Because they know best who did what and how people functioned ...they know about the changes in circumstances that people have*

had". So, by involving more employees in the process of hiring and providing feedback, skin in the game increases as everyone has ownership of their performance as well as that of others.

The last aspect of shared responsibility reaches back to the basics of skin in the game, tying the results of one's actions to the person who decides on the action. For example, the DevOps function, that ties together two functions that have skin in each other's game. However, interviewee 4 was sceptical, "*DevOps is a nice direction, but it's also ... kind of a utopia. It's a nice direction but not perfect. For example, you have this great developer and suddenly he needs to also support his solution. That is not that good*". A solution however is also proposed by him; "*The simpler solution I have heard about is to not make the same people support the software as the ones who developed but only sit them together. So, they become friends and they have discussions over coffee. It is much harder to do something behind the back of the guy who you discussed the recent game of thrones episode with than with some random guy from a different hemisphere*." This is supported by an example of interviewee 2; "*An example I encountered was someone who built sluices ...but the man had never set foot on a boat or talked to a skipper. He only had 100% technical perspective. The least you can do the, is to connect these functions to the work field. That's not 100% skin in the game, but it is a step forward*." And another solution to cater to this was given by interviewee 5, who gave the example of Colruyt, a supermarket from Belgium. "*Before becoming a manager there, you need to work for a year, where you change positions every 6 weeks. After a year and somewhat more you are effectively general manager...he is really embedded in the culture of each unit, he knows the people*." So, another way to create skin in the game is to let people experience all facets of an organisation to get a real understanding of the workings.

Hierarchy

Hierarchy can have detrimental effects on skin in the game. As described before, engagement stems from autonomy and shared decision making. Hierarchy can undermine this. Managers can become "*single points of failure in a Taylor-oriented organisation*" (Interviewee 1) and often "*the layers of management have more with hiding and covering your fragility than alerting you too it*" (Interviewee 6). However, there are several ways to counter that. Just as with connecting people to their respective areas of work, the GEMMA principle from lean management "*states that managers should also be physically at the workplace to get a better idea of the value stream*" (Interviewee 5). Another important aspect is to recognize and counteract not only the formal, but also informal hierarchy, for example the HIPPO (Highest paid person's opinion) effect. But this can be counteracted by implementing practices such as the ones suggested by Interviewee 8, switching the leadership role regularly or primus interpares, recognising and respecting the seniority and experience of certain employees but positioning them with the same privileges and authority as everyone else.

Pay

There has been a lot of research in what motivates people, and many have proven that for more difficult work extrinsic motivation such as pay do not give the desired results (Pink, 2012). Therefore, innovative ways to organise the payment of salary and bonuses might increase skin in the game. For example, interviewee 2 gave the example of *"teams dividing their salary together. That gives a lot of interesting conversations and literal appreciation of each other*." Interviewee 8 and 9 take a different route in their company; "*Ways of coupling salary to performance is contra-productive as for example Daniel Pink has shown*" (Interviewee 8) and "*Especially uncoupling the reward from production is important*" (Interviewee 9), because this creates perverse incentives and does not lead to better results.

Another aspect of pay in organisations are bonuses. About this too, the opinions are divided. Interviewee 1 proposed "*making bonuses dependent on team functioning. Because on one hand for skin in the game you need to couple it to something, but on the other hand it needs to be on the basis of the team, on the basis of what they contribute*". The practice of offering stock options only works for start-ups Interviewee 4 claims; "*I have seen in many corporations tried solutions such as that you could buy options for their stock. But in a company, such as ABB, that is such a huge corporation, that the decision of one small department in a regional office has absolutely no impact on the price of the stock of that company. So, there is no relationships. They could do shitty work, but the stock could still go up. No stock options program would work. Even on the CEO level they will benefit from hiding all the wrongdoing, so the stock price won't go down ...I think start ups have the most skin in the game,*

and this is also not because many people have shares, although this happens. Very often this is something called bested shares, so you have to for instance, stay for 5 years to actually receive your half percent, or your one percent shares. So, they have in such situation a lot of skin in the game." Others say that this system of shares can be functional in somewhat smaller companies, when there is no hierarchy, as interviewee 8 describes; "*everyone who works with us gets 1 point worth of shares a year, no matter your seniority everyone gets an equal amount*."

What ultimately is important is that these structures do not promote wrong practices, as interviewee 4 emphasizes; "*otherwise when it comes to bonuses or stock options there is always a problem. There are so many ways to exploit it and the typical position that has the huge amount of the salaries tied to the bonus are salespeople. And the typical incentive for salespeople is to sell everything that is possible without facing the consequence*s". Employee 5 supports that, "*it is not correct that one person then would get a bonus for the work of an entire team ...it is up to the strategic management team to make sure that the structure guides the employees via the way of least resistance to the goals that benefit value creation for all*."

More innovative ways of looking at salary are thus necessary, but maybe we need to even take a step further some say, such as interviewee 3 proposes to work with "*independent contractors, they have automatic skin in the game.*" Or "*more flexible ways of working and structuring of work*" as interviewee 2 calls it. The best advice about this came from interviewee 6, to keep "*an open mind of what an organization might be*" in order to achieve more skin in the game.

Skin in the game: people

Skin in the game is primarily a human aspect and as such the focus will lie on people in the next two parts. First the choice of people and how to enable people to make a choice about having skin in the game or not is discussed. Second, we talk about culture and how to create a culture that creates skin in the game.

Choice

Currently the division of skin in the game is unequal. As Interviewee 2 illustrated; "*our whole society is structured that 80% of the time someone's skin is not in his game. Take the average board member, when he does something wrong, he doesn't feel the consequences. He will have another position in no time*." But on the other hand, many interviewees highlight that skin in the game should be a choice. As interviewee 3 put it; "*You need to give people a choice. You have people that say I just want to work and for me the most important thing in life are my children and that I am there for them at 4 o' clock. And those people do not seek skin in the game and that's fine ...and there's another category of people that like their job and are ambitious. To those people you can offer skin in the game and they will probably like it.*" The thing many interviewees emphasized is that when you want to implement this skin in the game humanely, people should have this choice. When they don't want it "*It's fine, not everyone is a risk taker. Because that is often what it is ...some people find having that salary and that security preferable"* (Interviewee 7).

When you want to implement skin in the game with people, some options are pretty obvious, such as working with independent contractors "*then you inherently have that skin in the game because of the financial* structure" (Interviewee 3). But that also works the other way around, then they "*are responsible for developing their own business*" (Interviewee 6). Entrepreneurs and start-ups have the same characteristics, on the one hand *"I have got money and shares invested in this, so that's a clear skin in the game*" (interviewee 7). And on the other hand, interviewee 4 highlighted, "*regular employees of start-ups they also have a lot of skin in the game because they believe in it. And very often they are enthusiast and idealists that want to work for a company that earns some prizes and works for a goal*."

Some interviewees highlight the possible downside as being crucial in creating skin in the game. Interviewee 7 stated; "*with skin in the game it's crucial that you have something to lose ...for employees that is not the case. The only thing they stand to lose is a nice workplace. But on the other hand, when the company does really well, they also do not benefit directly from it, except for maybe that the workplace will become nicer. And that is fine.*" So there needs to be a mechanism for those that do choose skin in the game that enables them to also lose something. For example, buying or receiving shares. However, when a company gets too large, your performance does not influence the value of that share anymore. Another suggestion for this came from interviewee 6, "*Before they begin with that, they have to invest in that, they have to pay for that*", in this case that being a specific skill/course the business teaches them.

A different angle came from interviewee 4; "*What comes to my mind too is very often those SME's are owned by families. Those are owned by the family and then you have this factor of 'this is my name on the brand' and they want it to be successful,*" because they, "*would be ashamed to go bankrupt. So {they} tried really hard. And this is the same for many family companies. If it is the name of your family on the line*." A last method was mentioned by interviewee 7, in which you offer products that people also lease; "*And we also try that with products we offer. So not that people buy our product and that they have that product for five years. No ...we want that people stay with us because we are the best. And that makes it that our products can also be terminated when they want."* This way you have to continually provide the best service and products.

Culture

The second aspect to consider when talking about the relation between people and skin in the game is culture. Several aspects were highlighted. The first aspect is that goals and interests need to be aligned throughout the whole company and up to the top. For example, interviewee 1 told the following story: "*I have literally asked a manager once, after making a decision, you also work for this company, right? Yes of course he replied surprised, on which I said to him, but that decision that you made, that's not in the interest of the entire company right? You saw him thinking and finally realising that it was only in the interest of his department. But that was the thing that*

he was evaluated on. So that happens when goals and interests are not aligned on all levels." So, it is important to create "*clear goals, that fit the greater goals and that everyone knows them",* said interviewee 5, "*and it isn't enough to announce those goals once a year with your employees. You need to constantly communicate and repeat, this is where we are at, this is what we are working on, and this is where we want to go*." Several ways to do this were proposed, for example value stream mapping with which "*you can make sure that the value that a company produces is outlined from beginning to end and that there is one team responsible for the entirety of a process*" (Interviewee 1). What is also important, is to "*make clear, so we move towards accountability, who is doing what and when you want to make someone accountable for something, make sure that person has the most benefit from doing a good job*", that aligns with the companies goals emphasized by interviewee 5.

A second method was to increase employee engagement. Although some interviewees were sceptical because "*the only thing they can lose is a nice workplace* "(Interviewee 7), others shared the opinion it's possible, by creating an almost "*cult-like culture*" (Interviewee 8). Several aspects of such a culture were discussed. The first one being that having a strong culture, often also increases camaraderie and thus friendship between employees. Since you work every day with these people, having friends at the workplace increases people's incentive to stay at the company and their motivation.

The second aspects are the values a company has. That is a tricky part as shown by several comments from for example interviewee 4, *"Values for instance. And I mean then values that really work and that are true. That sometimes happens and sometimes not. Sometimes values are big bullshit. And sometimes people genuinely believe in them*", or interviewee 9, "*With a lot of companies you see that when it really matters that those values, who no one ever remembers, are thrown out of the window. And that things like shareholder value are the most important after all*." So, it is important to really think from those values. Interviewee 5 illustrated this by saying; "*Principles, that's your culture, your values as a company. People need to know those and not change them every two years. How that translates to practice is subject to change of course, you grow and have turnover internally and externally, the context changes. But those principles, those values shouldn't change. Otherwise you have chosen the wrong ones*." One example of values was presented through the single rule of interviewee 8; "*Our golden rule is, treat others as you want to be treated, use your common sense and when you still don't know it ask your colleagues."* According to interviewee 9 a good place to start is autonomy, mastery and purpose, "*when you implement those three completely and treat people as you would like to be treated then you will increase in performance at all areas of your company*."

These three aspects came back in other interviews as well. Autonomy is important to feel the ownership as has been mentioned before. "*It's independence, they have control*", as interviewee 6 mentioned. Mastery is also important, including the acknowledgement of that mastery through autonomy, so employees need to be "*skilled and competent at their kind of work*" (interviewee 6) for that to work. Nonetheless, the most important one is purpose, as interviewee 4 explains, "*regular employees of start-ups they also have a lot of skin in the game because they believe in it ... very often they are enthusiast and idealists that want to work for a company that earns some prizes and works for a goal*". "*It is about what I do matters and what I do contributes to the company",* illustrated interviewee 9, *"someone is constantly looking for purpose, for meaning*." And that makes that people have something to lose when they work at a company that implements this, "*because you lose working on that bigger purpose."*

A last aspect that is important is the psychological freedom that has been discussed before. "*You need to create a psychological freedom to enable people to speak their minds*", interviewee 3 stated, "*and they need to believe they can make a change ...they need to be able to have a free discussion with their managers and colleagues about how to structure the vacation or the new teams*." It also relates back to the fault-accepting culture, "*people need to know it is okay when things go wrong*" (interviewee 7). So, to create cult like employee engagement, the above strategies can be applied in order to create more skin in the game for your employees.

Other

Many interviewees also highlighted some other aspects of antifragility for organisations. For example, interviewee 1 emphasized that you should first work on reducing fragility before enhancing antifragility. Furthermore, he emphasized the importance of non-linearity, situations with inherently more upside than downside. Interviewee 3 talked about heuristics and that "*you can't calculate it*", with "*it*" being anything at all. Other aspects that were mentioned were the barbell strategy, large parts in very safe situations and small parts in very volatile assets, and healthy paranoia, for example through avoiding neo-mania by expecting things to be wrong with new things at first.

Aspects discussed by more than one interviewee were reducing information noise, simplicity, and the prevention of stripping oneself from randomness. As interviewee 4 put it "*I am also a big fan of reducing information noise. So, I try to moderate my information intake*", as decreasing information intake decreases the chance of reacting to normal variation. Interviewee 7 agreed saying; "*The problem is that when you have metrics, you want to do something with it. And I get where that comes from. But it would be better when you don't collect the information, then you can't act on it*." A second item these interviewees agreed on was keeping things simple, and to not try and plan "*5 years ahead*" (interviewee 4). The last point of focus was to prevent an organisation to strip itself from randomness, as this introduces fragility. Both because "*you will fail in it and this will cost you a lot*" (Interviewee 4) as well as that by not reducing variation you create practices to deal with this variation, which makes you more antifragile as supported by interviewees 7 and 8.

Communication

It was also interesting to note how some people experienced the communication around antifragility. Some, like interviewee 3, do not even communicate it because it is too difficult; "*But we don't communicate it like that to customers. Then you would spend an hour to explain it first*". And oftentimes, even when people do try to explain it, they do not completely understand the concepts, as illustrated by interviewee 2; "*people then often ask me, okay but how do you do antifragile then? But nonetheless, even if they only take on a couple of aspects, they become more antifragile*." However, having that discussion is very difficult as illustrated by interviewee 1; "*you notice that an average manager sees a lot that he recognizes if we break it down to concrete steps ...but the moment I tell him that he is already quite antifragile it becomes too theoretical for them and we lose them "* and by interviewee 4, *"When it comes to lack of some financial margin it is obvious for people to see, but when we discuss this other problem during a workshop they will nod their heads but not do anything about it, it is just too difficult*." Making antifragility more known and a standard tool in the vocabulary of future managers will therefore be an important aspect for this method to become more ingrained in today's economy.

4.5 Conclusion

In this chapter, sub question three was answered, "*What strategies, practices and insights for increasing antifragility as a company can be found by analysing the strategies and practices of companies through primary sources?*"

One of the main findings of the interviews was the creation of a categorization structure that was not identified before. Both redundancy and optionality have the two sub-concepts of organization and resources. Organisation is about the structures, practices, and acts that a company can do to increase that specific aspect of antifragility. Resources on the other hand are about which resources are fit to invest in, or which actions can be taken in regard to resources, in order to increase the concept at hand.

With skin in the game there is also a dichotomy, in this case between structure and people. Structure encapsulates how to organise the organisations in order to create more skin in the game. People is about the aspects of an organisation that relate to people, their choices and how to make them have more skin in the game.

Closing this chapter are a recollection of remarks on how the interviewees communicate about antifragility in their professional life, emphasizing the infancy of the field and theory. In addition, an overview has been provided about remarks relating to other concepts of antifragility and on how to implement these in an organization, which could possibly be an inspiration for future research.

For each of these sub-concepts several underlying themes were discussed and correlated with each other. Using triangulation between the different interviews and Chapter 2.1 Fundamentals of antifragility the concepts and strategies were discussed, defined, and validated, answering sub-question three.

5. DISCUSSION

Antifragility introduces a new way to look at the entirety of the field of strategic management. It's a new attitude that moves away from efficiency and specialization and towards being flexible and avoiding fragility. As the antifragile lens is very new in strategic management, fundamental work still needs to be done before its widespread adoption. In this thesis some of these fundamental mechanisms have been investigated.

The aim throughout this thesis has been finding an answer to the main research question, *what underlying mechanisms drive antifragility in strategic management through the concepts of redundancy, optionality, and skin in the game?* This in order to understand through which mechanisms organisations can create more redundancy, optionality, and skin in the game in order to become more antifragile. Thereby enabling organisations to become better equipped at dealing with a constant changing environment. In order to answer this question several steps were taken.

Each of these steps resulted in several insights, strategies, and conclusions. Each of these steps was executed on its own with minimum interference or building on previous conclusions. This approach has been chosen in order to be able to triangulate between three different sources of information, concluding something on the basis of two or three different information sources increases validity tremendously. This is necessary as the field is relatively young and thus the information available is minimal.

In chapter 2.1, the current literature was structured creating both a basic understanding to build on during the rest of this thesis, as well as a deeper understanding of what the concept of antifragility entails in a business environment. Additionally, a common vocabulary was created and inconsistencies in definitions were resolved. The value of this work lies in the common ground it creates for this and future research.

In chapter 2.2, sub question one was answered; *What is already known about antifragility in the field of strategic management and related fields, and what insights can be created by combining them?* The aim was to create both an overview of the work on antifragility in strategic management and related fields, as well as create a deeper understanding of the general tendencies underlying these. New insights were created by comparing and structuring the current literature on antifragility and how this related to strategic management. For optionality, short feedbacks loop & trial and error, real option theory, and the expansion of skills and capabilities were identified as strategies. For redundancy, tinkering and overreacting, project management strategy adjustments and decentralization were identified as strategies. And for skin in the game, increased responsibility, and freedom, and tying the work directly to the person were identified as strategies. These insights are new to the field and thus of added value to both the literature and this research.

In chapter 3 sub question two was answered; *What strategies, practices and insights for increasing antifragility as a company can be found by analysing the strategies and practices of companies through secondary sources?* To answer this question case studies were done on Haier and Zappos. For both companies, extensive literature was read and collected in order to create a description of their strategic management practices, strategies, and their relation to antifragility. This was done in order to identify practical applications from real world cases through secondary sources. In chapter 3.3 the case specific findings were then combined in the conclusions, creating new insights on general strategies to increase optionality, redundancy, and optionality. Six strategies were identified: having a culture of continuous change, creating an internal marketplace, having small-scale self-managed teams, creating redundancy in workplace skills, diversifying, and implementing Holacracy or similar organizational forms. These general strategies are identified for the first time in relation to antifragility for strategic management.

In Chapter 4, sub question three was answered; *What strategies, practices, and insights for increasing antifragility as a company can be found by analysing the strategies and practices of companies through primary sources?* By interviewing antifragility practitioners, a completely new set of information and insights was collected. First of all, many practical strategies, practices, and other concepts were collected increasing the pool of hands-on options that can be used in future research or by organisations. Second, information from the interviews was bundled in order to create generalized insights that answer sub question three. Third the analysis of the coding revealed a new

structure of classification of the three concepts and their sub-categorization of strategies practices and other aspects.

Redundancy could be divided in organization and resources. Under organisation the following sub-concepts were identified; creating redundancy in decision making processes, locating the right place of redundancy, practices that increase redundancy, and how to balance redundancy with efficiency. Under resources, there was a dichotomy between intangible and tangible resources, each providing their own way of introducing redundancy.

Optionality could also be divided in organisation and resources. Under organisation of optionality the following sub-concepts were identified; diversifying to increase optionality, structures that influence optionality, practices that influence optionality and how to balance optionality with efficiency. Under resources the same dichotomy as with redundancy was found.

Skin in the game can be divided in structural aspects and in aspects regarding people. Under structural aspects, the following sub-concepts were identified; influence of decision making on skin in the game, hierarchy, shared responsibility, and pay. Within people, choice and culture were identified.

Throughout the thesis the concept of antifragility has been used fluidly as a standing definition is hard to come by. Antifragility in that sense is not defined enough to be categorized as a framework, paradigm, or decision-making strategy. Antifragility should be seen as an approach to processes, in which one acknowledges the biases and assumptions that underly them, especially that nothing can be predicted, and thus minimising variation is not a viable strategy. In order to guide this approach several aspects of antifragility have been conceptualized, of which optionality, redundancy and skin in the game have been the focal point of this thesis. As such, in strategic management, one could argue that antifragility is a decision-making strategy. This is primarily influenced by the fact that the field of strategic management has a focus on decision making for the future, and less by the intrinsic characteristics of antifragility. For the propositions, as stated below, antifragility works mainly as a guidance or attitude towards decision making, helping managers to look at problems from a different angle.

5.1 Answering the main research question

The results from the three sub questions can be used to answer the main research question, *what underlying mechanisms drive antifragility in strategic management through the concepts of redundancy, optionality, and skin in the game?* To answer this question the strategies, practices, structures and mindsets from the three different parts of this thesis were analysed to create propositions that capture the underlying mechanisms that induce the increase of antifragility in organisations through the increase in optionality, redundancy and skin in the game.

The propositions were formed as following. First all conclusions were thoroughly read and summarized. Then all summaries were grouped and structured to show interrelations, similarities, and overlaps. From here on out, the conclusions from the different sources were combined taking the functional examples and conclusions, and form higher level conclusions that are captured in propositions. Eventually two major propositions were deduced. The process and connections are discussed below. The final product consist of two primary propositions and 24 sub propositions divided among them. This is a particularly high amount, however deemed necessary. The conclusions from the desk research, case studies and interviews overlapped significantly, weaving a comprehensive narrative with several building blocks, leading to sub-propositions which in turn lead to the major propositions. Therefore, it wouldn't do justice to the complete argumentation to reduce the number of propositions, and as such they are presented as below.

Dealing with variation

When structuring and grouping the evidence, examples, and outcomes from the research, there were many themes with a certain amount of overlap. Many themes revolved around one simple principle: moving the focus of a company from preventing variation towards embracing it by making sure that the structures, practices, strategies, and mindsets are aligned to deal with this variation. To absorb it, or to bend it in a good way. This is not a new insight, as this is stated as one of the main focuses of an antifragile system, but a fundamental one, nonetheless. Furthermore, dealing with variation instead of preventing it is at the core of the concept of antifragility, but has not been identified as a core of antifragility pertaining the field of strategic management. Therefore, it is fundamental to include this in the propositions, in order to ensure a complete and secure argumentation.

The first major proposition is thus.

1. **A focus on dealing with variation instead of reducing or removing variation with regard to strategies, practices, structures, and mindsets, can increase a company's antifragility.**

Three propositions underline this, a focus on experimentation, a focus on building redundancy and optionality through diversification, and a focus on decentralized decision making. Each proposition has several sub-propositions. These sub-propositions create added value by identifying the underlying strategies and mechanisms organizations can use to become more antifragile.

Experimentation

One of the main underlying principles of antifragility is to experiment. This already became clear for redundancy in the desk research as described by among others Tseitlin (2013), Blečić & Cecchini (2019a) and Bridge (2018). Through experimentation many aspects that increased fragility, such as single points of failure, could be identified and resolved. Also on the optionality side there are some aspects increasing antifragility, with real option theory (Babovic et al., 2018; Gorgeon, 2015) and a focus on trial and error with small feedback loops (Bridge, 2018).

The case studies also highlighted that experimentation and a setting that provides for continuous change increased the antifragility of organisations and that these strategies were viable. Two important aspects here are that Haier and Zappos initiate change from a position of strength (Crainer, 2015; De Smet & Gagnon, 2017) and that they utilize very short feedback loops that are ingrained in the structure (De Smet & Gagnon, 2017; Frynas et al., 2018), which increase the chance of success significantly. One particular example that resonates and has overlap with results from the interview is the internal marketplace that both initiate, Haier in the literal sense functioning as a start-up incubator (Crainer, 2015) and Zappos through crowdsourcing new initiatives (De Smet & Gagnon, 2017). Either way, a combination is made of autonomy of the employees, short feedback loops and continuous experimentation of plans not designed in a long-term manner. Next to creating multiple options which increases optionality, this induces redundancy as some of these projects can fail without harming the company and necessary skills overlap between entities.

The interviewees confirmed many of the conclusions from the literature research. For example, in *redundancy – efficiency balance*, the interviewees mention that building redundancy should be done in an experimental manner, since deciding the right balance upfront is almost impossible, as the desk research already established in the conclusions about the *redundancy – efficiency ratio*. And in *practices optionality*¸ interviewee 1 emphasizes this focus on experimentation with regard to optionality as these experiments should become "*a non-issue, since you do it so often*". An important remark made by interviewee 2 is highlighted in *structure optionality*, saying that experimentation, optionality in the exact quote, invites fragility. Thus, it is important as a company to make sure you have a certain level of robustness, thus of redundancy, before engaging in experimentation. You should always be able to absorb failed experiments, especially regarding optionality, as is emphasized in *optionality – efficiency balance* by interviewee 4;" *introduce in your selection criteria, would I be able to back off from this?"*

An interesting insight in *structure optionality*, *optionality – efficiency balance* and *practices optionality*, is presented by the interviewees, that organisations can use strategies and methods that normally are used by start-ups, to foster the kind of continuous experimentation that is antifragile. An example that was given multiple times was the lean start-up method, focusing on short feedback loops and quick testing with low stakes.

Lastly, it was emphasized that an organisation needs both a structure that promotes experimentation and a fault accepting culture in *practices optionality* and *structure optionality*, as well as in some of the skin in the game parts. Similarly, as illustrated in the case studies, within Zappos (and Haier) there was not only a structure that enabled experimentation, it was also widely ingrained that failure was accepted and that this didn't influence one's performance review or salary. This is supported by several interviewees, stating that without failure you cannot have successful experimentations. Important is thus the combination of these factors. These conclusions lead to the following proposition and sub-propositions

1.1 A focus on continuous experimentations with regard to strategies, practices, structures, and mindsets, can increase a company's antifragility.

1.1.1 Implementing short feedback loops into structures and practices can help companies integrate continuous experimentation.

1.1.2 Preventing experiments to occupy more resources than the company can afford to lose can help companies to integrate continuous experimentation in an antifragile manner.

1.1.3 Having both a structure that allows for continuous experimentation and a fault-accepting culture can help companies integrate continuous experimentation

1.1.4 A good source for strategies, practices, and structures to implement continuous experimentation can be found by looking at start-ups and start-up strategies.

Build redundancy and optionality through diversifying

The second underlying aspect of dealing with variation is to have a certain amount of robustness to be able to absorb or even benefit from these variations. The main strategy to obtain these two in the conclusions was to focus on building redundancy and optionality through diversifying.

The first problem that arises when talking about diversifying is something that is also concluded about redundancy in the desk research on *Redundancy – efficiency ratio*. As diversifying often means less efficiency and there is still no definite measurement method to decide on the antifragility of a company, the balance between efficiency and redundancy is quite difficult to establish. To establish this balance many of the interviewees point towards experimentation to establish the right balance, and especially to continuous experimentation to be able to adjust to the continuous change a company deals with. Diversification in this sense creates antifragility through creating both optionality and redundancy and by transferring fragility from the whole to the parts, as described in the case study conclusions under *Diversification*. But only under the assumption that one diversifies in such a way that one can absorb the failure of one component. This is also emphasized by the interviewees in *Diversify Optionality*.

Two other aspects that regard diversification and the balance a company must strike with it are argued for by the interviewees in *Redundancy efficiency balance.* The first aspect is that many companies have redundancies and diversifications in the "wrong" places. As such a lot of slack can be won by removing these, and as a benefit the process becomes more clear after this as "*this surplus of unnecessary redundancy it clouds the discussion*" (Interviewee 1) . A second aspect is that it is important to change one's view from efficiency to effectivity. As illustrated by the case study on Haier, the internal marketplace they have created is not very efficient, as several parts of the company could be working on the same product (Crainer, 2015). However, the process is highly effective as bottom line, the company makes money from the successful ventures. Several of the Interviewees, such as Interviewee 7 and 8 support this.

There are several aspects that organisations can diversify and build redundancy in. One of the cornerstones is to prevent single points of failure as argued by the interviewees in *location of redundancy*. This can be for example done by creating redundancies for structures and resources and by diversifying for income streams and markets.

One aspect of this is building redundancy and optionality through diversifying and creating overlap in the skills and capabilities of your employees. This prevents single points of failure when multiple people can do a certain task. This is for example illustrated in the case studies by Zappos' practice of expanding the skill of customer service in their company to prevent the call centre from becoming a bottle neck and their programme to allow people to expand their skill set (Perschel, 2010). It is also concluded in the desk research on optionality, *expanding skills and capabilities*, comparing it with creating multi-purpose buildings in urban planning and in many parts of the interviews. In *location of redundancy, resources redundancy* and *resources optionality*, people and their skills are mentioned as resources to create not only redundancy in but also optionality through. Having a diversified employee and skill pool also increases a company's optionality, since the skills necessary are available to act upon new chances are then available.

Other resources that are well fitted to diversify and thus create optionality and redundancy through are money, time, and information, as described in the interview conclusions under *resources optionality* and *resources redundancy*. Money is both useful to absorb negative variations as well as to act upon positive variations. However it is important to realise that also within the aspect money, diversifying can increase antifragility. For example, having multiple places where the money is kept, such as in real estate, stock, and cash can help absorb variations on one aspect. Diversifying your information (streams) works from the same principle. Time is an interesting one, which also was identified in the desk research, by realizing that project management as realized currently is very fragile due to the large size of projects and the little amount of buffer time. Not only does an increase in "slack" of time help an organisation to absorb setbacks, it also enables a company to act upon positive variation or use this time to try new projects or options. The connecting characteristics of all above resources is that they are inherently flexible assets. Just as discussed with Interviewee 4, it seems thus that organisations should build redundancy and diversify within and trough flexible assets, and build redundancy around inflexible ones. A

practical example that was given multiple times by interviewees as described in *resources optionality* is to lease, thereby building your flexibility around your inflexible assets.

The last way to increase redundancy and optionality through diversifying that was identified was primarily introduced by interviewee 6, which is to invest in partnerships and networks. This is described in detail in the interview conclusions under *structure optionality* and *location of redundancy*. Partnerships and networks increase redundancy by having the possibility to approach others and use them to absorb negative variation, but also to benefit from positive variations or options. Or as interviewee 6 puts it, "*having a network is like having one big option*".

These conclusions lead to the following proposition and sub-propositions:

1.2 A focus on building redundancy and optionality through diversifying with regard to strategies, practices, structures, and mindsets, can increase a company's antifragility.

1.2.1 Organisations can implement diversifications through continuous experimentation.

1.2.2 Diversifying in such a way that companies can sustain losing (one of) the option(s) can increase their antifragility.

1.2.3 Moving from an efficiency aim towards an effectivity aim can help companies internalise a diversification focus.

1.2.4 Th building of redundancies can be achieved through the eradication of single points of failures.

1.2.5 Organisations can build redundancy and optionality within and through flexible assets and around inflexible assets.

1.2.6 Investing in partnerships and networks could be a form of building redundancies and optionality for organisations.

Decentralized decision making

The last aspect is decentralized decision making, which can increase skin in the game, redundancy and optionality as shown in the case studies. As Haier shows, small autonomous teams and a system of decentralized decision making, increases optionality by being able to do small and fast experimentations (Crainer, 2015). In this way they almost functions like a start-up and, as argued before, those strategies are particularly useful to increase antifragility. As Zappos shows, it increases redundancy by increasing information streams since decentralized decision making often uses the input of multiple people (Hsieh, 2010). Lastly it increases skin in the game through accountability and ownership of employees.

This is also substantiated by the interviewee results under *decision making power SITG*. The interviewees argue that decentralization and the subsequent increase of employee autonomy increase antifragility greatly. First because it creates slack higher up in the command chain, freeing space to absorb variations or act upon new options. Second because it increases the skin in the game of employees, as they now have ownership and autonomy. Important for the second aspect is that that the employees have real autonomy and that this authority lies with the employee that has the most benefit from making the right decision. This is emphasized by interviewee 5 as described in *culture*, "*when you want to make someone accountable for something, make sure that person has the most benefit from doing a good job*". This also means that your goals need to be aligned throughout the whole company to prevent perverse incentives to arise, as exemplified by the anecdote of interviewee 1 in *culture*.

Another aspect important to successfully implement decentralized decision making is that there should be a balance between shared knowledge and decentralized decision making. Without the proper information at the right level, the system cannot work as illustrated by interviewee 5 under *decision making SITG*.

As the desk research also highlighted, decentralization has multiple ways in which it increases antifragility. It decreases the amount of single-points -of-failures, which have been described earlier, or at least make the impact of failures of these points smaller. Also, decentralization enables redundancy in skills and income streams (Babovic et al., 2018). More redundancy is created, as described in *decision making redundancy*, by including more stakeholders, increasing the number of different viewpoints, and thus increasing the chance of a good decision. Furthermore, delaying decision making also increases optionality as described by the interviewees and including more stakeholders often delays decision making. Another aspect in this is that more people understand what is happening in a company and thus information becomes more redundant as well as that people feel more involved, increasing skin in the game.

The optionality of companies is increased because more people having a smaller amount of authority allows for small and continuous experimentation more easily as described by the interviewees in *structure optionality*, and because smaller authorities are more easily taken over from each other when necessary. This is for example implemented in Holacracy by moving from complete jobs to roles, increasing redundancy by making it easier to absorb changes. A different aspect that can increase antifragility in decision making is, as mentioned earlier, delaying decisions, or retaining as much flexibility as possible. Or as interviewee 5 mentioned in his interview, when you can delay a decision with the cost of 500 euro's but that increases the chance you make a better decision worth 5000 then that is of course worth it. Another way is by making choices that might not have the largest pay-off, but make you retain the most flexibility. Then you are focussing more on dealing with variation, instead of trying your chances as described in *practices optionality*.

One form of organising that internalized decentralized decision making in a good way is Holacracy, which of course was shown in the case study highlighting Zappos' integration, but was also mentioned several times by the interviewees. It seems that many of the aspects that increase antifragility discussed in this thesis are internalized by Holacracy.

These conclusions lead to the following proposition and sub-propositions

1.3 A focus on creating a structure of decentralized decision making with regard to strategies, practices, structures, and mindsets, can increase a company's antifragility.

1.3.1 Giving employees substantial autonomy can help implementing decentralized decision making.

1.3.2 Aligning goals and criteria throughout the entire company can help implementing decentralized decision making successfully.

1.3.3 Giving authority to employees or roles that have the most interest in making the right decision can increase antifragility.

1.3.4 A good balance between shared knowledge and decision-making authority can help decentralised decision making succeed.

1.3.5 Decreasing the size of the autonomous units, for example from jobs to roles, can increase redundancy and thus antifragility through the decision-making system.

1.3.6 Delaying the process of decision making and a focus on retaining flexibility can increase the systems focus on dealing with variation, increasing the systems antifragility.

1.3.7 Organizational forms that internalize decentralization, such as Holacracy, can increase antifragility of companies.

Employee engagement

The second major trend in the results focused on the skin in the game aspects of antifragility. For skin in the game there were roughly two opinions voiced in the interviews that overlapped with the systems as presented in the case studies. On the one hand, skin in the game can be easily achieved by becoming an entrepreneur, hiring independent contractors, or by implementing a similar system as Haier did in the case study. Then the link between making the right decisions and the direct impact on you is clear, a classic example of skin in the game. However, having skin in the game this way is not for everyone as interviewee 3 put it, "*It's fine, not everyone is a risk taker. Because that is often what it is ...some people find having that salary and that security preferable*." So, something many of the interviewees emphasized was that this form of skin in the game should be a choice, something more in depth elaborated upon in *choice*.

On the other hand, you have the system of Zappos and of employee engagement as it is coined in *culture*. When employees have a large level of engagement, or a cult-like culture as interviewee 8 put it, they have more skin in the game in a company, as they identify with it, value it's goals, and have a place where they can develop themselves. As concluded in the desk research, employees are more engaged when they have autonomy, responsibility, and room for development. This is confirmed by the interviewees, as seen in *culture*. They emphasize the triad of autonomy, mastery and purpose. Purpose in the sense that they personally align with the goals and values of the company, and that a person finds meaning in what they do. Autonomy, both for the sake of what has been discussed before, and to have a feeling of independence, control, and importance. So they feel that they do something that has that meaning for the purpose of the company. And mastery meaning a place in which people can learn, develop themselves and feel they grow as a person.

Another way of increasing employee engagement is by building a structure that includes the opinions of all stakeholders and that makes a connection between the actors and the "acted upon". Both create a feeling of shared responsibility, as is described by the interviewees in *shared responsibility*. Connecting the opinions of all stakeholders can for example be done by expanding a decision-making process to include all parties involved or by involving a team in the hiring and development of their new member. This creates a shared understanding of the situation as well as a shared responsibility since people that have contributed to the decision feel responsible for its success. Important to consider with this is that people have a certain amount of psychological freedom, as is touched upon in *culture*. To really create that feeling of shared responsibility, people need to have the freedom to act and say as they wish.

The other aspect of tying the action to the acted upon is a variation on the core idea of skin in the game, that the one making the decision should face the consequences. On the one hand, this could be done via connecting roles impacting each other directly, such as DevOps as described in the desk research. Another method as described by the interviewees is to just make a personal connection between the groups, such as placing them in the same room or by having employees make a personal connection with the customer group. This makes that people have more skin in the game with these decisions, or as interviewee 4 illustrated "*It is much harder to do something behind the back of the guy who you discussed the recent game of thrones episode with than with some random guy from a different hemisphere.".*

One important thing to take into account with a system that relies on employee engagement to increase skin in the game, is that it cannot rely on traditional methods of salary and bonuses. Research of for example Pink (2012) has shown that carrot-stick incentive systems do not work with complicated work. As argued under *pay* these systems even harm the antifragility of an organisation through perverse incentives. And these traditional systems could even harm employee engagement. Therefore, more research into more novel ways of pay need to be performed.

These conclusions lead to the following major proposition and sub-propositions

2. **Organizations can implement skin in the game through a conscious decision from employees or by implementing strategies, practices, structures, and mindsets that focus on increasing employee engagement.**

2.1. Traditional methods of pay and bonuses are suspected to not lead to skin in the game and might even hinder practices that create antifragility. As such to increase employee engagement novel systems could be investigated.

2.2. Organisations can increase employee engagement through enabling forms of autonomy, mastery and purpose for their employees.

2.3. Organisations can increase employee engagement through creating a sense of shared responsibility and psychological freedom.

2.4. Organisations can increase employee engagement through connecting actors and the acted upon.

6. CONCLUSION

The environment that managers need to chart in order to successfully lead their company changes at a rapid pace and is very often unpredictable. The tools that these managers have at their disposition are limited and often aimed at reducing variation and predicting changes. However, almost none focus on strategies, practices, structures, and mindsets to work from the notion that you cannot predict the next thing that happens.

This research has aimed to develop the understanding of antifragility, a view that organisations and managers can use to increase their ability to deal with this unpredictability, called Black Swans or unknown unknowns. The focus lays on three of the many aspects of antifragility; redundancy, optionality, and skin in the game. These aspects lie at the heart of antifragility (optionality), go against the current trend (redundancy), and fit the current trend (skin-in the game) of the business environment.

This research made an analysis of the concept of antifragility, through the concepts of redundancy, optionality, and skin in the game. Using this analysis several higher-level mechanisms were identified to achieve a better understanding of what drives the benefits of antifragility. This in order to solve the defined problem that although antifragility in strategic management hold many promises, little is still known about it.

The set-up was to first get an understanding of antifragility in the literature on strategic management and relevant adjacent fields, second to get a view on antifragility strategies through two literature case studies and third to do a qualitative analysis of nine interviews with experts on antifragility or related concepts in order to get more insights into practical and theoretical applications, influencing factors, and examples. The results of these three endeavours were then used to create higher level insights into the mechanisms and factors that influence the antifragility of organisations related to redundancy, optionality, and skin in the game. These were encapsulated into several propositions in order to answer the main research question; *What underlying mechanisms drive antifragility in strategic management through the concepts of redundancy, optionality and skin in the game?*

These propositions have been formed, validated and described in chapter 5 Discussion. Using the conclusions and insights from the three separate parts of desk research case studies and interviews, these higher mechanisms were identified. Due to the fact that in separate occasions substantiations for these propositions have been found, increases the validity of the conclusions in this relatively new field of research. Organisations and managers can use these insights to increase the antifragility of their company, in order to be able to better deal with unknown unknowns, Black Swans, and normal variation in their business environment.

This research as a whole has shown that although there is little quantitative research into Antifragility for strategic management, it holds the promise of great added value for companies and their strategic decisions.

6.1. Implications

Being exploratory research, this thesis has pioneered in many area's and as such has many lessons to be taken from. In the coming chapter the implications and added values for different groups will be discussed.

Scientific value

This research has several areas of value for the scientific community.

First, this research has tried to give a comprehensive and complete overview of antifragility in strategic management, including a critique on the available literature and consolidation of terminology. As such chapter 2.1 Fundamentals of antifragility can be used by future researchers and other interested parties as an overview of the field and as a starting point for more in depth research. Furthermore, the overview of the literature on antifragility in strategic management also highlights which areas are underdeveloped and thus future research is necessary for the field to move forward. This is elaborated upon later under Chapter 6.3 Future Research.

. Also, this research links the field of antifragility in strategic management with other fields that sometimes are more advanced or have different insights on using the concept of antifragility, extending the literature pool and promoting a cross-domain view of the concept.

Second this research is one of the first to translate the explicit concept of antifragility to strategic management and making the step towards practical applications and propositions. Therefore, it opens up a new avenue of research, one that can be put to contrast to other area's of and techniques in strategic management such as JIT or Lean.

Third, next to creating more possible avenues of research and shaping the field of literature, this research also adds to the validity of the concept of antifragility itself and hopefully to the acceptance and notoriety of it. As the concept is quite new and little research has been conducted on it, adding new research and informing more people about it's existence, increases it's spread and maybe it's adoption in the longer term.

This research especially adds value to the perspective of the Management Of Technology programme and subsequently the entirety of the faculty of Technology, Policy and Management. It provides the programme with an innovative and new perspective or tool to look at typical challenges of our field. It can be seen as a dissenting voice from the traditional views and also in itself can be a way to look at different techniques and strategies, and how they relate to each other in a novel way. Furthermore, one major benefit of adding the view of antifragility to the curriculum is that, when understood, it becomes very clear what assumptions and biases underly different frameworks, strategies, and techniques currently discussed in the curriculum, because Antifragility has several of these realisations at it's core. Being more aware of these underlying assumptions as a student and as a professional later in ones career is an extremely beneficial skill.

Societal and managerial value

The research adds to society by enabling companies and organisations to analyse and change their structures, practices, strategies, and mindsets to increase their antifragility. As such companies can create more sustainable, long term growth, with an environment in which employees are engaged in their work and feel fulfilled. And maybe if enough companies implement the ideas from antifragility, a next crisis, comparable to Covid-19, will have almost no impact on the economy, freeing up space to deal with the crisis itself.

The managerial value lies primarily in adding to the toolbox a view that does not focus on predicting the future or influencing it. It adds a view that is used to look inward and adjust the company in such a way that the environment is of minor importance. Each of the propositions has it's own implications and as such each will shortly be discussed, illustrating the impact of accepting the concept of antifragility and moving towards it.

The first propositions states: *A focus on dealing with variation instead of reducing or removing variation with regard to strategies, practices, structures, and mindsets, can increase a company's antifragility.*

The first proposition focuses mostly on how to structure a company and its parts to become more antifragile. This insights represents a major departing from current management wisdom, which is focused on prediction through market research and forecasting, or on minimising changes. Even though the proposition sounds very logical, the supporting propositions show that the most effective manners to implement this are often not widely implemented.

1.1 A focus on continuous experimentations with regard to strategies, practices, structures, and mindsets, can increase a company's antifragility.

This proposition identifies that a practice of continuous experimentation makes a company more antifragile. Inherently this means no structured long-term planning and a preference for quick field tests above extensive customer research. The implications of this are vast as managers that want to implement antifragility needs to be critical about their current structure and preferences. As seen in the sub propositions, several factors influence a successful implementation, with a larger focus on sustainable growth and n environment in which mistakes are celebrated. Companies and organisations can use these insights to improve their company on every facet.

1.2 A focus on building redundancy and optionality through diversifying with regard to strategies, practices, structures, and mindsets, can increase a company's antifragility.

This proposition identifies that a company becomes more antifragile when it doesn't put all its eggs in one basket. As discussed in many companies this is overlooked in certain areas such as staffing, or even explicitly done the opposite as more and more companies focus on specializing. The antifragility lens shows that these strategies rely on certain assumptions and predictions and that when unknown unknowns appear, the company might not survive. The implications are that companies can take measures such as investing in their networks or changing from an efficiency to an effectivity aim, in order to achieve better antifragility.

1.3 A focus on creating a structure of decentralized decision making with regard to strategies, practices, structures, and mindsets, can increase a company's antifragility.

The last supporting proposition highlights primarily implications influencing how a companies hierarchy and decision-making authority is distributed. It shows that to really move towards successfully working with variation, employees need to have more freedom and authority to adjust as they see fit. Not only makes this for a more enjoyable workspace and more skin in the game, it also promotes experimentation and eradicates major single points of failure in a company. Factors influencing successful implementation of decentralized decision making are focused on enabling employees to make the best decisions possible, without creating perverse incentives or withholding information from them.

The second proposition states: *Organizations can implement skin in the game either through a conscious decision from employees or by implementing strategies, practices, structures, and mindsets that focus on increasing employee engagement.*

This proposition focuses on the creation of skin in the game. One central aspect there is that skin in the game in the traditional sense, where rewards and punishment are directly connected to one's actions should be a conscious choice of people. If not, it is considered unethical. The other aspect is that skin in the game can also be created by employee engagement. This is illustrated by the often-high skin in the game with scale-up employees and companies with cult-like-cultures. Factors influencing this, focus on creating an environment in which employees also thrive to implement practices that support proposition one. Next to adding to the antifragility lens, this new way to look at employee motivation hopefully also adds to the vast pool of literature on this subject.

In essence this research implicates that the current standard for companies or organisations; working from hierarchical structures, with long term planning, hyper specialization, and an efficiency mindset, are actually very fragile and thus susceptible to bankruptcy once variation increases. Although there is no collected evidence yet, the effects of the corona-crisis show that currently companies are not able to survive and are badly equipped to deal with large variations. As many conclusions and propositions sound very logical, it is surprising to see how far off organisations currently are. Hopefully, this thesis can be the start of a change towards a more antifragile future.

6.2. Limitations

As the research done is relatively new, truly little amount of research is available to guide and evaluate. Furthermore, the quality of many papers is questionable, primarily in the application of antifragile terms and concepts to the business environment. The author has tried to highlight and resolve these problems as much as possible in the desk research. However, the number of sources to draw from is thus minimal.

Another limitation is the amount and selection of interviewees. Since antifragility is so novel, not many professionals have implemented it into their work, therefore finding and interviewing these people has been a challenge. Therefore, primarily the most enthusiast implementors and first adopters were interviewed, creating a bias in person. Secondly, with such a wide scope the limited number of interviewees can also easily introduce bias into the research.

Furthermore, this research is biased in favour of the antifragility paradigm and as such there is limited talk of the negative sides of antifragile approaches. One of the disadvantages as described is the focus on organic growth without debt, thus realizing slower growth than with other strategies. A second disadvantage is that antifragile approaches may be too costly in the case of simple and predictable systems. However, since there is no measurement method yet that is widely accepted, these kinds of limitations can not yet be attributed to antifragility with certainty. This highlights the central reason why there has been little attention to the disadvantages of antifragility in this thesis; there is not enough known yet to say with certainty what are the disadvantages. It is to be expected that as research furthers, several situations and conditions will be discovered in which the approach is unfit.

6.3. Future research

The research as presented is almost unique and thus the concepts are quite broad. This has two consequences. First many of the concepts are interrelated quite intensely and as such dissecting that to come to singular propositions is a hard task, especially when there is disagreement over many aspects. Therefore, the interpretation as presented above is just one of many ways in which it could be interpreted and thus future research that replicates or re-analyses the interviews and information might be beneficial for the field. Second because these are some of the first steps into antifragility related to strategic management and a wide array of interviewees was consulted, there are many open ends and potential subjects for future research.

First off several of the above propositions invite for more in-depth research. For example, the relationship between effectivity and antifragility is interesting to dissect further, to decide whether effectivity is indeed a prerequisite for antifragility, or that the relationship is more complex. Also, the relationship between Holacracy and other organizational forms such as the one presented at Haier would be an interesting lead for future research. Related to this, the notion that the creation of smaller roles instead of job descriptions is something that is expanding further than just Holacracy, might entice interesting research that then can be looked at through an antifragile lens.

Furthermore, the insights that a networked organisation can have many interesting lessons for the implementation of antifragility into strategic management are worth more attention. When it would be clear how the relationships, responsibilities and autonomy relate to each other in such systems and how to translate that effectively towards more traditional organisations, it would give us more insights in how to take that antifragility of an ecosystem into more organisations.

The literature on promoting innovation in large corporations is vast and thus proposition 1.1.4 *"A good source for strategies, practices, and structures to implement continuous experimentation can be found by looking at start-ups and start-up strategies",* could be validated by that, and it could be criticized whether more is necessary than simply copying the strategies to increase antifragility. The same is true for employee engagement. The triad of autonomy, mastery and purpose is widely known and thus an analysis in whether this increases skin in the game, or even whether employee engagement is even a good vehicle to increase skin in the game could be done by future researchers.

One of the least elaborated upon propositions is proposition 2.1: *Traditional methods of pay and bonuses do not create skin in the game and might even hinder practices that create antifragility*. As such to increase employee engagement novel systems should be investigated. Future research into the different methods of pay and bonuses could give remarkably interesting insights that would be both academically relevant as well as practical. Several examples were already highlighted for example in the system of Haier and by some interviewees.

There were also potential leads in the desk research, case studies and interviews that were so insubstantial that they were not included in the propositions but might be clues for new lines of research. In this research for example there was no explicit focus on reducing fragility, while many interviewees pointed that out as being the primary method of increasing antifragility. Other subjects are the influence of having no rules or standardizations on the ability to deal with variations, the division of redundancy between the core business and innovations or how these propositions relate to companies very reliant on IT systems. Lastly project management and the resource of time in relation to that has been touched upon several times. It would be practically and academically interesting to see how the antifragile lens can help with evaluating project management methods. A last look might be given to the subjects that were discussed in the other section, which touched upon other aspects of antifragility such as non-linearity, heuristics, and barbell strategies

When explicitly asked what the most useful research for antifragility would be, most interviewees pointed at a method to quantify the benefits of antifragility by for example investigating whether companies that implemented more antifragile practices survive longer. Unfortunately for this kind of research to be done, a measurement method needs to be developed first, as until now the measurement methods available are insufficient.

As antifragility is firmly based in natural models and nature, it would also be interesting to see research that combines insights from for example biology. One example could be to compare the balance between investment

in the skills of employee and the chance they leave before they have earned back that investment with the systems dynamics in evolutionary microbiology. Systems with so called cheaters are widely researched and can give insights in tipping points and natural solutions for this phenomenon.

Also, the subject of communication was highlighted in the interviewee results. As concluded there, the lack of shared language, agreed upon definitions and obscurity of the subject prevents an open discussion about the solutions it might bring. Therefore, increasing the knowledge on antifragility and making the term part of the vocabulary of future managers will increase uptake of the positive effects this new lens can bring. Research that focuses on creating a more common language is therefore also of great importance.

Lastly, as touched upon under Limitations, the disadvantages or situations in which antifragility is not suitable are not yet well known. Research investigating the cases that happen on the edge of antifragile and predictive strategies can help further insights on when to use either system.

6.4. Why is antifragility not more widespread?

One of the issues that the interviewed practitioners highlighted was that communicating about antifragility was really difficult, because the concept was not well known yet. Several reasons could be hypothesized on why this is.

First of all, the concept is relatively new, as the term has been coined in 2012. Second the book is written as a socio-economic critique, not specifically for strategic management. As such, the book is often placed in the philosophy section. Third, the book is simply said hard to read. As some interviewees remarked, Taleb's style of writing is not very reader-friendly and is often described as arrogant.

However, similar work is being done, for example in the business resilience research. Unfortunately, this does not quite overlap with antifragility due to several reasons. First, business resilience misses one crucial aspect of antifragility and that is to also build a system so it can benefit from variation, whereas business resilience primarily focuses on absorbing variations. Secondly, as an article of Mckinsey on business resilience aptly concludes about itself, and what is also a property of the whole field, is a bias towards action. "*Underlying the priorities, we've been describing is a bias toward action—an urgency that reminds us of a quote: "Every morning in Africa, a gazelle wakes up. It knows it must run faster than the fastest lion or it will be killed. Every morning a lion wakes up. It knows it must outrun the slowest gazelle or it will starve to death. It doesn't matter whether you are a lion or a gazelle: when the sun comes up, you'd better be running." Are you a lion or a gazelle? Or, put differently: If you are concerned about the resilience of your business, are you already moving?*"(Hirt, Laczkowski, & Mysore, 2019, p. 9). This bias to action has already been discussed in the background and is called iatrogenics. Therefore, the field of business resilience also has several basic principles that differ from antifragility.

Last the lack of common vocabulary is also a cause of the lack of spread of antifragility. As argued before, resilience coupled with adjectives often are antifragile concepts that are not recognized as such. This splintered vocabulary hinders a common ground to group research and future research. That is why the 2.1 Fundamentals of antifragility is of added value, as it tries to consolidate this problem and create a common starting point for future research and to structure existing research.

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APPENDIX A

Questionnaire English

General

- /Permission for recording the conversation/
- Current position and history of employment
- Contact with antifragility
- How implemented in current work/life

Antifragile for companies (*Keep in mind optionality, Redundancy and Skin-in-the-game will be discussed in more detail later*)

- General insights on how antifragility can be used for companies
- Antifragile practices outside of strategic management (short)

Redundancy

- How can companies implement redundancy in their (strategic) management?
    - What factors are of influence with implementation of this?
- How can companies balance between redundancy and efficiency in a long-term manner?
- What resources are most fit to have redundancy in?

Optionality

- How can companies implement optionality in their (strategic) management?
    - What factors are of influence with implementation of this?
- How can companies balance taking many small options with their core business?
- How to decide on which options to enact upon and which to dismiss?

Skin in the game

- How can companies implement skin-in-the-game in their (strategic) management?
    - What factors are of influence with implementation of this?
- How to implement SITG in a humane/ethical manner?

Research gaps

- What research would benefit the antifragile paradigm/community the most at this point?
- What research gap is now the biggest most pressing problem for antifragility to be accepted?

Closing

- Is there anything left that you want to add on your view of Antifragility for strategic management?

Questionnaire Dutch

General

- /Toestemming voor opnemen/
- Huidige positie en vorige posities
- Contact met antifragiliteit
- Hoe geïmplementeerd in huidige werk/leven

Antifragiliteit voor bedrijven (*Hou er aub rekening mee dat redundantie, optionaliteit en skin-in-the-game later nog uitgebreid aan bod komen)*

- Algemene inzichten in hoe antifragiliteit gebruikt kan worden voor bedrijven
- Antifragiele strategieën buiten strategisch management

Redundantie

- Hoe kunnen bedrijven redundantie opnemen in hun (strategisch) management?
    - Welke factoren beïnvloedden de implementatie hiervan.
- Hoe kunnen bedrijven de balans inschatten tussen redundantie en efficiëntie op de lange termijn
- Welke resources zijn het meest geschikt om redundantie in te hebben

Optionaliteit

- Hoe kunnen bedrijven optionaliteit gebruiken in hun (strategisch) management?
    - Welke factoren beïnvloedden de implementatie hiervan.
- Hoe moeten bedrijven de balans vinden tussen vele kleine opties en hun kernactiviteit?
- Hoe moeten bedrijven beslissen met welke opties ze doorgaan en welke ze stopzetten?

Skin-in-the-game

- Hoe kunnen bedrijven optionaliteit gebruiken in hun (strategisch) management?
    - Welke factoren beïnvloedden de implementatie hiervan.
- Hoe kunnen bedrijven op een humane/ethische manier dit implementeren.

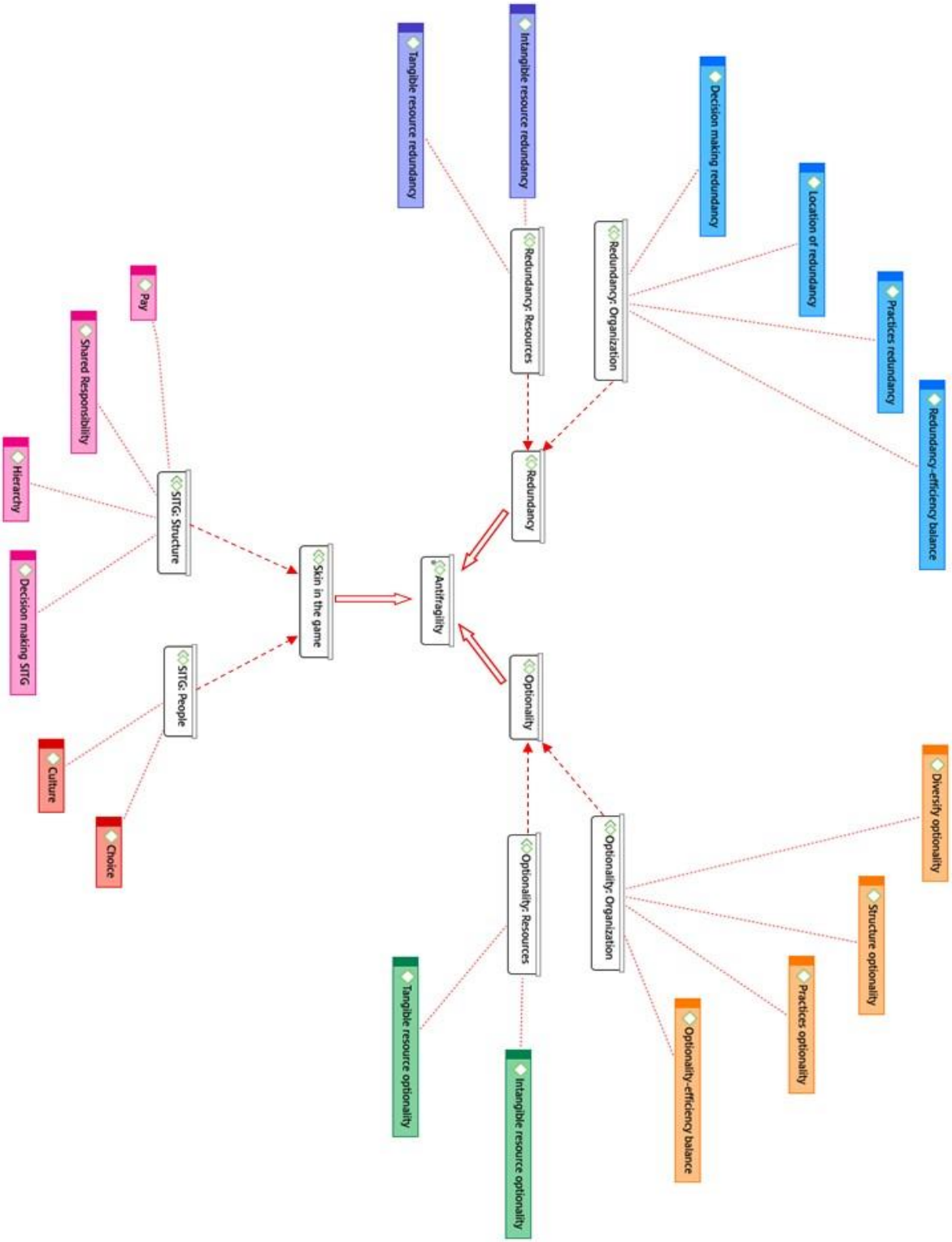
Onderzoeks-gaten

- Wat voor onderzoek zou de meeste waarde hebben voor het antifragiliteitsparadigma/ de gemeenschap?
- Wat voor gat in de literatuur/onderzoek is nu het grootste probleem voor antifragiliteit om te worden geaccepteerd?

Afsluiting

- Heeft u nog aanvullende opmerking die u wilt delen over antifragiliteit voor strategisch management?

APPENDIX B


Redundancy-efficiency balance
Practices redundancy
Location of redundancy
Decision making redundancy
Redundancy: Organization
Intangible resource redundancy
Tangible resource redundancy
Redundancy: Resources
Redundancy
Pay
Shared Responsibility
Hierarchy
Decision making SITG
SITG: Structure
SITG: People
Culture
Choice
Skin in the game
Antifragility
Optionality
Diversify optionality
Structure optionality
Practices optionality
Optionality-efficiency balance
Optionality: Organization
Optionality: Resources
Tangible resource optionality
Intangible resource optionality

APPENDIX C

Concept Sub-concept	*Category*	*Theme*	*Interview mentioned 1st round*					
Redundancy								
Organisation								
	Redundancy - efficiency balance	Balance cannot be determined, let go of efficiency.	7	8	6			
		There is too much redundancy in the wrong places, first trim down, then add redundancy.	1	5	2			
		If you go too lean, you lose redundancy.	2					
		Use Flow efficiency and visualise it	3					
		Focus on long term growth, not rapid growth.	6					
		You need to look at the redundancy - efficiency balance from a meta-level.	2					
		Value stream mapping	5	1				
		Small & continuous experimentation	1					
	Decision making Redundancy	Small teams, multiple skills pp	5	1				
		Decentralise decision making	1	5	7	6		
		Micro-services as example	5	1				
		Delaying decision making	5	7	2			
	Location of redundancy	Single point of failure	4	1	3			
		Redundancy in organisational structure	2					
		Redundancy in core business, or not?	7	3	8			
		If asset flexible, redundancy in, if inflexible redundancy around	4					
		Rather have redundancy in skill or process than standardisation	7	6				
		Partnerships and networks	5	8	6	3		
	Practices Redundancy	Redundancy building via experimentation	3	5				
		Redundancy not funded by company but by employees	6					
		Responsible for creating own business	6					
		Continuous deployment	1					
		Move from job descriptions to roles	2	9				
		Don't bet everything on the same idea/income stream/etc	3	1	4	5	8	6
Resources								
	Tangible resource redundancy	Amount of employees	7					
		Two employees on 1 task/part	8	3				

		Cash	4	7	1	8		
		Spreading capital over different resources	7					
	Intangible resource redundancy							
		Slack in time	3					
		Redundancy in time	5					
		Diseconomies of scale in project management	1					
		Share (too much) information / Transparency	3	1				
		Have redundancy in information sources	8	6	7			
		Skills and knowledge	3	1	5	8	6	
		T-shaped profile	4	3	8	1	9	
		Ability to learn	2					
		Diversity	8	2				
		Ability to recover	2					
Optionality								
Organization	*Diversify optionality*	Ability to absorb failure of options	7	8	9	4	5	
		Have more than one business/client/product/market/etc	4	5	8	6		
		Optimise over projects, not within project	3					
	Optionality-efficiency balance	Lean-start-up/pivot	1	5	8			
		Options will bleed out on their own	7	8				
		Start-ups are options	4					
		Risk-appetite	4	1				
		Limit capacity to retain capacity for new options	3	4				
		Small options are your core-activity	7					
		Decide on criteria upfront	3	2				
		Impact mapping	3					
		Innovators Dilemma & Blue ocean strategy	1					
		3-horizon model McKinsey	8					
	Practices optionality	No application procedures but trial periods	7	6				
		No linear planning, slack in planning for change	5	3				
		Change positions regularly	5					
		Institutional Yes	1					
		Continuous deployment / experimentation	1					
		Don't decide for others	5					
	Structure optionality	Have as little rules as possible	7	9	8			

		Fault-accepting culture	7					
		Delay decisions	7	5				
		Decision making power at the right level	5	8				
		Decentralisation	5	6				
		First robustness then optionality	1	2				
		Iterations, Experimentation, and feedback loops	4	5	2	6	9	
		Move from job descriptions to roles	2	9				
		Partnerships and networks	5	8	6	3		
Resource	*Tangible resource optionality*	Leasing	7	4				
		Virtual offices	8	9				
		Produce own machines / upstream expansion	8	9				
		Cash	4	8	1			
		People and their Skills	7	8	9	2		
		Temporary unemployment	5					
	Intangible resource optionality	Events	6	7				
		Diversity (in profiles)	3	8				
		Media attention / publicity	8					
		Slack in time	4	5				
Skin in the game								
Structure	*Decision making power SITG*	Decision making power at the right level	5					
		Accountability at the right person	5					
		Autonomy	5	6	9			
	Shared Responsibility	Hire together	8					
		Performance review and feedback by peers	9					
		Support and input of everyone in decisions	3	5	7	6	9	
		Consent / Amendment principle	8					
		DevOps	1					
		Link function to people/field it impacts	4	5	2			
	Hierarchy	Hippo-effect / Informal hierarchy	8					
		Connect managers to employees/workplace	5					
		Roulating leadership / Primus Interpares	8					
	Pay	Rewards and Bonuses	4	5	8	1	7	
		Open mind about organizational forms	6					
		Salary	8	6	2	9		
		Autonomy/Mastery/Purpose	6	9				

People	*Choice*	SITG has to be a choice	3	7	2			
		Freelancers	6	5				
		Coupling name to product or company	4					
		Start-up/entrepreneurs	7	4	8			
		Employees need to invest in company	6					
		You need to have something that is at stakes	7					
		Create products that people lease	7					
	Culture	Culture	3	8	6	2	9	
		Autonomy/Mastery/Purpose	6	9				
		Purpose	9					
		Values	6	4	9			
		Goals (and interests) aligned up to the highest level	1	6				
		Camaraderie	9					
		Psychological freedom	8	9	3			
Other								
	Communication	Don't communicate it with customers	3					
		Practical applications are easily understood, theory not	2	4	1			
		Balance between antifragility and costs is difficult for people	1					
	Other	Non-linearity	1					
		Avoid Neo-mania	4					
		Simplicity	7	8	4			
		Heuristics	3					
		Mean-time-to-repair	1					
		Do not reduce variation	4	8				
		Reducing information noise	4					
		Reduce fragility first	1					
		Barbell	4	2				