

POTENTIAL APPLICATIONS OF ANTIFRAGILITY PRINCIPLES IN THE
LOGISTIC

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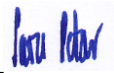
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ABSTRACT

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The logistics industry plays a central role in the global economy by enabling the cross-border movement of goods and services. The COVID-19 pandemic and other geopolitical conflicts or unpredictable events in supply chains have highlighted the vulnerability of the logistics industry. They have shown that global supply chains are far more susceptible to crises or disruptions than previously assumed. This vulnerability can lead to unpredictable chain reactions, which in turn have a significant impact on the global economy and the companies, institutions and economies within it. Based on Taleb's concept of "antifragility" from his 2013 book, this paper explores the paradigm shift from mere resilience to shocks (robustness) to profiting from unpredictable events and crises. Despite the potential to revolutionize organizational preparedness and response to crises, the application of antifragility in the logistics industry has not yet been sufficiently researched and utilized. This dissertation seeks to address this gap by mapping the industry's current resilience practices, identifying potential applications for antifragility, examining concrete strategies for applying antifragility, and proposing a comprehensive framework for integrating antifragility strategies in the logistics sector. The research aims to give companies in the logistics sector the opportunity to become antifragile through

concrete applications that they can implement in their business apparatus and thus profit from unforeseeable events and crises.

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CHAPTER I: INTRODUCTION

In spring 2020, headlines such as "The pandemic is here. What now, Mr. Drosten?" (Max-Delbrück-Centrum, 2020) or "How coronavirus infected the world - how the crisis began" (ZDF, 2020) caused a stir in the German and global media landscape. The questions posed by countries, economies and, above all, the people behind these institutions are featured in the titles of the news articles and describe the problems facing entire economies quite succinctly: "What now?" Of course, the question needs to be fleshed out, but it encapsulates the core of the issue. The phenomenon of a global pandemic, or even a global crisis, is nothing new in the context of the sometimes cyclically evolving world history (Council of the European Union, 2023). Even before the industrial revolutions of the 19th century and without a globalized world with its seemingly fragile and cost-optimized concepts such as "just in time" production, outsourcing or dropshipping, global pandemics have existed (Mordechai et al., 2019). Notably that not all of the effects of the last period are foreseeable today and will manifest themselves in subtle ways in all sectors and markets in the long term. In the event of global crises, increasing globalization has the potential to become the Achilles heel of the global economy and the companies and institutions operating within it (Kirby, 2009). The tightly woven web is clearly too fragile in the event of unforeseeable events, no matter where in the world. Another problem that should not be underestimated is the exponentially and chain reactions caused by problems within the network. The logistics industry in particular is heavily affected by such chain reactions, as one of its core services is connecting the world through deliveries (UPS, 2023). However, one thing is certain: the corona pandemic as a global crisis will probably not be the last crisis, and there is a likelihood that subsequent crises could be more severe. We experienced this when the war in Ukraine and the recent conflicts in the Middle East emerged. Here too,

the interconnectedness of the global world has led to interdependencies, and fragility in certain industries has led to further fragility in other sectors (Council of the European Union, 2023). After all, crises often have one thing in common - their unpredictability and underestimability. The latter resembles a psychological anomaly (Krystek, 2005). Forecasts of crises and their probability of occurrence are usually made based on historical data - i.e. based on the worst crisis that has occurred in the past. However, as even worse events than the worst that have ever occurred still have a certain, albeit lower, probability of occurrence, solid preparations have rarely been made for these events to date - they are also referred to as "black swans" (Bendel, 2023). Because of these dynamics, there is an urgent need to examine the concept of 'antifragility' in the logistics industry. Introduced by Taleb (2013) in his book "Antifragility: Instructions for a World We Don't Understand", this concept has yet to be fully integrated into mainstream lexicons and dictionaries and therefore represents a significant gap in academic research. The aim of this research is primarily to understand how companies within the logistics industry and their structures can get antifragile by researching specific applications. This will prepare them better for future global crises and pandemics. Instead of dealing with current crises simply by adapting strategy and operations accordingly, this can ensure that the company is better positioned for subsequent crises and, in the best case, benefits from them. Due to the described effects on the logistics industry, there is a prevailing interest in researching the development of antifragility through the implementation of clear applications in the logistics industry (Nikookar et al., 2021; Zitzmann, 2014). If you imagine a package that says, "Attention fragile", you should be careful not to expose it to heavy impacts, as otherwise it would be damaged, i.e. exposed to a negative consequence - often a sticker with a broken glass and the word "fragile" can also be found on such packages. Many people would now claim that the opposite of "fragile" would be "robust".

Taleb (2013) denies this. If dropping a package labeled "fragile" damages the package, i.e. a negative consequence occurs, the package with the opposite of fragile would have to say: "Please treat extra badly", as this would have a positive consequence for the package. robust, on the other hand, would be if only a neutral consequence would result and neither something positive nor something negative would happen to the package. The primary aim is therefore to make companies within the logistics sector and their structures antifragile through concrete applications and thus better prepared for future global crises and pandemics, rather than to relativize the current crises.

1.1 Problem statement

In today's economically globalized and deeply interconnected world, the once advantageous inter-global networking of industries in the Covid 19 pandemic, as well as due to geopolitical conflicts and resulting crises, has shown that global supply chains within the logistics sector are more vulnerable than initially suspected (Kirby, 2009). It has been shown that the supply chains within the global logistics sector are far too fragile in the event of crises or unexpected events and that this can lead to unpredictable chain reactions, as the sector is largely responsible for maintaining the cross-border movement of goods and services and thus the global economy (United Nations Conference on Trade and Development, 2022). The Antifragility concept offers a paradigm shift from merely resisting crises and stressors (robustness) to thriving and improving in the face of chaos and volatility. Despite the concept's potential to revolutionize the way organizations prepare for and respond to crises, antifragility has been under-researched and under-utilized in academic circles and in industry practice, particularly in the logistics sector.

The research presented here aims to change this as follows:

- Capture current industry practices to improve resilience and antifragility
- Identification of potential fields of application for generating antifragility
- Explore concrete applications that lead to antifragility stewardship.
- Propose a comprehensive framework for integrating antifragile strategies into logistics operations with the aim of transforming future crises into opportunities for growth.

By answering these research questions, the study aims to fill a critical gap in academic literature and provide actionable insights for logistics companies seeking to become antifragile in an era of increasing global uncertainty and interconnectedness.

1.2 Research interests and objectives of qualitative-quantitative-empirical research

Due to the effects on the Logistic industry described in the problem statement and my work in this field, there is a prevailing interest in researching the development of "antifragility" in the logistic sector. This work is therefore primarily concerned with making companies within the logistic industry and their structures antifragile and thus better prepared for future global crises and pandemics than with overcoming the existing crisis by adapting the strategy and operation accordingly and thus ensuring that subsequent crises have a positive impact on the organizations in the long term. The aim is to empirically develop ideas and concepts as recommendations for action that make this rather complex concept feasible and therefore to transform its inherent weaknesses into strengths. In the context of global crises and uncertainties, this is of essential relevance. The study is oriented towards the following specific research objectives and questions:

- Investigate and document the current strategies and practices of the logistics industry to improve resilience as their answer to global crises and disruptions.
- Identify and delineate specific areas of application within the logistics sector where the principles of antifragility can be most effectively applied to mitigate the impact of crises.
- Identification of specific applications that promote or lead to antifragility in the company.

1.3 Research question

The research questions that need to be answered are:

- What current practices are in place in the logistics industry to increase resilience and prepare for global crises and unforeseeable events with a potential negative output?

The aim of this question is to understand the foundations from which the logistics sector currently operates in terms of crisis management and resilience-building efforts, and to identify gaps that prevent or make antifragility unachievable.

- In which areas of the logistics sector can the principles of antifragility be applied most effectively to achieve significant improvements?

Areas such as e.g. organizational structure or working and planning methods in the logistics company. By identifying these areas, the study can focus efforts on the most effective intervention points for introducing antifragility into the sector.

- What specific applications and strategies can lead to antifragility in the logistics sector and how can they be implemented?

This question is the focus of the research and seeks actionable insights and concrete strategies for the practical implementation of the concept.

The answer to this question aims to synthesize the research findings into a coherent, actionable framework that logistics companies and organizations can adopt like a blue print to become antifragile.

1.4 Methodological structure of the research

The methodological structure of the work is described below. It starts in the first chapter with the problem description followed by the research interest and the objectives of the qualitative empirical work. The following chapter describes the relevant research questions. The introduction concludes the first chapter with this chapter, in which the methodological structure is described in order to provide an initial overall picture of the study. In the second chapter, theoretical foundations are conveyed through a literature review. The terms crises, disruptions, robustness and resilience, as well as their distinction from the concept of antifragility, are presented in literary form. There is also a chapter on antifragility in the context of logistics in order to show the reader what knowledge base exists in this area and why there is still a large research gap which this research attempts to close. At the end of the second chapter, agile strategies and organizational forms are discussed, as these can have an important influence on achieving an antifragile company. Chapter 3 then begins the qualitative research project. It describes the research methodology used, the selection and introduction of the interview partners and the development of the discussion phases and guidelines for the interviews. The qualitative research is intended to provide a deeper understanding of the application

and impact of antifragility principles in logistics. Chapter 4 analyzes the qualitative data using Mayringer content analysis. The findings are presented and analyzed in detail. This is followed by a hypothesis derivation. This chapter thus plays a central role in the research process. It represents the transition from data collection and theoretical analysis to the first hypothesis formation. These hypotheses must be validated in Chapter 5 and the quantitative research carried out in it. The empirical testing of the hypotheses with a large number of respondents in the logistics sector represents a further significant step in the research. The research design, the survey methodology, the definition of the study population and the development of the questionnaire are presented first. This is followed by a descriptive presentation and inductive analysis using R. Various test procedures such as multivariate regression, bootstrapping, mean difference tests, permutation tests, Chi2 independence tests and other test procedures are used to carry out extensive validation at various confidence levels. Finally, the results are presented in chapter 6 and recommendations for action are derived. A reflexive evaluation of the research quality is also carried out and the degree of target achievement is measured. The outlook creates perspectives for future research work in this relevant area. By combining qualitative and quantitative research methods, the study provides a robust and multi-layered analysis of the topic that is both theoretically sound and practically relevant. The structure of this outline reflects a comprehensive and methodologically well thought-out approach that aims to examine in depth the potential applications of antifragility principles in logistics.

CHAPTER II:

THEORETICAL FOUNDATION

2.1 Crises

In the following chapter, the term crisis is defined, and examples are used to gain a basic understanding as the theoretical basis for the thesis. The word crisis is the buzzword par excellence in Germany's current media landscape and is booming. Regardless of whether it refers to personal problems of individuals such as a midlife crisis or threatening financial and collective developments such as economic and financial crises, crisis regions or hot spots in society. Crises often occur suddenly and escalate very quickly. However, they can also occur gradually and come to a head if the parties involved in the crisis are unwilling or unable to adapt to the new circumstances. Crises are therefore often indicators, even symptoms, of outdated approaches. This applies equally to individuals, societies and their systems.

There is no universally accepted definition of a crisis, although there is general agreement that a crisis is an event that can destroy or at least have a major negative impact on an entire organization, society or economy. (Mitroff et al., 1996) Originally, the word crisis comes from ancient Greek. Here, "κρίσις" or "krisis" was initially used as a term for a decision, an expression or an opinion, later also as a turning point or decisive point in a negative course of a disease and thus the turning point in a critical development in which a decision had to be made (Dornseiff, 1950). Pearson and Clair (1998) define a crisis as a low-probability, high-impact situation that is viewed by critical stakeholders as a threat to the viability of an organization or institution. In sociology, on the other hand, a crisis is defined as the sudden occurrence of massive problems that cannot be easily solved (Reinhold et al., 2000). In sociological lexicons, crises are primarily assigned to the

economy. Hillmann (2007) describes an economic crisis as a phase of reversal from a boom phase through a recession to a depression. This downturn is accompanied by inflation, insolvencies, increased unemployment, pessimism and a negative outlook for the future, which reinforce each other in the downward trend. This is also referred to as a threat dynamic, as problems generate synergies of a negative nature. On the other hand, political and scientific crises, which can be described as upheavals in a new power structure and scientific, fundamental and sustainable structural change, or revolution, are much rarer in the literature (Ploch and Cook, 2010). For some years now, social crises such as refugee migration, the refugee crisis (ARD, 2023) and environmental crises, such as the buzzword climate change (Zeit Online, 2024) or the reduction of biodiversity, have repeatedly appeared in the news headlines of the German populist mainstream media landscape. The previous examples show quite impressively the variety of circumstances behind the concept of crisis and the influence of subjective perceptions in defining what is considered a crisis and what is not. It is like walking a tightrope to determine when a crisis is a crisis or simply a challenge. Based on and in line with the definitions used and the original meaning from the development of the Greek language, a crisis is defined in this thesis as an undesirable event with initially largely negative consequences for all actors involved. However, positive consequences resulting from a crisis are explicitly not excluded and can even lead to positive developments, for example in organizations, by deliberately causing them. Kim (1998) called this form proactively constructed crises, which were actively used at Hyundai Motor to intensify organizational learning effects. According to Kim (1998), proactively internally generated and thus constructed crises, similar to red-teaming in IT security, unlike externally generated crises, can clearly identify performance gaps and shift an organization's learning orientation in its direction

from imitation of competitors to true innovation, thus intensifying organizational learning efforts.

However, the most important insight from Kim's explanations is probably that crises can be overcome with the right approach. According to the Diamond (2019), there are various factors that promote crisis management both in the private sphere and in organizations, i.e., a collective association of individuals:

1. crises must be seen as a fact and must not be denied.
2. the assumption of responsibility is essential for crisis management.
3. through selective change, the things that need to be changed must be separated from the things that need to be changed to create a focus on change.
4. crisis management can be facilitated by external help and the external perspective that this makes possible.
5. knowledge about the crisis management of actors who have already been challenged with similar crises can help to overcome them again.
6. Critical self-reflection allows both individuals and organizations to grow beyond the status quo.
7. the knowledge gained from overcoming past crises can also make a positive contribution to overcoming them again.
8. mental flexibility promotes crisis management.

Following this detailed discussion of the concept of crisis and the factors involved in overcoming crises, it is now necessary to examine the biggest historical crises of the last 20 years and their impact on our society in order to complete the basic theory. As already covered in the discussion of the concept of crisis, there are not only economic crises but also scientific, political and social crises as well as environmental crises. Due to the

subject matter and in order not to overstretch the scope of the thesis, this work is limited to the biggest economic crises of the past 20 years as well as the Covid-19 crisis, which began in 2020 and whose effects on the CEP industry are still omnipresent. The classification of the crises as a crisis is assessed on the basis of the monetary impact on the German economy, measured by the DAX share index (also DAX Performance Index) of the respective crisis year and on the basis of the overall impact on society. The DAX Index is the most important German share index and was introduced on July 1, 1988 (Umland, 2021). The DAX measures the economic performance and value development of the most liquid German companies, which account for around 80 percent of the market capitalization of listed stock corporations in Germany (Umland, 2021). The following 2 crises can be identified on the basis of the DAX over the last 20 years:

The worst DAX year 2002

In 2002, the DAX recorded the worst price slump in its history at 44% (Osman, 2002). According to Manager Magazin, the catastrophic stock market year and the slump in share prices were due to a long war in Iraq, accounting fraud by large US companies and the link between the German economy and the US economy, which had still not recovered after the dotcom bubble in 2000 (Osman, 2002). The dotcom crisis was one of the biggest financial crises worldwide in the last 20 years. Due to the low correlation between the DAX and the NEMAX All Share, in which dotcom companies were traded, the DAX still performed solidly in 2000, falling by just 10 percent (Umland, 2021). However, the global consequences of the dotcom crisis and its chain reaction continued to be felt by the German economy in the following years and thus also in 2002. The consequences of the dotcom bubble lasted another 5 to 10 years worldwide, making it the two biggest speculative bubbles of the last 20 years alongside the 2008 financial crisis (Kucera, 2010).

The dotcom bubble 2000

The dotcom bubble or dotcom crisis occurred in 2000. The term, which was established by the media as a neologism and made-up word, describes a speculative bubble that burst, which particularly affected US technology companies, so-called dotcom companies, which were overvalued on the stock markets without any underlying economic performance or substance due to the Internet hype of the 2000s (Glebe, 2008; Knupfer, 2020). It led to a massive loss of wealth for small investors. The bubble was triggered by investors' high profit expectations due to the gold-rush mood caused by the widespread establishment of the internet and cell phones. This establishment led to numerous start-ups of so-called dotcom companies - the name is derived from the domain extension “.com”, which stands for commercial (Gorthmanns, 2008). The focus of these companies was on the innovative and lucrative business model of conducting business via the Internet (Dittmann, 2010). As early as mid-1999, the stock market valuation of numerous newly founded dotcom companies expanded many times over within a few months, driven by increased activity and demand for tech shares from new investors on the stock market. This triggered a further chain reaction, as the newly acquired liquidity of the companies was used to expand by buying shares in other companies (Glebe, 2008). Driven by the price increases, numerous new investment funds were also founded in the “new market” (Glebe, 2008). However, the permanent flow of money into tech companies only artificially delayed the insolvency of non-marketable companies. But then came the awakening at the beginning of 2000, when it became clear that the profit expectations of investors were nowhere near achievable. Moreover, the sales expectations were mostly fictitious and the book values largely consisted of intellectual and non-tangible assets, which therefore could not be liquidated (Glebe, 2008). As expected, the

share price plummeted and many small investors lost their investments as they did not choose the right time to exit and hoped for a price recovery. The bankruptcies of the companies were due to the overvaluations on the stock markets and wrong investments - because although there was enough liquidity, most companies did not have a functioning business model (Dittmann, 2010). In contrast to the companies operating in the USA, the German dotcom bubble was also influenced (Borchers, 2010) by criminally active companies such as Comroad, Informattec (Rose, 2003) and Metabox (IDG Tech Media, 2000).

The second worst year for the DAX in 2008

Due to the bankruptcy of the US investment bank Lehman Brothers and others, 2008 was the second worst year for the DAX - 5 of the 20 worst DAX days occurred in this year. The bank failures were the beginning of the 2008 economic crisis, which was triggered by the US real estate bubble. As a result, the DAX plummeted by 40 percent (Mezger, 2023).

The US real estate bubble as the trigger for the 2008 global financial crisis

The US real estate bubble, often referred to in the literature as the subprime crisis (Badek and Nguyen, 2010), burst at the end of 2007, triggering the global financial crisis in 2008 (Stockhammer, 2009). However, this development was due to a variety of factors, which are only briefly discussed in this section.

Due to the preceding dotcom bubble and the terrorist attack on September 11, 2001, the USA found itself in a prolonged economic crisis. As a result, key interest rates were lowered by the Federal Reserve Bank (FED) in order to promote consumption and investment (Werbler, 2024).

As a result, employment figures rose and the US economy also recovered, leading to fixed incomes and prosperity in the USA (Grandt, 2010). This also boosted the number of

apartments and houses purchased in the USA, where owning a house or apartment was considered a symbol of prosperity at the time for cultural reasons (Rottwilm, 2017). However, the increased demand also led to higher prices for apartments and houses. As a result, debt per household rose to 125 percent (Grandt, 2010). Despite these high levels of indebtedness, banks granted loans to private individuals for the purchase of houses and apartments, the probability of default of which now appears questionable. The banks continued to receive AAA ratings (the highest rating for a bank's creditworthiness) from the rating agencies responsible for classifying and assessing a bank's default risks until almost the end (Beqiraj, 2012; Grandt, 2010). As a result, the fourth largest investment bank, Lehman Brothers, filed for insolvency in September 2008. This was foreseeable at an early stage, as the Fed had already raised key interest rates in 2004, causing lending rates to rise (Werbler, 2024). Although the banks had factored a certain number of defaults into their interest rates, the number of defaults far exceeded the calculated figure, as debtors were unable to continue making repayments and more and more properties were foreclosed on. This resulted in an oversupply of properties and pushed property prices down further. Driven by this development, the prices generated per property could no longer cover the loans and the banks had to write them off as losses (Grandt, 2010). The consequences for the global economy were devastating. 2.4 trillion dollars were wiped out in just one year and states and governments had to bail out the banking system with trillions of dollars to prevent the global financial system from collapsing (Grandt, 2010). As a result, fewer loans were granted due to liquidity bottlenecks, banks such as Lehman Brothers, Merrill Lynch, Morgan Stanley and Goldman Sachs were liquidated and other banks such as Northern Rock Bank in England became state-owned (Beise and Schäfer, 2009). As a result, the global economic crisis of 2009 took full effect due to the close interdependence of the financial systems (Kuhr, 2010). In Europe, which is by no

means immune to the effects due to the close link between the euro and the dollar, the European Central Bank injected 166 billion euros into the market under pressure (Dullien, 2011). In addition, the G20 countries decided in April 2009 to support the financial market with an economic stimulus package of 1.1 trillion dollars, or to be precise, to save it (Dullien, 2011). National economies, including Germany, are still confronted with the consequences of this crisis and the high investments and debts that were necessary to maintain the financial system. However, due to the complexity and scope of these chains, they can rarely be clearly traced back to their origins.

The latest and most recent crisis to be described is the coronavirus crisis, also known as the Covid-19 crisis or pandemic, which began and originated in the Chinese province of Wuhan at the end of 2019. In order to establish a link to the thesis title, the crisis is briefly described below and then some general effects in Germany as well as direct and indirect consequences for the German CEP industry are roughly discussed.

According to a study entitled “Origin of the coronavirus pandemic” by Roland Wiesendanger (2021), who holds a chair at the University of Hamburg, all evidence points to a laboratory accident at the Wuhan Institute of Virology as the cause and origin of the coronavirus pandemic. The crisis was thus caused by people themselves due to unsafe high-risk research in the laboratory and not, as previously assumed, by a natural disaster. The effects of the ensuing global pandemic were and are catastrophic for the world, for people's health and, on a monetary level, for the global economy, dramatically demonstrating that the traceability of chain reactions resulting from crises cannot be fully foreseen by humans. Some of the effects in Germany include:

- At a macroeconomic level, gross domestic product (GDP) slumped by 10% compared to the same quarter of the previous year and price-adjusted GDP fell by 3.7% (Destatis, 2024a). To date, German economic output has not returned to pre-

crisis levels despite the increase in 2021. The slump in economic output was a result of the decline in incoming orders in the manufacturing industry (Destatis, 2024b) and thus a decline in the productivity index and turnover index in the manufacturing industry (Destatis, 2024c, 2024d), a massive increase in producer prices for industrial products in the chemical, mechanical engineering and automotive sectors (Destatis, 2024c), which make a significant contribution to economic output in Germany, partly triggered by extreme price increases in import prices (Destatis, 2024e).

- At the employment level, a massive decline in employment in Germany from the 1st quarter of 2020 to the 1st quarter of 2021 as a supplement to the economic statistics in the national accounts (Destatis, 2024f).
- A decline in the average gross monthly earnings of full-time and part-time employees in aviation, gastronomy, accommodation and the manufacture of motor vehicles and parts which is still under the average of 2019 in 2024 (Destatis, 2024g).
- A significant and ongoing decline in Germany's foreign trade balance to the level of 2012 and thus the loss of its status as a leading export nation (Statistisches Bundesamt, 2024).
- As a result of the decline in GDP (gross domestic product), there was initially a massive fall in the transportation index in 2020 (Engelhart et al., 2020). This reflects the use of transport routes such as road, rail, air and shipping and indicates the predominance of trade in physical goods. From December 2021 to October 2021, there was an overcompensation of transport volumes as a result of catch-up effects and also a significant change in habits in society from online purchases to local purchases in retail stores, followed by another winter slump

and a subsequent stagnation at this level in 2022. The parcel volume of CEP service providers increased by 11.4 percent from 2020 to 2021 with 4.51 billion parcels sent. However, it then fell significantly again in 2022 to 4.15 billion, which corresponds to a further decline of 7,98% (Janson, 2024). By 2024, the parcel volume was unable to work its way back to the peak value of 4.51 billion parcels and stands at 4.2 billion parcels, which corresponds to growth of just 0.6% from 4.175 billion in 2023 (Statista, 2024a). At the same time, there was a significant increase in unit costs in the CEP market. Due to the significant decline in volume and the previous establishment of service provider structures, there was a massive price increase in the market. In 2020, average costs had fallen to a low of €5.81 per parcel since 2007, but since then costs have risen annually to a new all-time high of €6.36 in 2023 (Statista, 2024a). This led to a higher level of sales in 2023 than in 2020 despite lower volumes. The ongoing war in Ukraine and its impact on the economy as well as rising consumer prices, which could influence consumer behavior and possibly lead to a reluctance to spend, also have an impact on the parcel volume forecasts. Accordingly, no significant increases are expected, even though previous forecasts once predicted up to 5.1 billion parcels by 2025 (Statista, 2024a).

The crisis has led to enormous volume volatility in the CEP industry, which is quite fragile due to the following factors:

- Lack of resources or cost-intensive overcapacity in the area of aircraft and transport equipment, in particular aircraft, containers and the road fleet, as well as the short-term need for personnel resources in the area of operations and sorting, which, however, will again mean an increased unnecessary cost structure in the

event of a decline in volume in 2021-2022 (Behn, 2022a) and no return till 2024 (Statista, 2024a).

- Increased cost structure due to the shortage of resources in the market: costs for personnel, containers, aircraft, etc. have risen sharply in transport logistics as volumes have increased, while revenue per parcel has stagnated at the same time, as contracts are concluded over several years in the industry, especially for large customers (usually for at least one year). (usually at least 1 year in duration)
Attempts were made to counteract the decline in margins with capacity surcharges, as is customary at Christmas time. In 2022, UPS and other CEP service providers saw a rate increase during the year for the first time in history (Gärtner, 2022; Plewinski, 2022a).
- Lack of network planning and therefore no stable planning capability, but “driving on sight” with simultaneously rigid planning structures to enforce stakeholder interests.
- Decline in import volumes due to lockdowns in Asia (Behn, 2022b), which led to a lack of resources in Germany's secondary economic sector and was followed by renewed increases in volumes after the opening of production facilities in Asia (Behn, 2022c, 2022d; Plewinski, 2022b) - the catch-up effects led to explosive increases in volumes that exceeded the import capacities of freight service providers and then CEP service providers.
- Domestically and within Europe, there was a decline in B2B deliveries and an increase in B2C parcels of around 18.6% (BIEK, 2021). This is due to the lockdown and the associated closure of the retail sector. However, even after the opening of the retail sector, a partial change of habits in society meant that the relationship did not return to pre-corona levels (BIEK, 2021). However, the cost

structure for B2C shipments for CEP service providers due to the longer delivery time in the last mile is significantly higher and requires more personnel resources than B2B shipments. Marten Bosselmann, Chairman of the German Parcel & Express Logistics Association (BIEK), says: “The pandemic has had a lasting impact on the CEP market. Faster than expected increases in shipment volumes are intensifying the challenges associated with delivery in conurbations and city centers. The need for innovative solutions for urban logistics is increasing” (BIEK, 2021).

The full impact of the Covid-19 pandemic on the logistic industry cannot be presented due to the complexity and scope of this work. Therefore, the question remains within the industry as to how to adequately prepare for future, possibly even more volatile, crises in order to emerge as a winner. Certainly, areas such as the procurement of qualified workers, better working conditions, the advancement of digitalization and thus the establishment of digital processes, the development of alternative drive technologies and more efficient last-mile delivery are just some of the factors that need to be optimized. All the crises described in this chapter have one thing in common: their unpredictability, the unpredictability of consequences and chain reactions in the global economy and the lack of measurability of their effects to date. Especially in crises, companies are confronted with an increased level of uncertainty resulting from frequent changes in information.

2.2 Disruption

Crises and disruptions have always had a reciprocal relationship with each other over the course of time. The word disruption is derived from the word "disrupt", which also has synonyms in the words destroy or interrupt (Agbaria, 2008). At its core, the term disruption refers to disruptive technologies in which existing or traditional business

models and their products or services are replaced and in some cases pushed out of the market. (BIEK, 2021) The term was created by Christensen (2013), who taught at Harvard Business School and was succinctly defined as "disruption". The term is widely used, especially in the start-up scene. Disruption or disruptive Innovation must be distinguished from evolutionary innovation (Matzler et al., 2016). Innovation typically refers to the improvement or development of new products, services or processes within existing markets. Disruption, on the other hand, refers to a form of innovation that radically changes existing markets or business models or makes them obsolete, often by creating new markets or value networks (Matzler et al., 2016). In contrast to disruptive innovation, evolutionary innovation develops an existing market further, whereas disruptive innovation opens up a completely new, previously unheard-of market (Jaekel, 2020). This involves a complete restructuring of the existing business model, which often destroys the established market through substitution (Keese, 2014). One example of this is the replacement of the classic telephone with dial buttons by the smartphone with touchscreen. The ability to completely restructure and rethink products is therefore crucial to the success of disruptions. In the context of services, this can also mean rethinking and realigning a service. This can go so far that the company don't even has to provide the service itself - as Uber and Airbnb have impressively demonstrated, disrupting the passenger transportation, hotel and hospitality industries (Schneider, 2017). Because the world's largest provider of accommodation does not own a single hotel or apartment and Uber, the largest cab company, does not have its own vehicles (Keuper et al., 2018). The most valuable retailer (as of 2018) Alibaba does not have its own stock either (Keuper et al., 2018). According to the founder of the term, Christensen (2013), every company in its life cycle is threatened by one of these existence-destroying, radical and industry-disrupting innovations and will either emerge stronger as a result or fail as a

company. Nevertheless, the process is necessary for the evolution of industries. Without innovation and disruption cycles, industries would stand still and not develop further. Just as established companies fail, radical innovations also give rise to new companies that can use their agility and high willingness to take risks to secure new markets. This is because established companies take fewer risks and are therefore geared towards continuing to innovate and improve existing technologies (Shahzad et al., 2021). They push for increasing growth rates and product performance improvements based on existing technologies. One example of this is the Kodak brand, which was the market leader in analog photography and did not make the transition to digital photography in time (dpa, 2015). But the well-known Nokia moment also resulted from the failure to recognize a disruption towards smartphones (Lederer, 2020). The market leader in the cell phone sector, Nokia, failed due to a complete misjudgment of what its customers' needs were. The digitalization of retail by Amazon and the Alibaba Group, whose turnover and thus market capitalization has increased more than a hundredfold in the last 15 years, shows quite impressively what disruption can still mean and achieve (Amazon, 2023; Alibaba, 2023). Companies such as Apple and Samsung have also been able to dominate entire markets with ground-breaking and disruptive innovations (Samsung, 2022; Statista, 2024b). This happens when established companies underestimate the power of disruptive innovations and thus pave the way for new market players until they have secured so much market share that they displace the top dog. This underestimation is often not due to poor management on the part of established companies. It is precisely because capturing customer wishes is a central component of successful corporate management. With disruptive technologies, it is often the case that customers themselves do not know what they want until it is made available to them, thereby completely changing their views, demands and even expectations. New markets therefore have a

certain degree of unpredictability and incalculability. After all, established companies invest a lot of resources and constantly monitor the market environment in which they operate. This gives you a lot of historical data and facts for your decision-making. But not in new, unprecedented markets. There is simply no basis for deciding whether innovations are worthwhile or completely unprofitable. As established companies are also quite unagile and are forced to act in a risk-averse manner, they wait and see when it comes to disruptive technologies, leaving new market players with pioneer status. This requires flexibility and agility, as well as a willingness to take risks. All characteristics that newcomers bring with them due to their attitude of not being able to lose much. Creativity helps established companies to establish disruptive technologies, because in essence they are a better substitute for established solutions. All that is needed is to find a customer group whose needs are better met. Current disruptive examples include tablets such as Apple's well-known iPad (Crothers, 2010), which can increasingly take on more and more functions that were previously reserved for PCs with a lot of computing power, or cloud computing, which makes even the computing power in the device superfluous. Future disruptions could include 3D or 4D printers (Anderhofstadt and Disselkamp, 2022, p. 4; Pretsch et al., 2022), which could enable consumers to produce many objects themselves in the future, or university education, which is expensive and very inefficient in many countries. Here too, alternatives such as distance learning universities and online offerings are on the rise and are increasingly replacing traditional universities (Weßels, 2021).

In addition to creativity, there are other strategies for promoting disruptive technologies in established companies. The well-known saying "survival of the fittest" is often misinterpreted. It is not the strongest - in an entrepreneurial context, the one with the most resources - that prevails, but the one that can adapt optimally to new environmental

conditions. In the economic context, there is permanent cut-throat competition. In addition to resources, which certainly play a role, adaptability and flexibility also play a major role in the age of digitalization to respond to market requirements. Established and conservative companies in particular are at risk of being left behind if they are not careful. Another example of this is Sony with the Walkman (Du Gay et al., 2013). They invested heavily in the development of players and were pushed out of the market by the emergence of MP3 files (Du Gay et al., 2013). Today, Sony no longer plays a major role in the market for music players, partly due to the development of smartphones (Brandt, 2019; Statista, 2019). However, Sony could have entered the new market itself when the MP3 trend emerged. Due to the threat of cannibalization of its mainstay through substitution, Sony hesitated, left the field to disruptive brands such as Apple with the iPod (slogan: “1,000 songs in your pocket”) and dropped out (Wilkins, 2021). The message to established and long-established companies with regard to disruption is therefore quite concise and clear: in order to meet the demands of the markets and continue to survive, companies must have the courage to embrace radical change and establish fundamental and radical changes in their business models at an early stage, even if, as the experience of past disruptions has shown, social acceptance of new technologies must first develop. In the past, people have always been skeptical of new things and technologies. The establishment of the computer, the internet and smartphones are examples of this. After the initial scepticism, people tried to use technology for everyday problems and recognized the advantages it offered until technology was finally fully integrated into everyday life. The establishment periods even halved in the three examples from innovation to innovation (Appenzeller and Appenzeller, 2021; Lippmann, 2016; Weka Media, 2024).

Established companies in particular can be enormously innovative and disruptive due to their capital structure if they structure themselves correctly. “Self-disruption” should not just be used as a buzzword but must be actively practiced and implemented. This radical approach poses decision-making challenges for the management of companies as, if the disruption developed is successful, it would mean cannibalizing part of the self-occupied market and this would defy any (short-term) efficiency logic. The approach is by no means unrisky, but major players such as Netflix, for example, make it clear with their success stories how high the opportunities are on the other side. Netflix as an example: What many who are unaware of the successful streaming platform and now largest film and series producer, was itself a DVD rental company from 1990-2007 and has undergone “self-disruption”, overtaking Walt Disney in terms of stock market value in 2020 (Jenner, 2018).

Management consultants Ernst & Young (2018) have developed and presented five methods that managers can use to promote disruptive innovations in established companies:

1. Thinking as an organism instead of an organization. Basically means that an organization, like an organism, can best perceive the market environment through its individual components, in this case through each individual, and must be open to innovation, whether internal or external.
2. Focus on human resources and the development of their skills - AI, blockchain, IoT are all tools and enabling technologies to drive disruption. However, the disruptions and concepts must be conceived and to some extent envisioned and lived by people before they become reality. This makes people and their skills, which cannot be replaced by technology, a competitive advantage.

3. The development of a new personnel and management model based on a new knowledge culture - until now, a knowledge advantage has been a way to make a career in established companies, but this barrier, which ensures that knowledge is kept “to oneself”, must be broken down. After all, employees who are involved in day-to-day business are the most important receptors in the market for identifying changes. When they share their knowledge, they become generators of added value for companies. For this to happen, a management style is needed that breaks down barriers to knowledge sharing and rewards disruptive approaches. But be careful, it's the mix that makes the difference, because only employees who think disruptively prevent day-to-day business from being managed.
4. Transform skepticism into curiosity. As already described in the chapter, new disruptions are initially viewed skeptically. To resolve this skepticism, a company must transform the reflexive “no” into a question that could be: “How can this benefit the company?”
5. Disruption and innovation do not necessarily require capital, but it is beneficial to drive innovative disruptions forward.

2.3 Robustness and resilience

The terms robustness and resilience can be equated with the ability to withstand stress and resistance and thus express the ability to overcome crises. Resilience comes from the Latin "resiliere", which means "to bounce back" (Cyffka, 2010). The initial response to a negative influence is not positive, as in the antifragile system, but neutral. However, resilience is difficult to define due to its situational complexity and applicability. Resilience has its origins in physics, more precisely in materials science, and describes substances that return to their original form after deformation (Scharnhorst, 2012).

However, the term has long since left its origins and today brings the natural and social sciences closer together. The term was used in a sociological context by Murphy (1974) to describe the "resilient child" that lies dormant in every human being during their lifetime or in family relationships that have been able to overcome fractures, threads and crises together (Werner and Smith, 2019). The term was primarily coined in developmental psychology approaches to resilience. In a business context, the term first appears as a characteristic of employees and describes their physical resistance to stress, stressful influences and other circumstances in which an employee is exposed to an increased number of stressors (Gilan et al., 2018). In this respect, resilient employees are those who have the ability to remain mentally healthy despite adverse circumstances or to quickly regain their health (Gilan et al., 2018). Furthermore, authors state that in interdisciplinary terms, the term can be defined as the "tolerance of systems to disturbances". It appears in almost every sub-discipline of the social sciences and humanities: Whether in dealing with natural disasters in the framework of civil security (Kaufmann, 2015), in the philosophical framework in poverty research (Gutwald, 2015), in the framework of geological developments (Christmann et al., 2011), in psychology (Norris et al., 2008), or even in the ecological framework (Bennett et al., 2014). In the context of personality research, it was initially assumed that resilience is a permanent personality trait. Various experiments have since proven that it is an adaptive response to stressors that individuals manage better or worse (Lehr et al., 2018). The much more important insight from this change of assumption is that resilience can be achieved through learning processes, both for individuals and for collectives and therefore organizations. This massively increases its relevance in the economic context and has been leading to a new field of business concepts for some time now, which consulting institutions and company management alike have been pouncing on. The second

buzzword that often appears in the context of resilience for organizations is the VUCA world. VUCA stands for uncertainty, complexity, ambiguity and according to resilience researchers, makes building resilience in organizations indispensable and necessary (Heller, 2019). VUCA describes the difficult conditions that companies are exposed to in a highly dynamic and rapidly changing world (Mack and Khare, 2016). Today's concept of resilience thus encompasses a kind of situational learning effect through situational growth and maturation - but this can be understood as an effect that goes beyond the ability to master situationally resilient challenges, i.e. a neutral consequence, and at first glance softens the distinction between antifragility and other concepts such as salutogenesis, robustness, adaptability and transformability, making them conceptually related approaches (Anderies et al., 2013).

2.4 Antifragility

In the following chapter, the concept of antifragility is discussed in detail by setting out 8 theses. However, a distinction is first made between the concepts of resilience and robustness of systems. The discussion and delimitation of the terms serves to create an understanding as a basic theory for the following qualitative-quantitative research project and thus fulfills an essential part in achieving the objectives of the dissertation.

It is well known that there are elements that develop better in an environment characterized by uncertainty, volatility and unpredictability than in perfect stability, equilibrium and security. Antifragility examines why this is the case and posits that all human progress, dating back to well before the dawn of time, has been driven by this volatile and random world, which since the 1990s has often been referred to as the VUCA world (Heller, 2019). Taleb (2013) is considered the forefather of the term. But even before Taleb, there were terms that described similar concepts, at least to some extent. For example, the term *ultrastability*. *Ultrastable* systems are therefore also

characterized by the fact that the increase in stressors in the system does not, as expected, lead to an increase in chaos, but rather acts in the opposite direction and brings about an increase in order with an increase in stressors (Niemeyer, 1977). Wiener, Ashby and von Foerster (Beck and Ritter, 2019) put forward this theory in the 1950s when they abandoned empirical data analyses, which can always be characterized by historically occurring coincidences, in favor of analysis at model level (Heylighen et al., 1999). The stability of systems and their subsystems, also known as subsystems, indicates how well a system can return to its stable initial state in the event of a disruption. According to relevant business dictionaries companies are defined as multi- and ultra-stable systems (Stiller, 2024). Accordingly, if ultrastability prevails and the system is disrupted, it can adapt the subsystems completely or partially to return to an equilibrium state. In the case of multistability, new subsystems or partsystems can also be integrated to achieve this stability (Slot, 2024). For example, multi-stable companies can react in an agile manner and create new departments in the event of disruption to regain (economic) equilibrium. The concept of antifragility goes further than the theory of ultrastability and critically examines modern society in particular (Taleb, 2013). Society's attempts to impose more order on systems such as the economy by interfering, for example through legal regulations, do not change them positively, but prevent shocks and fluctuations that would trigger antifragility and thus bring about human progress within the systems. The article "Working with Convex Responses: Antifragility from Finance to Oncology" by Taleb and West (2023) defines antifragility in terms of response to volatility and variability. Antifragility is described as a mathematical property that refers to locally advantageous convex responses, as well as the generalization of fragility as its opposite, locally concave in the tails of the statistical distribution. Taleb and West (2023) establishes a link between the convexity/concavity of the dose-response function and the

statistical properties of the results. Antifragility refers to when a system benefits from this variability, much like the term "vega" is used in quantitative finance for an option or a nonlinear payoff, that is, its sensitivity to volatility or a similar measure of a distribution scale. Antifragility is therefore defined in this paper as the property of a system or entity to benefit from disorder, randomness, stressors or volatility. This is in contrast to fragility, where a system suffers or is harmed by similar conditions.

If we take a closer look at the distinction between the concepts of resilience and antifragility, which at first glance appear similar, antifragility goes one step further than the situation-elastic adaptation to framework conditions that exists in resilience and the resulting learning effect, and creates an overcompensation of the performance condition prevailing in the status quo towards an actual competitive advantage. This also becomes clear in the objective of the concepts. Resilience is about surviving a crisis and can be seen as a kind of insurance for the continued existence of the company. Antifragility, on the other hand, aims to welcome crises with open arms to emerge better from them.

Robust companies can withstand an attack but can be permanently destroyed with enough pressure. Resilience goes further: the more resilience a company has, the shorter the period between the onset of the crisis, the collapse of the system and the restoration of the system to its previous starting point. If VUCA (Mack and Khare, 2016) is added to this, i.e. several crises at the same time, companies react with agility. Instead of attempting to plan rigidly and inflexibly, a small-step approach is taken, thereby reducing the risk of delays in adaptation in the event of incorrect planning and thus of failures. Antifragility goes one step further, as described above: from the very beginning, it defines the unforeseen not as a crisis, but as stress, which can also be of a positive nature, for example through above-average growth that came unexpectedly for the company and presents it with the challenge of having to grow faster. An antifragile company would

absorb and carefully examine this stress, take a break, and emerge stronger. It neither collapses like a robust organization, nor does it try to return to the old status quo like a resilient organization but uses the stress to achieve qualitative growth. The related concepts thus appear to hold many promising prospects for a wide variety of challenges and crises. The interdisciplinary use of the terms is due to their descriptive and normative dimension (Brand and Jax, 2007); (Nida-Rümelin and Gutwald, 2016). They can sometimes wonderfully complement the interdisciplinary hype terms of sustainability and vulnerability with their concepts and have the potential to be widely cited as value-added concepts. At its core, however, only the concept of antifragility aims to align organizations in such a way that they can react as agilely and flexibly as possible to crisis situations to emerge from them not damaged, but at best stronger.

Now that the demarcation has taken place and has been explained in detail, the 8 theses will now be discussed and substantiated with examples.

The first thesis in relation to antifragility is therefore: **Fragile elements are destroyed by shocks and pressure from outside, whereas antifragile elements are strengthened by these seemingly negative influences and benefit from them (Taleb, 2013).**

In addition to the explanation of the concept of antifragility in the introduction using the fragile package, there are other examples to illustrate the concept succinctly. For example, a closer look at the evolutionary process reveals that every shock in the evolutionary process has led to an adaptation of life forms to so-called mutations. The evolutionary process therefore unfolds in an unstable environment. The life forms have benefited from the shocks, as they were subsequently better adapted to their habitats. Without these partial shocks, no successive adaptation would have taken place and the survival of many species would have been at stake. This is because if too great a shock

had occurred, which could not have been mitigated by partial adaptation, this would inevitably have led to the extinction of the species in question.

One example is the evolutionary process of the dog, which is known to have descended from the wolf. It is the ideal example of a life form adapted to humans. According to historical excavations, the evolutionary process goes back more than 15,000 years, where a dog has already been unearthed as a companion to humans near Bonn (Filser, 2016). According to one theory, wolves fed on meat scraps from humans and therefore adapted to the needs of humans instead of fighting them to coexist alongside them. Today, the dog is perfectly adapted to humans, whereas the wolf is threatened with extinction in some heavily populated areas. Further studies have shown that the well-known canine gaze is the result of an evolutionary adaptation to the human social system (StN, 2019). The so-called “canine gaze” - the loyal, innocent look with raised eyebrows - has evolved over the course of domestication. Studies show that dogs have a special muscle, the levator anguli oculi medialis muscle, with which they can raise their inner eyebrows. This movement makes their eyes appear larger and more childlike, which triggers caring reactions in humans. Wolves, the closest relatives of dogs, do not have this distinct muscle and therefore do not exhibit this behavior. It is believed that during domestication, humans unconsciously favored dogs that showed this look, which increased this trait over time (Arnold, 2019).

One thing that is important for the second thesis becomes clear: the evolutionary process is anti-fragile, as it benefits from the shocks that occur during the process. Individual organisms that are forced to adapt, on the other hand, remain fragile.

The second thesis is therefore: **The anti-fragility of a system is based on the fragility of the system components within the system** (Taleb, 2013).

In the example of the evolution of living organisms in particular, only the genetic code needs to be passed on, not the organism itself, to achieve progress. The same can be applied to the economic context. Companies in the logistics sector, for example, can fail and go bankrupt. The industry, on the other hand, learns from the mistakes of failure and continues to exist. It is even essential for the further development of the industry that companies in it are fragile and fail, as they release information about what fails and what works. Similar to living things: What works survives, what fails dies out (Taleb, 2013). If this were not the case, the industry would stagnate in its progress. The fragility of the components therefore promotes the quality of the economic system.

The third thesis is that pressure strengthens the antifragile system, as additional performance potential is built up through instability and shocks.

True to the management wisdom that options are better than predicaments, the stressors in antifragile systems ensure that performance potentials are built up in the event of shocks, which can cushion this as options in the event of future shocks. As an antifragile system, the human body builds up these capacities each time after exercise through adaptation and subsequent supercompensation. It first falls to a lower performance level due to the stressors and then exceeds the previous performance level through supercompensation (Weineck, 2010). This process can be measured by an increase in strength or an increase in the relevant muscle groups. The example illustrates quite succinctly how antifragile systems work. If the body is loaded with weights, it improves its ability to perform to be better equipped to deal with future stressors or dangers. Even if this build-up of performance potential is mostly surplus resources that are not needed. In economic systems, building up these surplus resources is often seen as inefficient, as these systems are built on the efficient consumption of resources for long-term success. Cost-cutting programs and lean management are used to create structures that are as

“lean” as possible, but which prevent the company from being prepared for real crises. This prevents the creation of a redundancy layer and ultimately prevents antifragility. It initially seems inefficient to create additional capacities that are not needed. However, when a shock occurs, these can be a company's salvation. Then the resources appear to be useful (Weineck, 2010).

The fourth thesis is: Volatility is the motor of an antifragile system - stability makes systems fragile (Taleb, 2013).

The concept of an antifragile system needs to be explained in more detail. A rough distinction can be made between organic or natural systems and synthetic or artificial systems. In other words, things that live and things that do not live (Taleb, 2013) Natural or organic systems are usually antifragile, whereas artificial or synthetic things are typically man-made and fragile. A tire, chair, table, etc. wears out and will never benefit from shocks, but will be destroyed by them at some point, as in thesis 1. Humans or animals as organic systems, on the other hand, can benefit from minor shocks and stressors through subsequent overcompensation, as in the examples of evolution, sport, vaccinations or hormesis. Despite this paradigm, there are systems created by humans, such as cultural customs, societies and economic systems and activities, which cannot be directly categorized in the clustering of organic and synthetic. However, as they follow their own laws and self-organization due to their complexity and resemble natural living beings in their complexity through layers and sub-layers, they can also have an antifragile structure. Complexity is therefore a sufficient condition for antifragility - but volatility is a sufficient condition for maintaining antifragility. As stated in the first 3 theses, antifragile systems only exist in the presence of fragile system components - some must fail to strengthen the system itself. The volatility of the system determines which fragile

systems fail and which persist. Without this volatility, there would be no improvement in the content system.

A good example of this are states that try to move markets in one direction through regulations and subsidies with the aim of strengthening the economy. However, this prevents any volatility, which means that there are no more shocks that would lead to successive small improvements and innovation in the market. The result is ailing structures that lead to the fall of companies within the industry in the event of major shocks. In Germany, sectors such as energy and transportation, telecommunications and financial services in particular banks are particularly affected (Chorowski and Kutner, 2020; Haucap and Coenen, 2011; Porter, 2013). In the German banking sector in particular, this approach has meant that the business model of many banks has hardly improved over the decades, as there have been no shocks and has led to various bank failures such as Maple Bank in Frankfurt 2016, Bremer Landesbank 2016, Süddeutsche Aktienbank in Stuttgart 2017, Wirecard Bank 2020 and Greensill Bank 2021 (Kommer, 2021). These banks are merely recent examples of actual bankruptcies without regulatory intervention by the state. Other bankruptcies have been cushioned and prevented by mergers and takeovers, such as in the case of Dresdner Bank (Reuters, 2009). In Italy, it is clearer how ailing the banking landscape is. Here, rescue packages worth billions are being put together by the state to keep the systems together (Forchheimer, 2016). However, the Bundesbank has apparently learned from its mistakes and is at least trying to regulate the banking landscape less to increase volatility and promote antifragility. An interview with Bundesbank board member Andreas Dombret states: “No, it is certainly not the task of regulation and supervision to completely prevent bank insolvencies. On the contrary: the best business models must be able to prevail. The task of regulation is to make market exits as market-friendly as possible - even for large or networked banks. We

are still lacking a breakthrough here, but progress is being made” (Hennersdorf and Fischer, 2014). Without any regulation, the market exit would probably be tougher, but the learning effects for banks that continue to operate would be significantly greater. Therefore, any form of regulation and cushioning of consequences is damaging to the system and creates increased fragility of the overall system at the expense of reducing the fragility of individual system components. This is because companies that do not act efficiently are protected by the regulations and rescue packages and do not exit the market at an early stage.

The fifth thesis is: with the right timing, antifragility can be beneficial.

Whether in the stock market or, for some years now, on the crypto exchanges. There are numerous reports on the relevant news sites about sudden winners and crypto millionaires on the marketplaces. It is noticeable that most of these people are not trading experts or crypto gurus or even have a high level of education. They simply took an option at the right time and sold their shares or cryptocurrencies at a higher price at the right time, thus taking advantage of the antifragile system. Market participants did not need to understand exactly how the stock market or cryptocurrencies work in detail to make a profit and they had no obligation to take the option to invest. However, similar patterns can also be found time and again in a private context. The randomness in antifragile systems enables us to become antifragile ourselves. The world is characterized by unpredictability: natural disasters, accidents, economic crises or even wars are usually unforeseeable and can occur suddenly. It is therefore not possible to prevent them. Instead, antifragility can be achieved through a kind of “domestication”, which is understood as the taming of biological or natural things through possibilities (Krotz and Thomas, 2007). This works with the dumbbell strategy, for example. In this strategy, the negative and positive extremes are forced like a dumbbell and the middle is largely ignored. On the negative

side, the dumbbell strategy attempts to largely avoid the most negative consequences that could occur, and which would probably lead to the user's ruin by minimizing the risk of occurrence. As soon as this risk reduction is secured and it is the case, for example, in the investment context that 80% of an investor's money is invested in safe havens where it is unlikely to generate much return, the focus begins to shift to the positive side of the barbell. Here, the investor can now use the remaining 20% to invest in volatile and so-called “risk-on assets”, which tend to be volatile but also offer great opportunities for profit (Schneider, 2017; Taleb, 2013).

With the dumbbell strategy, it is therefore possible to make large profits while simultaneously hedging purchasing power. After all, the risk of loss is minimized to 20%.

The sixth thesis is: Unexpected crises always hit large companies, institutions and organizations harder than small ones. The increase in severity correlates with the size of the system.

This thesis can be substantiated quite well using current examples. A person who only uses a car to do things in their free time has the option of filling up the car when it is cheapest and, if necessary, doing without these trips and doing other things. An employee, on the other hand, who has to drive to work every day because it is too far away, is in a predicament if fuel prices rise. At some point, they will be forced to fill up the car to get to work or buy alternative means of transportation. Now the example focuses on a single person who does not use much fuel in their car. The situation is very different for a haulage company that uses trucks. The situation described therefore hits them much harder. The situation is similar for an individual who works as a keynote speaker and is booked to speak at an important global conference in China. The speaker books a flight early, but it is canceled on the day of departure and has to change to an expensive last-minute flight. If the same situation were to occur with a 20-man soccer

team including crew, the size of the organization would also lead to a significant increase in the consequences. In both situations described, there is a predicament in which those affected have to do something regardless of the cost. Particularly with regard to the logistics sector, whose goal, according to this thesis, should be to achieve antifragility, it is noticeable that most companies in the logistics sector are very large and are therefore hit harder. However, this phenomenon can be observed in every industry due to the globalization of the economy. The world's corporations are much more susceptible to predicaments, which are the opposite of options. Global interdependence triggers uncoordinated and long-lasting chain reactions that are felt by everyone in the system. If the truck driver can't pay for the fuel, the food that is transported to the supermarket will become more expensive. And the prices for worldwide parcel shipping are also increasing. It's like a domino where the observer can no longer see the end of the line, triggering global and unforeseeable problems.

Seventh thesis is: The social desire to avoid volatility leads to increased fragility within society.

Due to the unpredictability of volatility, societies and therefore also politicians and economists strive to eliminate volatility. It is considered inefficient and time-consuming and completely disrupts the desire for steady growth. However, by attempting to eliminate and control volatility, society intervenes to make it controllable, the full extent of which is rarely predictable and can therefore be planned. By interfering, society removes the volatility needed to strengthen the system from antifragile systems. However, by avoiding vitality, many small problems can exist without negative consequences and thus add up to large problems and emerge explosively and unpredictably after a period of calm.

The following example is a good illustration: In Croatia, but also in other southern Mediterranean countries, there is always an increased risk of forest fires during periods of drought in summer. In order to limit the risk of a wildfire or as a defensive control method, small fires are set to create firebreaks that can stop the fire at the containment line in the event of a large fire (Kaulfuß and Hofmann, 2011). The smaller forest fires thus help to prevent a much larger fire. Volatility works in a similar way, recognizing and eliminating small problems and preventing major crises.

Eight thesis is: Society and therefore organizations, institutions and companies suffer from the “turkey illusion” and draw conclusions about the future based on the past.

Turkeys generally have a fairly carefree life. They are well fed by their owners, their health is taken care of and so on. Turkeys have a fairly carefree and worry-free life. Turkeys can therefore be reasonably sure that their owners like turkeys and that they will have a good future. However, this illusion is shattered quite suddenly and unpredictably at Thanksgiving, when they are slaughtered and eaten (Hauk, 2020). The turkey illusion as well as Taleb's Black Swan (Taleb, 2013) theory illustrate quite succinctly a problem of our time: society and thus organizations, institutions and companies try to forecast future events on the basis of a combination of an overvaluation of available factual information, the illusion of an understanding of current events, an overvaluation of the intellectual abilities of the elite and the illusion of an unrestricted and distortion-free view of past events. Huge sums of money are spent on risk and strategy managers to capitalize on the best-case scenario by forecasting the future. The findings only represent retrospective information and do not take into account the unprecedented, which is still likely to occur despite a lower probability of occurrence. The greatest risk of this approach is the illusion that nothing worse than the worst ever event can occur. As a

result, crisis plans are drawn up on the basis of worst-case analyses, the safety lines of which are symbolically knitted far too thinly and, in the event of a major crisis, break regardless of any planning.

The following rough and admittedly very general insight can be derived from the 8 theses: A broadly diversified preparation for the future is preferable to making forecasts and preparing for individual scenarios that appear to have the highest probability of occurrence. The potential to become antifragile is increased by hedging against all possible events, not just individual ones, and in case of doubt also by building up overcapacities and minimizing efficiency while incorporating the dumbbell strategy. Because what is certain is that nothing is certain. Surprises and coincidences of both a negative and positive nature will occur. This approach increases the proportion of options that hedge against the occurrence of negative events and minimizes the proportion of predicaments.

The related concepts antifragility and resilience thus appear to hold many promising prospects for a wide variety of challenges and crises. The interdisciplinary use of the terms is due to their descriptive and normative dimension. Antifragility in Logistics refers to a strategic framework that allows supply chains not only to endure shocks and disruptions but to thrive and improve as a result of these challenges. This concept, popularized by Taleb, emphasizes the need for logistics systems to be adaptable, decentralized, and innovative in the face of uncertainty, reflecting a significant evolution in supply chain management practices. In an increasingly volatile global market, where unexpected events such as natural disasters, economic fluctuations, and geopolitical tensions are commonplace, the ability to embrace rather than evade uncertainty is becoming a critical advantage for businesses

They can sometimes wonderfully complement the interdisciplinary hype terms “sustainability” and “vulnerability” with their concepts and have the potential to be widely cited as value-added concepts. At its core, however, only the concept of antifragility aims to align organizations in such a way that they are able to react as agilely and flexibly as possible to crisis situations to emerge from them not damaged, but at best stronger. This rather theoretical perspective is complemented by a practical component in the following chapter “Agile organizations and organizational forms”

2.5 Antifragility in the context of logistics

This paper synthesizes key research contributions in the field of antifragility, aiming to understand how organizations, particularly in logistics, can transform crises into opportunities through clear fields of application and application possibilities. For this reason, it is essential to show what the current state of research in the context of logistics looks like and whether there is already significant research on this subject or not. Antifragility in Logistics refers to a strategic framework that allows supply chains not only to endure shocks and disruptions but to thrive and improve as a result of these challenges. This concept, popularized by Taleb (2013), emphasizes the need for logistics systems to be adaptable, decentralized, and innovative in the face of uncertainty, reflecting a significant evolution in supply chain management practices. In an increasingly volatile global market, where unexpected events such as natural disasters, economic fluctuations, and geopolitical tensions are commonplace, the ability to embrace rather than evade uncertainty is becoming a critical advantage for businesses. Historically, logistics has evolved from ancient trade routes to sophisticated global networks, yet traditional models often prioritized efficiency at the expense of resilience. The shift towards antifragility began in earnest during the late 20th century as companies recognized the vulnerabilities inherent

in just-in-time manufacturing and centralized supply chains. Events like the oil crises and more recent disruptions, such as the COVID-19 pandemic, have highlighted the limitations of conventional approaches and sparked a growing interest in building logistics systems that can learn and adapt through adversity (DEUFOL, 2024; Unis, 2025; Wahyd Logistics, 2024). Key principles of antifragility in logistics include maintaining diverse supplier networks, employing real-time data analytics, and fostering a culture of continuous improvement. These practices enable companies to respond swiftly to market changes, mitigate risks associated with over-reliance on single sources, and leverage technology to enhance operational efficiency (Taleb, 2013). While antifragility offers significant benefits, such as improved adaptability and enhanced customer satisfaction, it is not without challenges. Critics argue that the concept can be misinterpreted, that its implementation may be difficult for organizations accustomed to traditional models, and that it may inadvertently increase systemic risks if not carefully managed (McGovern, 2024). Modern technologies can become essential for making companies in the logistics sector antifragile. They enable real-time transparency, rapid adaptability and continuous optimization through data-based decisions. The technologies are only roughly outlined so as not to exceed the scope of the dissertation. The most important technologies to support antifragility and their possible applications in an antifragile logistics company could be:

- **Blockchain:** This technology offers tamper-proof transparency along the entire supply chain (Stahlbock et al., 2018). Example: A global logistics company uses blockchain to document and monitor the origin, delivery and customs clearance of sensitive goods. This allows delays in the import process to be detected immediately and alternative procedures to be initiated.
- **IoT and sensor technology:** Sensors record important data such as location, temperature or humidity in real time (Ding et al., 2021). Example: A provider of

temperature-controlled transportation monitors its refrigerated containers with IoT sensors. If the temperature deviates, immediate measures, such as rerouting the transport or maintenance orders, are triggered automatically.

- **Artificial intelligence (AI):** AI analyses large volumes of data, recognizes patterns and provides precise forecasts for risks and demand trends (Kolmykova, 2020). Example: A logistics service provider uses AI to predict demand trends and dynamically adjust routes and storage capacities. This enables the company to react to market fluctuations at an early stage and avoid unnecessary costs.
- **Data analysis based on big data and predictive analytics:** Risk analyses and simulations are used to make informed decisions and simulate potential disruptions in advance (Roepert, 2020). Example: A logistics company simulates scenarios such as strikes or natural disasters and develops alternative supply chain strategies based on the data to prevent bottlenecks.
- **Automation and robotics:** Automated processes increase efficiency and flexibility in order processing (Dhaliwal, 2021). Example: A fulfillment center uses automated picking robots to make reliable and fast deliveries, even during seasonal peaks such as the Christmas season, without risking staff shortages.

But what does the literary landscape look like in terms of studies that deal explicitly with the achievement of antifragility by companies in logistics? The following section is intended to provide an overview of why this research gap still exists and why it is worth investigating: One of the first studies of Zitzmann (2014) scrutinizes the handling of uncertainties and risks within global supply chains, highlighting the significance of efficiency and complexity. It delves into various management frameworks, including agile, robust, and resilient supply chains, as well as continuity management and the concept of

antifragility. The study delineates these methodologies, exploring their distinctive features and synergistic potentials, thereby constructing a comprehensive framework for managing uncertainties in supply chains. The analysis highlights the need to integrate robust, resilient and agile management approaches to effectively manage the complexity and uncertainty of modern supply chains. However, it does not go into detail about which applications can be used to achieve this. In the study of Grössler (2020), antifragility in supply chains is operationalized and analyzed through system dynamic modeling and simulation. Antifragility is defined as the ability of a system to benefit from volatility and disorder. It is theoretically superior, but is compromised in practice by complex and dynamic environments. It finds that antifragility in real supply chains is highly dependent on assumptions about future external volatility. Once again, it is emphasized that it is necessary to investigate and contextualize antifragility in a complex and dynamic environment, but no areas of application are defined. Nikookar et al. (2021) challenges the conventional view of supply chains as fragile systems. They argue for a paradigm shift towards antifragility, inspired by Taleb's work (2013), suggesting supply chains should not just withstand but gain from disorder. This perspective is particularly relevant in the context of COVID-19, highlighting the limitations of focusing solely on robustness and resilience. The article emphasizes the need for supply chains to adapt and transform proactively in the face of disruptions. It redefines resilience in terms of social-ecological resilience and proposes that antifragility, as a dynamic and fluid property, can lead to both financial and non-financial gains. The authors conclude by suggesting future research directions, including how to build antifragile supply chains and the role of digitalization and sustainability in this process. This work significantly contributes to the foundation for the current research, underscoring the need for logistics companies to adopt antifragile strategies to thrive in an increasingly disorderly and unpredictable business environment.

Munoz et al. (2021) conceptualizes antifragility in organizations through organizational routines in uncertain environments. This theoretical framework provides a deeper understanding of antifragility in organizational behavior, despite its lack of direct application examples in logistics. This theoretical exploration lays a foundation for applying antifragility in organizational settings. However, it is also very general. Munoz et al. (2022) offers a comparative view of different organizational strategies in facing challenges. While providing a broader perspective, the study might not delve deeply into specific logistics applications. The examination of antifragile supply chains in the construction industry, specifically in the context of chaotic conditions, provides sector-specific insights into applying antifragility in supply chain management. This study is focused on the construction industry. Lastly, the review of various concepts including agility, robustness, and antifragility in supply chain management offers a comprehensive look at different strategies to handle supply chain uncertainties. Although broad in scope, once again it only improves the understanding of antifragility in the context of supply chain management and not the practical implementation in applications in the logistics sector. Ivašcenco's (2023) exploration ties the concept of antifragility to contemporary business challenges and innovations. Its discussion on the relationship between antifragility and business model innovation, especially in digital transformation, is a testament to the concept's relevance in modern business practices. However, its limited focus on digital transformation may not directly apply to all aspects of logistics either. Corvello et al. (2023) work on small and medium-sized service companies during COVID-19, offers practical insights into antifragility in crisis management. The study's emphasis on real-world applicability is commendable, though its focus on service SMEs might not represent the complexities of larger logistics companies. Raziee (2023) research on Artificial Intelligence (AI) and Machine Learning (ML) as antifragile drivers is highlighted for its

relevance in the logistics industry. The study explores how AI and ML not only withstand challenges but also adapt and improve from them, showcasing their potential to support antifragility. This research is crucial for understanding how these technologies can enhance decision-making, anomaly detection, and process automation in logistics. Raziee's (2023) findings offer valuable insights into utilizing AI and ML for developing resilient and opportunistic strategies in a dynamic industry landscape and therefore be one potential application. Nevertheless, this aspect necessitates a more in-depth examination and elaboration within the scope of this study.

In conclusion, while existing research provides a foundation for understanding antifragility in various business contexts, there is a noticeable gap in its application specifically to the logistics industry. The current research aims to bridge this gap by exploring how antifragility principles can be effectively implemented in logistics, thus transforming the industry's approach to handling global crises and uncertainties.

2.6 Agile strategies and organizational forms

Based on the prevailing literature, this chapter determines how the need for increased operational flexibility and continuous cross-organizational learning in times of crisis can be addressed through agile strategies and organizational forms.

As noted in the chapter on crises and disruptions, crises increase uncertainty due to constantly changing information and thus make it more difficult to maintain operations using traditional management operating models. Crises of an existential nature can spread quickly due to their novelty and unfamiliarity in addition to increased uncertainty. In the 2008 financial crisis, many companies were affected at the same time. The Covid-19 pandemic cumulated with the war in Ukraine and a global recession resulting from these and other social problems such as the over-indebtedness of most nations, unfunded

pension systems, incorrect interest rate policies and a disrupted financial and banking system is a much more serious crisis in qualitative terms. Uncertainty at a global level is rather rare. However, it can be countered with the same knowledge of agile strategies and forms of organization and the measures resulting from this knowledge as existential crises in individual organizations and communities.

Most companies, including stock corporations, have been working for decades with planning cycles in which the strategy, budgets and developments in each division for the year are clearly defined once a year. There are then hardly any changes to these plans during the year (Jones and Bouncken, 2008). However, other organizations have also established agile forms of organizational management in order to make planning more reactive and flexible. These strategies are understood as agile strategies and organizational forms. The techniques of these strategies enable managers throughout the company to recognize challenges and to overcome them quickly and flexibly, and are thus significantly equipped to help the organization survive crises with increased uncertainty. This is because operational requirements change with increasing uncertainty. Permanent review of prevailing assumptions and continuous adaptation and learning become a necessity for survival in uncertain times of crisis. Instead of a static and fixed plan, these models work with continuous changes to the plan in order to react dynamically to developments. They always work according to the same pattern of detecting changes using suitable sensors and early warning systems, examining the development and attempting to make a forecast and ultimately defining suitable measures to contain and, at best, overcome the challenge. In a nutshell: Detection, analysis, action. As this is a cycle due to the iterative process, the measure is followed by the detection. Just 21% of IT departments in which agile methods originated, 15% of research institutions and 13% of HR departments in Germany use agile working methods

(Schnabel, 2018). Around a third of all company managers in Germany assume that they already work in an agile manner as an organization, but if you ask employees, this is rarely perceived as the case. Agility seems to be perceived in part as a fad that will pass, whereas it is much more a way of dealing with a world of rapidly changing conditions in the form of disruptive technologies and digitalization as well as numerous other megatrends. Those who act agilely emerge as winners. This can be quantified: Companies that rely on agile methods are up to 5x more successful than their market competitors (Roghé et al., 2017). For a clearer classification of the term agility and the resulting procedures, it is necessary to describe the original model, the agile manifesto, which was written in Utah in 2001 by software development leaders (Beck et al., 2001).

It follows the following 4 guiding principles:

1. individuals and interaction are more important than processes and tools,
2. the focus is on functioning products rather than extensive documentation,
3. cooperation with the customer is more important than pure contract negotiations,
4. reacting to change is more important than simply following a plan (Beck et al., 2001).

Both sides of the four guiding principles are relevant, but those on the left are more important than those on the right. Looking at the guiding principles in detail, it is quite clear that they are hardly ever practiced in German companies. The first guiding principle means that employees and their interaction have priority over processes and tools. In large companies in particular, silo thinking and a “clean my desk policy” prevail instead of cross-departmental and interdisciplinary cooperation. Once processes have been defined, they are vehemently defended with phrases such as “That’s the way it is” and

“It's always been that way”, which simply prevents simple solutions. Making new products marketable quickly often fails due to internal bureaucracy and adapting to changing market situations quickly becomes a stumbling block in large companies, as organizational inertia delays decisions for a long time or prevents them altogether in the short term. In order to promote and support the ability of agility in companies and business units, there are numerous methods and frameworks that serve as support for teams and organizational departments to a certain extent. The options available and how these can make the organization and its form more agile will be examined in the remainder of this chapter. First of all, however, it should be noted that agility and the associated ability to be forward-looking, innovative and reactive would not appear to be part of human nature if special techniques had to be learned. However, a different way of looking at agility is often the decisive factor. This phenomenon is described in the specialist literature in two different ways: The formal view and the complementary view (Tißen, 2019). The formal view sees agility as what it is usually labeled. It is about adapting quickly in a rapidly changing environment in order to constantly satisfy changing customer needs and focusing a transformation process on the use of innovation and disruptive technologies. The following terms are understood as core elements of the formal perspective: Transformation, innovation, adaptation, speed. (Omol, 2024)

However, agility must inevitably be expanded to include the supplementary perspective in order to be successfully established. This is also shown by a study by Prange, who looked at companies that see agility as a concept that strengthens and reflects resilience alongside speed and adaptability. The core idea of this way of thinking moves away from agility, which means “everything must be changed”, towards a balance between preserving the old and trying something new. This makes it possible for companies to

preserve old values and at the same time establish new, contemporary values in corporate management. This requires measures that complement the concept of agility through resilience-building, active reflection and the conscious timing of opportunities, making it a complementary approach. The formal view sees agility as what it is usually labeled. It is about adapting quickly in a rapidly changing environment in order to constantly satisfy changing customer needs and focusing a transformation process on the use of innovation and disruptive technologies. The following terms are understood as core elements of the formal perspective: Transformation, innovation, adaptation, speed. However, agility must inevitably be expanded to include the supplementary perspective in order to be successfully established.

This is also shown by a study (Clauss et al., 2019), who looked at companies that see agility as a concept that strengthens and reflects resilience alongside speed and adaptability. A key finding from the study by Clauss et al. (2019) is that strategic agility does not contribute to improving the performance of companies in isolation, but rather develops its added value in particular through the promotion of business model innovation. The authors identify three key dimensions of strategic agility - strategic sensitivity, leadership coalition and resource flexibility - and show that these capabilities enable companies to continuously adapt and innovate their business models. This makes it clear that agility is particularly effective when it is used specifically to design innovative business models. The core idea of this way of thinking moves away from agility, which means “everything must be changed”, towards a balance between preserving the old and trying something new. This makes it possible for companies to preserve old values and at the same time establish new, contemporary values in corporate management. This requires measures that complement the concept of agility through resilience-building, active reflection and the conscious timing of opportunities, making it

a complementary approach. A current method for evaluating whether the use of agile methods in organizations makes sense is the application of the Stacey Matrix. This was published in 1996-2001 by Ralph Stacey as “Complexity and the Group Matrix” in various literature (Stacey, 2001, 1996).

However, the published version served as a management strategy in times of uncertainty. As a professor at the University of Hertfordshire, Stacey was mainly concerned with organizational theories and the complexity of systems (BCom. and Hertfordshire, n.d.). The original version dealt with the answer to the question of how decisions should be made by organizations in times of uncertainty and which management strategies should be used. The first version should not be understood as a matrix, but as a model for situational management of organizations. The X-axis of the original version went from certain to uncertain and thus described the level of certainty, the Y-axis from full agreement to no agreement as a description of the agreement of decision-makers in organizations. Stacey, on the other hand, used the model to try to explain the uncertainty paradox. If the management of a company creates plans and is demonstrably unable to achieve them because there is no agreement from within the company, what should be done? His result, which he wanted to describe with the situational model, was “complex action as a response to uncertain situations and not, as is often misleadingly presented, complexity as the intersection of uncertainty and disagreement” (Stacey, 1996). The original matrix results in the 5 fields of action that I have translated from the original: Implement, Negotiate, Advise, Create and Interact.

Realize: With maximum certainty and full agreement, nothing stands in the way of implementation through simple, quick but rational decisions (in the original “technical rational decision making”).

Negotiate: With maximum certainty and slight disagreement between the decision-makers, it makes sense to negotiate about the steps to be taken (in the original “political decision making”). However, the necessity of an action must be clear to all those involved, otherwise the decision-making process may be delayed or no decision will be made.

Consultation: There is full agreement between all those involved, but in times that are not entirely certain. Experts who can correctly assess the situation should be on hand to advise and support the management. (in the original “judgmental decision making”

Creativity: With increasing disagreement and certainty, decisions and their decision-making become increasingly complex, as the number of opinions and the pressure of uncertainty increase at the same time. In this case, creativity and openness to new solutions are required. In the original, Stacey speaks of “complex decision making”. Current transformation projects triggered by digitalization can be seen as the best example of creativity phases in the corporate context. There are numerous ways and possibilities to implement digitalization and various opinions as to which path is the right or wrong one. At the same time, digitalization is leading companies into increasing uncertainty, as missing out can be associated with missed opportunities.

Confusion: In the last area, there is no longer any unity in the organization and it finds itself confronted with maximum uncertainty. In this situation, companies can easily fall into confusion, as the opinions of those involved are so diverse that organizations run the risk of becoming unstructured. In the reduced continuation of the Stacey Matrix 2004 by Ken Schwabers in “Agile Project Management With Scrum”, he also describes this state as anarchy (Schwaber, 2004).

The 4 areas simple, complicated, complex and chaotic result from the dimensions of the what-requirement and how-procedure. The what requirement is determined by the

progression from clear or unambiguous to unclear and ambiguous requirements for the respective project or organizational goal. The specific question of the Y-axis dimension is: What problem needs to be solved and what requirements are associated with it? The how approach is determined by the progression from clear and known to unclear and new or untested. The specific question on the X-axis could therefore be: How and with which methods should we proceed in order to solve the problem in the best possible way? These two dimensions result in the strategies described above, which look like this in detail:

Simple: No agile methods are necessary here, as the requirements and the procedure are already clear. The “best practices” must be applied. Using agile methods only leads to more work, which is inefficient.

Complicated: The number of unknowns in the equation has increased in this sector and is no longer directly manageable. The use of agile methods already makes sense in this sector. These can be Kanban boards, for example, in which the tasks are visualized and thus improve the workflow. Kanban boards are ideal for allowing project teams to proceed in a structured manner in complicated projects.

Complex: In this dimension of the Stacy matrix, the various variables and unknowns now also interact, which excludes predictability from the outset.

To better understand the effectiveness of agile strategies in times of crisis, it is essential to embed them in broader theoretical frameworks. One key foundation is the concept of Complex Adaptive Systems (CAS), which describes organizations as dynamic, networked systems capable of evolving in response to environmental stimuli (Stacey, 1996). Unlike mechanical systems with linear cause-effect structures, CAS thrive on

iteration, feedback, and emergent behavior – conditions under which agile methods like Scrum or the Spotify model unfold their potential.

Building on this, the theory of Antifragility (Taleb, 2013) goes beyond resilience by highlighting how systems can actively benefit from volatility, stressors, and disorder.

Agile organizations - particularly those with decentralized decision-making, fast feedback loops, and iterative development - exhibit precisely these antifragile properties. They don't just survive crises; they improve through them.

Another relevant framework is the Dynamic Capabilities theory, which emphasizes an organization's ability to sense, seize, and transform in rapidly changing environments (Teece et al., 1997). Agile methods serve as enablers of these capabilities, supporting continuous learning and resource reconfiguration in real-time.

Lastly, the concept of organizational ambidexterity (O'Reilly and Tushman, 2004) explains the strategic tension between exploration and exploitation—between innovation and operational efficiency. The complementary perspective on agility, as discussed by Clauss et al. (2019), aligns with this by showing that true agility lies not in constant change, but in the balance between preserving core strengths and pursuing adaptive transformation.

The use of agile methods becomes a necessary condition for project success. In times of uncertainty and crisis, it is precisely these interdependent variables that are largely responsible for unpredictability, as they set off chain reactions whose consequences are unforeseeable due to their complexity. In this case, it is only possible to make assumptions about outcomes and react to changes in the assumptions through agile readjustment. The use of agile project methods in the individual affected areas of the company is suitable for this, which are roughly described below due to the scope limitation of the work:

The Scrum model describes an incremental and iterative approach for project teams. Product versions are created one after the other in individual sprint phases, which are continuously improved by obtaining direct feedback after each run until a finished product is available. For this purpose, a project team with different roles is familiarized with the various phases.

The Scrum roles at a glance:

Scrum Master: The Scrum Master ensures that the Scrum rules are adhered to (Atlassian, 2025a).

Product owner: The product owner is responsible for the final product. It is more or less his or her project result (Atlassian, 2025a).

Developers/participants: Support by co-developing the project with their areas of expertise

Stakeholders: Stakeholders are outside of the project team but still have an impact on it. These can be clients, customers, internally also the management of the company or users of the final product.

The following 3 artifacts in Scrum projects can be understood as work results. They are continuously adapted as the project progresses and are: The project backlog, the sprint backlog and the project increment.

Product backlog: The product backlog contains the requirements that the finished product must have. These are sorted by importance within the log. It is maintained and constantly adapted by the product owner. This can be done by adding or removing requirements, but also by re-sorting the priorities based on new findings (Scrum Alliance, 2025).

Sprint backlog: The sprint backlog can be understood as a kind of work list on which work instructions are recorded after each product backlog, which must be completed in the sprint (Scrum Alliance, 2025).

Product increment: After each sprint, there is a product increment, which can be understood as an intermediate product. It must fulfill the requirements from the current version of the product backlog (Scrum Alliance, 2025).

In addition to the Scrum roles and artifacts, it is now necessary to describe the 4 events that take place in each sprint of the Scrum process:

Sprint planning: Sprints are planned at the beginning of each sprint. Approximately 2 hours are required per sprint week. To this end, the product owner defines the objectives of the sprint by defining the requirements. The participants/developers then agree on how the goal can best be achieved and which steps need to be taken. The requirements and steps must now be manifested in the sprint backlog (Scrum Alliance, 2025).

Daily Scrum: The team meets daily for the Daily Scrum, which lasts approx. 15 minutes, to discuss the daily tasks in a brief exchange and to provide a brief status of what has already been worked on, what is pending for the day and what may stand in the way of the sprint goal. (Scrum Alliance, 2025).

Sprint review: At the end of the sprint, a sprint review takes place, which lasts approx. 1 hour per sprint week and presents the result to the stakeholders. The product backlog is used as a comparison to the achieved goal and the product increment is tested. The product owner can record the feedback in the product backlog and adapt it as a basis for the next sprints (Scrum Alliance, 2025).

Sprint retrospective: At the end, the sprint retrospective takes place in approx. 45 minutes per sprint week, in which the sprint is reflected upon. However, this is not about

the product increment but about the team's cooperation and how this can be improved if necessary (Scrum Alliance, 2025).

Scrum is just one of several concepts that can be used in complex situations. In addition to Scrum, other procedural agile methods such as “Objectives and Key Results” (OKR) can also be used (Mooncamp, 2025).

The Spotify model takes a completely different approach, which can also increase the innovative strength and productivity of companies in complex situations, but is not directly counted among the process-based agile methods, but rather uses them in subgroups. The Spotify model is an autonomous model for the agile scaling of companies by focusing on employee orientation, culture and network, communication, responsibility and autonomy. It can therefore be described as an agile organizational model (Atlassian, 2025b; HiQ, 2025; Kniberg and Ivarsson, 2012). Unlike the previous models, the Spotify model does not act as a framework or process, but as an organization of a company consisting of different teams with a focus on the necessary conditions of culture and network. At its core is the structuring of companies to enable and facilitate agility. Each team can autonomously choose and implement a previous agile model such as Scrum, OKR, Kanban, etc. In the Spotify model, a team is simply called a squad (Atlassian, 2025b; HiQ, 2025; Kniberg and Ivarsson, 2012).

All components of the Spotify model at a glance:

Squad: As above, describes an autonomous team consisting of 6-12 participants that can choose its own agile method or framework.

Tribes: Describes several squads within a functional area that coordinate in parallel. A tribe consists of up to 150 employees. The tribe is managed by a tribe lead, who coordinates the collaboration between the squads in a supportive manner.

Chapter: Although the squads are autonomous teams, there are certain experts in each squad who differ in their functional area, such as designers, developers or engineers. They in turn belong to a type of expert in the chapter, who also exchange information with each other. The chapter is led by a leader in the field of technology of the genre.

Guild: So-called guilds can be founded by team members in different areas of interest, similar to AGs at school. Guilds can consist of different tribes and squads and their participation is voluntary. They are coordinated by a guild leader, who is appointed by the guild and helps to organize the guild.

Trio: Each Tribe has a Trio consisting of the 3 functional areas of Product Management, Design Management and Tribe Lead, which ensures coordination within the Tribe from the 3 perspectives.

Alliance: If several tribes have to work together, an alliance of several tribes and their trios is formed in order to achieve parallel coordination of the tribes. This makes sense for 3 or more tribes and enables all tribes to work towards the same goal.

The Spotify model has numerous advantages. It focuses on the organization around the work, not on the work, and thus enables squads to determine their own processes. As a result, it sustainably promotes the autonomy and self-determination of the team to achieve the goal in the way the team deems appropriate, instead of dictating to the team that certain methods must be used. We can speak of decentralized decision-making, which takes place in an environment of high trust towards the employees. This promotes the motivation of the squad members and can ultimately lead to higher customer satisfaction. However, for the Spotify model to work, these key cultural elements (trust and autonomy) must be practised in the organization. Many companies, especially matrix-structured organizations, fail in this attempt because the cultural adaptability of the company does not exist and teams are simply renamed squads. Of course, this has no

lasting effect (Atlassian, 2025b). When applying the Spotify model, Spotify's original model should therefore not be copied outright, but adapted to the company's needs and the goal of promoting collaboration within the company. The key elements of trust and autonomy must be guaranteed and all employees must be brought on board transparently during the restructuring process. Only with transparent communication can employees be engaged. Communication is not a one-way street. Simple tools for giving feedback are also fundamental, precisely because the establishment of agile models depends on iterative development processes that require an open culture of error in order to grow through experiments that can fail (Kniberg and Ivarsson, 2012). The greatest innovation takes place in the area of chaos, the last section of the Stacy Matrix (1996), which is characterized by the maximum number of mutually dependent variables, which is why this area should by no means be actively avoided or avoided by companies. In order to achieve this innovation, an iterative process is crucial for the development of successful innovations (Atlassian, 2025b). Processual agile methods tend to be a hindrance here, as fast action, experimentation and a constant flow of information are required. Methods such as design thinking and the lean startup method are suitable, as are the fastest possible breakthrough to a minimum viable product (MVP). As companies stay in the zone of maximum complexity even in uncertain times and do not have to develop completely new business models whose requirements they do not know, the models are not discussed further and the transition to the research project now takes place.

This chapter shows that agile strategies and organizational forms are not just reactive tools for operational management, but integral components of a broader theoretical understanding of how organizations can operate and evolve under conditions of uncertainty. Building on the discussions of crises, disruptions, robustness, resilience, and

antifragility in the preceding chapters, agility emerges as a practical manifestation of antifragile thinking—characterized by iterative learning, decentralized decision-making, and adaptive resource allocation.

The integration of theories such as Complex Adaptive Systems (Stacey, 1996), Antifragility (Taleb, 2012), Dynamic Capabilities (Teece et al., 1997), Organizational Ambidexterity (O'Reilly & Tushman, 2004), and Sensemaking in Organizations (Weick, 1995) provides a comprehensive conceptual foundation. Together, they clarify why agile models such as Scrum, OKR, or the Spotify framework do not represent isolated methodologies, but rather structured approaches that enable learning, innovation, and ultimately organizational survival in volatile environments.

This theoretical consolidation forms a robust basis for the empirical research that follows in the next chapter. It ensures that the study of potential antifragility applications in logistics is not only rooted in practical phenomena but is also deeply embedded in relevant organizational theory. Thus, the transition from theory to applied research is logically and systematically completed.

CHAPTER III: QUALITATIVE RESEARCH PROJECT

3.1 Research methodology

The methodology for this study involves a mixed-methods approach that integrates both qualitative and quantitative research techniques to investigate potential applications of antifragility principles in the logistics industry. This approach is particularly suited to address the identified research gaps regarding the concept of antifragility and its practical implications in logistics. Initially, the study delves into a detailed analysis of existing literature, encompassing both academic and practical insights into antifragility, resilience, and robustness and in related fields such as agility methodologies in the context of logistics, supply chain management and organizational structures and behaviors. This review serves as the foundation for understanding the current state of knowledge in the field and identifying gaps where further exploration is required. The design corresponds to the guiding principle of the structure of empirical social science research processes, starting with the formulation of the research question followed by theoretical considerations in the chapters and the development of a research strategy carried out here. The second phase of the study involves conducting qualitative interviews with 4-5 industry experts from various companies within the logistics sector. The selection of a qualitative research design is intentional, as it allows for open-ended questioning and discovery, providing rich, in-depth insights into the potential applications of antifragility in logistics. This exploratory approach is crucial for gaining new understandings in an area where conceptual clarity and practical applications of antifragility are still evolving. To ensure comprehensive and relevant insights, the study will focus on interviewing long-standing industry insiders who have interdisciplinary and international exposure in the logistics field. These interviews aim to extract nuanced perspectives on how antifragility can be implemented and leveraged within the logistics sector. Possible

interview partners are selected by researching the largest logistics companies by turnover. Experts from these companies are then selected and asked to participate in an interview. The experts must demonstrate numerous quality factors such as interdisciplinary experience in various positions and many years of experience in the logistics industry preferably in an international environment. After selecting the interview partners, a detailed interview guide and an open questionnaire are developed. The interview should enable a focused yet flexible discussion. The interviews take place via video conference and are recorded. This transcription of the content and the linking of facial expressions and gestures to what is said increases the informative value of the interviews. The pure duration of the interview is designed for approx. 20 minutes while all interview phases last approx. 45 minutes. Mayring's content analysis provides the rough framework for the qualitative evaluation carried out in this work. The object of the analysis is communication recorded in text, i.e. fixed communication (Mayring and Fenzl, 2019). It is guided by rules and theories and thus proceeds systematically (Mayring and Fenzl, 2019). The content analysis is based on the preliminary understanding of the subject matter from the basic chapters. Preconceptions are explicitly formulated before the content analysis begins. The Mayring table is used as the analysis technique, through which a summarizing content analysis since an interest in the content level of the material prevails. of the material prevails (Mayring and Fenzl, 2019). At the beginning, evaluation units are identified and paraphrased for each question. The context units are then broken down by guideline sections through generalization and subsequent reduction to the core statement for each interview. The most important statements are thus extracted from the transcription, brought to a similar linguistic level and generalized and reduced to the essential statements. The reduction serves as the basis for formulating hypotheses. These hypotheses are then tested in the quantitative phase.

Following the qualitative phase, the study will incorporate a quantitative approach, employing descriptive and inductive statistics with a sample size of $n \geq 400$. The quantitative analysis will focus on capturing correlations and assessing probabilities of occurrence, thereby enabling the formulation of clear, actionable recommendations for the industry. The combination of qualitative and quantitative methods will allow for a thorough exploration of antifragility in logistics, providing both depth and breadth in the analysis. The qualitative interviews will offer detailed insights and uncover new possibilities, while the quantitative analysis will validate these findings and quantify their relevance and applicability (Raithel, 2008). A cross-sectional study is conducted using the survey method: online questionnaire. Primary research by means of an online survey was chosen for the purpose of research economy in this study. It enables the collection of large amounts of data using electronic communication devices while saving the scarce resource of time (Raithel, 2008). Several participants can take part in the same survey at different locations at the same time. This leads to a high response rate within a short period of time. The data is then directly available and can be collected centrally in digital form. Interviewer effects, which distort the objectivity of the survey, are also eliminated by the survey method. One disadvantage of the survey method, which can lead to distortions, is that there is no identity check and therefore samples may be recorded twice (Schwaiger and Zimmermann, 2011). Filter questions and time stamps are used to eliminate incorrectly completed surveys before the data is processed. In the quantitative phase, too, a questionnaire is developed in advance based on the data from the qualitative research and made available via the online survey tool as described. The survey period still needs to be defined. The work is based on one population. In order to capture the construct "company in the logistics industry", a certain degree of abstraction is necessary, which limits the scope of the research. Companies in the logistics sector form their idea

through the people who work within the companies. Under this assumption, the samples of the population "companies within the logistics industry" are samples with a reference to activities in the logistics industry. To ensure the random selection of samples necessary for the research project, the following procedure is used, differentiated by population. It should be noted that no secondary statistical data is available as a comparison for the population. A multi-stage selection procedure is used to ensure a random selection within the population despite the selection procedure and the absence of a list of the elements of the population (Röbken and Wetzel, 2017). For this purpose, all companies that have agreed to participate in the quantitative survey are drawn from a lottery pot and the employees are then invited to take part in the survey. This continues until the critical mass of $n \geq 300$ is reached. After completion of the field phase, the data consisting of the online survey data sources are merged into the "Antifragility applications" data set in Excel to form a CSV file and loaded into the R statistical software. This is followed by a descriptive description of the data according to location measures of the population to validate a normal distribution within the field data. The median as well as the arithmetic mean, and the 4 quartiles are determined for this purpose (Röbken and Wetzel, 2017). This is followed by a descriptive description of the recorded variables using bar charts, box plots or Lorenz curves, depending on their characteristics. The statistical evaluation culminates in the inductive analysis of the data set using a combination of univariate, bivariate and multivariate methods depending on the data structure: Frequencies, mean values, percentages, measures of dispersion, crosstabs, correlation, bivariate regression, comparison of means, partial correlation, multiple regression analysis, analysis of variance, discriminant analysis, structural equation modeling, factor analysis, cluster analysis, multidimensional scaling, mean difference tests with permutation, proportion value tests with simulation and χ^2 independence tests (Raithel, 2008). However, the set

of inductive analyses can be expanded during the research. The quantitative research concludes with the formulation of concrete recommendations for the application of recorded antifragility promoters. These could, of course, serve as a basis for further qualitative surveys in future work.

3.2 Selection and introduction of interview partners

To develop the most detailed recommendations for action and a concrete procedure for achieving antifragility for the logistics industry in this thesis, it is imperative to interview long-standing industry insiders with interdisciplinary and international points of contact in the logistics industry. All the experts available for this thesis have many years of experience in the logistics industry at well-known companies with national and international functions and can therefore assess the concept of antifragility holistically and contextually on the basis of a comprehensive picture of the industry. 3 of 4 interview participants were anonymised in accordance with GDPR, the Interview Consent Form and common qualitative research standards. The first interviewee is Volker (Sales & Operations Executive KEP Carrier), who has been with UPS for over 30 years and currently holds the position of German South Sales Manager. He started out as a delivery driver and switched to sales relatively quickly, where he worked in almost every position. He then played a key role in setting up the German internal sales team, followed by area sales management of a field sales team. Subsequently, Volker helped to develop the risk assessment and planning for the German sales organization of UPS. This area of experience in particular is a sufficient qualification for the assessment of the anti-fragility concept. After a further 2 years, Volker took over the Small Business Customer Management with all functional areas in Germany and managed approx. 160-170 employees. The next stage in his career was the Sales Strategy department, where he was responsible for developing the long-term strategy for EU sales. In this role, he reports

directly to the Member of the Board at the EU headquarters in Brussels. After six months, Volker took over the Sales Training department for the DACH and ISMEA region for the next seven years, until he moved into his current role as Head of Sales in Northern Germany. Due to Volker's many years of interdisciplinary experience in both day-to-day operations and strategic planning, he is ideally suited as an expert for gaining insights in this study.

The second interviewee is Markus (Senior Manager KEP Carrier), current UPS General Manager for UK & Nordics in the role of Country Manager (previously 2 years in the same position for Austria and Switzerland). Markus worked in Germany for the first 11 years, 7 of them in sales and 4 years in HR. He then ventured into the international environment in various HR functions. First as HR Manager in Western Europe and then as Vice President for HR and Labor for the whole of Europe. At the beginning of 2022, Markus made a change of perspective and moved into the role of General Manager for Switzerland and Austria and most recently in the same function for the UK and Nordics from London.

Markus's 16 years of experience in the international sector have given him a comprehensive overall picture of the European logistics industry, thanks to his activities in various Europe-wide functions. On this basis, he is able to provide a broad range of insights for this thesis. His somewhat different focus of activity also sets him apart from the first interviewee and completes the picture of the first interviewee. A different focus also allows a clear distinction to be made.

The third interview partner is Oliver Rütter. Oliver has more than 25 years of professional experience in the logistics industry and has held various national and international management positions during this time. His professional background includes both operational responsibility and management roles in logistics companies, as

well as the development of digital and networked business models. In addition to classic logistics expertise, Oliver brings in-depth knowledge in the areas of IT, network structures, and process optimization. With his dual perspective of traditional logistics and digital transformation, he provides valuable insights into structural, organizational, and technological developments in the industry.

The fourth interviewee is Boris, a senior executive with more than 25 years of experience in the logistics industry. His career spans operational, commercial and digital transformation roles across major European logistics organizations. After starting in traditional freight forwarding, Boris spent over two decades in a large international logistics group, where he advanced from key account management into senior leadership and later built one of the company's largest digital and IT organizations. In his subsequent role at another major logistics provider, he was responsible for last-mile operations as well as founding and leading a dedicated digital and SaaS unit.

Boris's long-standing experience at the intersection of logistics operations, digital product development and organizational transformation enables him to offer a multi-layered perspective on crisis management, agility and antifragility. His industry background differs notably from the other interview partners: while the first two interviewees are embedded in classical parcel and express logistics, Boris provides insights shaped by contract logistics, last-mile innovation, and digital business models. This complementary viewpoint further enriches the overall understanding developed in this thesis.

3.3 Development of discussion phases & guidelines

The interview takes place via the video conferencing tool Microsoft Teams and is recorded in video and audio. This offers the advantage that passages can also be transcribed and interpreted using gestures and facial expressions if they are formulated verbally with uncertainty. The interview takes place roughly in 4 interlinked phases:

1. warm up: In the first section of the interview, a brief greeting and small talk take place to create a relaxed atmosphere. This phase of the interview is deliberately not recorded.

2 Structure and procedure: In the second phase, the structure and procedure of the interview is roughly clarified in order to give the interviewee a certain overview and certainty about the structure of the interview. The structure also makes it clear that the interview will be recorded, anonymized if desired and treated confidentially.

3. interview phases: In the third phase, the open interview takes place with the aid of the following guidelines.

- a. Interviewer opening with a general open question without a direct topic focus with reference to the experience elicitation.
- b. Detailed follow-up on the topics of action in times of crisis, structure of the company and best practices.
- c. Specific questions on agile methods and organizational forms.
- d. Explanation of the concept of antifragility through theoretical background from the thesis.
- e. Specific questions on the concept and transfer questions on feasibility in the logistics sector.
- f. Recording of missing aspects to ensure that all areas have been examined.

4. final phase & adoption: Finally, in the closing phase, the final assessment of the problem is made. The interviewee is then bid farewell.

Section 1. serves to elicit experience:

1. how long have you been in the logistics industry and what rough stages have you gone through in which companies in the logistics industry?

Section 2: Acting in uncertain times:

2. how does your company plan in “normal times” with few disruptive factors or what planning processes are used?

3. which years were particularly volatile and how did you act?

4. what worked well in the planning process in crisis years?

5. what failed and therefore did not work?

6. what should work better?

Section 3 Company Structure & Best Practices:

7. how is the company you work for structured?

8. do you know best practices for operating in uncertain and volatile times from other companies in the same industry?

9. do you know best practices for operating in uncertain and volatile times from other companies in a different industry?

Section 4 Agile methods:

10. which process-based agile methods do you know?

11. do you know the process-based agile method Kanban Board?

12. do you know the process-based agile method Scrum?

13. do you know the process-based agile method Objectives and Key Results Model, OKR model for short?

14. do you use such methods in your company - if so, what is your experience and can you make recommendations for your company?

Section 5 Agile forms of organization:

15. are you familiar with agile forms of organization such as the Spotify model?
16. do you see such an organizational approach as an alternative approach for a company in the logistics sector?

Section 6 Antifragility concept:

17. many companies pursue strategies that make them more robust, but there is an approach not only to cushion crises, but to welcome them, as they actually strengthen the company's competitiveness. Can you imagine what this means?

The following is an excerpt from the chapter on antifragility in order to present the concept to the interviewee in an understandable and comprehensive way.

- 18 Where do you see problems with implementation?
19. do you think it is a suitable concept and where do you see advantages of the concept?
20. to what extent do you consider antifragility to be a feasible concept for your industry - what would have to happen for companies to position themselves in this way?

Section 7: Recording of missing questions/aspects

- 21 Was an important aspect of crisis management overlooked or not asked in my questions?

Between the guideline questions there are confrontation questions & comprehension questions for control, e.g: Can you give an example? Can you describe this in more detail? The guideline should therefore not be understood as a rigid list of questions, but rather as a rough framework. In addition, empirical values are recorded between the two interviews and slight modifications may be made to the questions to improve them.

Section 6 of the guideline in particular forms the basis for theory development and is therefore essential for achieving the objective.

CHAPTER IV:
QUALITATIVE DATA EVALUATION CONTENT ANALYSIS & KNOWLEDGE
GAIN

4.1 Process introduction and formulation of implicit premonitions

Mayring's content analysis provides the rough framework for the evaluation carried out in this paper. The object of the analysis is communication recorded in text, i.e. fixed communication according to Mayring. It is guided by rules and theories and thus proceeds systematically (Mayring and Fenzl, 2019).

The content analysis is based on the preliminary understanding of the problem from 1.1 - 1.4. Preconceptions are explicitly formulated at the beginning of the content analysis in 4.1. The information is collected through an interview, participation in which is voluntary. The interview is conducted by the author via the digital communication tool Teams in the form of a video conference. There is no incentive in the form of a mutual agreement. The material on which the analysis is based is semi-structured, which is why the interview is based on the guidelines from 3.3, although these are not rigidly adhered to during the interview, but are flexibly adapted to the statements. As described in 3.1, the information comes from expert interviews with 4-5 random samples. The material includes information from employees in management roles at companies in the logistics sector. The Mayring table is used as the analysis technique, through which a summarizing content analysis is carried out, as there is a predominant interest in the content level of the material (Mayring and Fenzl, 2019). At the beginning, evaluation units are identified and paraphrased for each question on the basis of the guideline from 3.3. (Mayring and Fenzl, 2019). Subsequently, the context units are broken down by guideline sections through a generalization and subsequent reduction to the core statement in chapters 4.2 - 4.6 for each interview. The most important statements are thus extracted from the

transcription, brought to a similar linguistic level and generalized and reduced to the essential statements. The reduction serves as the basis for formulating hypotheses. In addition, in the presentation of results in chapter 4.7, a comparison is made between the two interview findings in terms of essential content-related similarities and deviations in order to finally formulate a hypothesis for the research question of the thesis on this basis.

Based on the previous knowledge from the descriptive part of this thesis and my experience of working in the logistics sector, there is an implicit premonition that there is little to no agile and flexible planning and working in the logistics industry. Due to the conservative nature of the industry, planning and action is usually based on old management theories. These offer minimal scope for flexibility and try to avoid volatility by all means. This precludes the development of anti-fragility. The managers of logistics service providers are also very cost-sensitive and efficient. By establishing “lean” structures and cost-cutting measures, the build-up of unused (buffer) resources is prevented wherever possible. Especially in the areas of operations, it will be difficult to build up these resources in the future, as shareholders can only be convinced if there are demonstrable competitive advantages. In more creative and freer departments such as marketing, sales, IT or product development, however, the antifragility concept could be better implemented, as more agile structures are easier to implement here.

4.2 Findings from Interview 1 – Expert Volker (Sales & Operations Executive KEP Carrier)

Section 1: Gaining experience

Volker (Sales & Operations Executive KEP Carrier) has been in the logistics industry for over 30 years and has held all kinds of positions and activities in sales. Volker

subsequently carried out risk assessments and scenario analyses for Germany at a strategic level and established model considerations in strategic planning for Europe and ISMEA. In particular, analyses on a 5-10 year basis were developed in this position. Today, Volker is responsible for sales in the northern segment of Germany.

Reduction:

- 30 years in the logistics industry
- Various management positions
- in strategic planning

Section 2: Acting in uncertain times

According to expert Volker, UPS has always learned from difficult situations. Back then, there were fewer disruptive factors than today. Fifteen years ago, certain scenarios were planned for in 2-3 planning stages. UPS still adheres to this type of scenario planning with normal-case, best-case and worst-case scenarios today. From Volker (Sales & Operations Executive KEP Carrier)'s point of view, particularly volatile years were the corona period 2020-23, the financial crisis in 2008 and the 16-day strike at UPS in 1997. Cost-cutting initiatives were always used to save money quickly. For Volker (Sales & Operations Executive KEP Carrier), it worked well in crisis years that UPS was able to implement savings quickly and take a strict and almost military approach. This made it possible for UPS to save money in the short term. According to Volker, the situation of having to cope with a smaller budget has taught them to be more creative with the resources available. At the same time, Volker also sees a deterioration in services as a result of the cost-cutting measures.

This has therefore not worked well. Nevertheless, according to Mr. Rössler, learning effects have emerged in processes that have manifested themselves beyond the crisis.

However, the expert also says that UPS also sees a crisis as an opportunity to become even more efficient. For this reason, crises caused by external factors have generally made UPS stronger. What should work better is for UPS not to lapse into blind actionism in crisis situations, i.e. taking measures just to get something done. According to Volker (Sales & Operations Executive KEP Carrier), long-term planning makes more sense here.

Reduction:

- UPS has learned from difficult situations
- Fewer disruptive factors in the past
- Scenario analysis with 3 plan levels is still used today
- Volatile years: Covid-19 pandemic (2020-2023), financial crisis (2008), UPS strike (1997)
- Actions: Cost-cutting initiatives with deterioration of services
- Learning effects beyond the crisis
- Should work better: Avoid activism and plan for the long term

Section 3: Company Structure & Best Practices

UPS is structured as a classic matrix organization. Under “Corporate” (USA management) there are different “Regions”, which are roughly oriented to the accounts. These have all functional areas bundled under them. Volker does not know any “best practices” for acting in uncertain and volatile times from other companies in the same sector, as it is difficult to make comparisons. He sees the greatest parallels in the market with the competitor DHL. The expert cites BMW and the reduction from 3-shift to 2-shift operation as an example of “best practices” for operating in uncertain and volatile times from other companies in a different industry. He transfers the example to his own

industry and the measures in the delivery sector. Essentially, the best practices cited are about cost savings in the personnel area.

Reduction:

- Matrix organizations
- Best practices from the same industry are unknown
- Best practices shift system BMW: Reduction of shifts with volatility
- Core of the best practices: Cost savings in the personnel area

Section 4: Agile methods

Volker is not aware of any agile methods ad hoc. The expert knows the Kanban board as an organizational tool. The agile method Scrum means nothing to the expert without context. Volker is familiar with the agile method Objectives and Key Results Model (OKR). In essence, agile methods are not used at UPS, even though the expert Volker appreciates the flexible possibilities that the method offers, especially with regard to the OKR model. He has even tried to implement this method at UPS, but failed because the company sticks to the old, non-agile KPI model in too many facets. Nevertheless, the expert finds the way agile methods work better than rigid planning. He sees the fact that planning only took place once a year as a major weakness in the organization. This has probably become more flexible in the meantime, but it is still very inflexible. Old goals that have been set remain the same, even if the external situation changes. New goals may be added, but it rarely or never happens that goals are adjusted downwards. The expert speaks of a rigid adherence to plans once they have been defined.

Reduction:

- Agile methods are rather unknown (except for the OKR model)

- agile methods are not used at UPS / have not yet been able to establish themselves.
- However, agile methods are seen as value-added concepts
- Planning is rigid and inflexible. This is seen as a major weakness.

Section 5: Agile forms of organization

However, Volker is not familiar with agile forms of organization such as the Spotify model in detail. It is therefore not possible to provide information on an alternative approach in the logistics industry.

Reduction:

- Agile forms of organization such as the Spotify model are not known in detail.

Section 6: Anti-fragility concept

Volker understands the strategy of using crises to strengthen competitiveness. Essentially, he understands it to mean that there are companies that use crises to emerge stronger from them. He says that companies either belong to the group that achieves this or not and counts UPS among the winners of crises, as the company has generally benefited from crises in the past. He sees UPS's aggressive planning in terms of challenging plans to achieve as the strategy that achieves this. Accordingly, there will rarely be plans that employees can easily achieve. Volker sees the realistic setting of goals as both a risk and a feat, as they should not be unattainable.

After explaining the antifragility concept, the expert sees the problem of scalability in every part of the organization during implementation. Volker sees a further problem in the mindset of the employees and the creation of openness towards the concept, as it is difficult to prepare for things that are not acutely visible or foreseeable. This results in a lack of understanding for the action. The expert sees a further problem in the company's reaction time when a crisis situation arises. It is simply not possible to prepare for

everything. Therefore, when a new situation arises, a kind of moment of surprise would still prevail. Recognizing this within a reasonable period of time and generating appropriate reactions is a major challenge in large organizations. Every single employee in the organization must first have an understanding of how to recognize critical situations and act as a kind of sensor in order to communicate this to the right channels in the company. Essentially, then, there are three problems and challenges when it comes to implementation: scalability, the mindset of the employees and the recording periods in order to be able to react. Volker sees the gaining of competitive advantages as an advantage, which in turn translates into more turnover and more profit for the organization.

The expert does not currently see antifragility as a feasible concept in the logistics sector. Firstly, because the industry is made up of companies with different corporate strategies and the concept is not suitable for every corporate strategy. In addition to UPS, he sees FEDEX and DHL in particular as comparable, leaving Hermes DPD GLS and Co. out of the equation. According to Volker, it also plays a role that the employees are ready for such a change, which he views critically. When asked what would have to happen to enable the concept to become established, the expert replies that the external situation must become even more acute on the basis of macroeconomic factors, thereby increasing the pressure to change. He sees this as a key driver of leaps in human development. The pressure to change must first assume existential proportions. For both people and organizations.

Reduction:

- The expert can visualize the strategy.
- UPS tries to profit from crises by planning aggressively in terms of targets.
- There is a risk of setting goals too high and the resulting demotivation.

- Problems of the concept:
 - o Problem of scalability in each sub-area due to the size of the organization
 - o Problem of reaction time: recognizing crises and acting in time
 - o Problem of the mindset of the employees: The concept must be lived
- Advantages of the concept:
 - o Competitive advantages and therefore more profit for the organization
- Not feasible in the logistics sector because:
 - o Concept cannot be implemented for every corporate strategy and is therefore not suitable for the entire industry.
 - o Employees must be ready for the change. This is viewed critically.
- What would have to happen to establish the concept: The external situation based on macroeconomic factors would have to come to a head in order to significantly increase the pressure to act.

Section 7: Recording missing questions/aspects

According to the expert Volker, nothing was overlooked that should have been asked in context.

Reduction:

- Nothing was overlooked.

4.3 Findings from Interview 2 – Expert Markus (Senior Manager KEP Carrier)

Section 1: Gaining experience

Markus (Senior Manager KEP Carrier) has held various positions at UPS in the logistics sector for 18 years. These included European responsibility in the HR area as Manager HR and Labor. Today, he is General Manager for the UK & Nordics, previously

responsible for Austria and Switzerland in the umbrella district until 2024, thus combining all interdisciplinary functional areas under one roof.

Reduction:

- 18 years in the logistics industry
- Europe Responsibility HR
- General Manager Austria and Switzerland
- Responsibility for all interdisciplinary areas

Section 2: Acting in uncertain times

The planning structure at UPS takes place in cascade form, as the prevailing global strategy must be broken down into targets for the individual business units. Plans are drawn up on the basis of historical results for the coming year. These are fixed and inflexible. The planning method has little planning flexibility. In exceptional cases, there are influences due to extraordinary planning events that are taken into account. According to Markus, the pandemic and the financial crisis of 2008/2009 were particularly volatile years for UPS. However, the ongoing war in Ukraine is also causing volatility. According to Markus, the same instruments were used as in normal times. However, it has become even more conservative in terms of targets. However, there was also an innovation at UPS: business planning now takes place every six months and no longer annually as before. This allows for greater flexibility in volatile times. On the other hand, this sense of security also came at a price. It meant that there was hardly any flexibility to react in an agile manner. Markus sees potential for improvement here. He also complains that rigid planning based on the previous year's results is often doomed to failure when external events occur and would like to see more flexibility in planning. This is difficult for UPS as an organization and should work better.

Reduction:

- Cascade form from global strategy to regionally realizable goals
- Plans based on history
- Fixed and inflexible
- Volatile times: Pandemic 2020-2022, financial crisis 2008-2009, Ukraine war 2022-today
- Planning instruments remain unchanged
- Half-yearly instead of annual planning and even more conservative
- No flexibility to react agilely
- Wishes for flexibility in planning for the future

Section 3: Company Structure & Best Practices

UPS is a classic matrix organization in terms of both its business and organizational approach. Markus sees “best practices” for operating in uncertain and volatile times from other companies in the same industry, namely that companies in the logistics sector are becoming increasingly technologically advanced in order to provide customers with the best possible services. He sees lean structures as a promising factor in volatile times. Markus points to DPD as an example of a market companion. As “best practices” for acting in uncertain and volatile times from other companies from a different industry, Markus points out that other industries are struggling with similar challenges, but that their best practices are not universal solutions either. Nevertheless, he cites nearshoring as an interesting example in contrast to the offshoring trend of recent years for a Swiss company, which is certainly not the most cost-efficient approach, but can still be the most profitable.

Reduction:

- UPS is a classic matrix organization
- Best practices in the same industry: Technological optimizations (DPD)
- Best practices in other industries: Best practices are not a universal solution, e.g. nearshoring as a contrast to the offshoring trend in certain industries

Section 4: Agile methods

Agile methods that can be listed directly are not mentioned. The agile method Kanban Board is not known. The agile method Scrum is known in theory. The agile method Objectives and Key Results Model (OKR Model) is also known. There have been approaches to the OKR model, but these have not become established due to a lack of acceptance and high management costs. Attempts were also made to implement it in the area of performance measurement, but it did not catch on. According to Markus, however, this is counterproductive. There are therefore hardly any empirical values and recommendations.

Reduction:

- OKR is known and attempts have been made to implement it. However, it has failed due to a lack of acceptance and high management costs.
- There are hardly any empirical values and recommendations for agile methods at UPS.

Section 5: Agile forms of organization

Agile forms of organization are known, but the expert sees this as being reserved more for organizations like Spotify. However, he would also like to see a more agile approach at UPS. The expert sees the implementation of such a form of organization in all functional areas of UPS as extremely difficult. On the one hand, there are too many interdisciplinary sub-disciplines that would have to be organized, which would exceed

the size of the teams and make them unmanageable, and on the other hand, agility would fall by the wayside due to the size. However, he finds the concept exciting in individual functional areas and as a form of sub-organization. All major logistics players have probably turned away from a complete switch to this type of organization.

Reduction:

- Agile forms of organization are known, but experts tend to reserve them for organizations such as Spotify in the digital sector.
- However, there is still a desire for more agility
- He sees the implementation of agile forms of organization as difficult at UPS. The reasons are: Many sub-disciplines in the business, resulting in teams that are too large and cannot be controlled and a loss of agility.
- However, the concept is exciting for UPS, but as a sub-organizational form in certain areas

4.4 Findings from Interview 3 – Expert Oliver Rütter

Section 1: Gaining experience

Oliver Rütter has been active in the transport, forwarding, and logistics industry for over 25 years. The sector is deeply rooted in his family (Kretschmar, founded in 1836). He first gained hands-on experience, e.g. in port and tank disposition in Singapore and later at Heppner in France. Rütter played a key role in building System Alliance Europe, where he is now Chairman of the Board. In addition, he co-founded an IT company (“Rütter Connected Logistics”) to digitize both internal processes and customer integration into networks. Today, he is Managing Director of Kretschmar Cargo Süd, which handles international and European operations.

Reduction:

- 25+ years in transport and logistics
- International stations (Singapore, France)
- Co-founder of “Rütter Connected Logistics” (IT platform)
- Managing Director of Kretschmar Cargo Süd & Chairman of System Alliance Europe

Section 2: Acting in Uncertain Times

Rütter emphasized that there are hardly ever truly “quiet times” in logistics, as customer requirements fluctuate constantly. Planning is done in six-year cycles, top-down from mission and vision through strategy to KPIs. Particularly volatile were the last 16 months due to major forecasting uncertainties on the customer side. Historically, he recalls the Southern Europe crises (1992, 2002) and the real estate crisis.

Response strategies: focus on “asset-light” (low fixed costs, flexible networks), open communication with employees, and cost-cutting in real estate and personnel.

Problems: Short-term adjustments with large customers often failed because reactions were too slow. Peaks like Christmas are difficult to manage when capacity (e.g. ramps) is limited. Improvement potential: Better data quality and forecasting systems.

Reduction:

- Six-year planning cycles (Mission → Vision → Strategy → KPIs)
- Volatile years: last 16 months, Southern Europe crises (1992, 2002), real estate crisis
- Actions: asset-light, transparency with employees, personnel cost adjustments
- Positive: employee communication, flexible cost base

- Negative: slow customer adjustments, peak management issues
- Improvement: data quality & forecasting

Section 3: Company Structure & Best Practices

The organization follows a hybrid model: own sites combined with international cooperations (System Alliance Europe, Log Coop, Seatransporter Alliance). Holding structures ensure central steering of data, quality, and products to guarantee uniform services. Best practices mainly come from networks and customer exchange. Data control is seen as a decisive factor. As inspiration from other industries, Rütter cites IT – “Logistics as a Service” modeled after “IT as a Service.”

Reduction:

- Hybrid structure: own sites + cooperations
- Central steering of data, quality, products
- Best practices from networks, data as key asset
- External inspiration: IT industry (“Logistics as a Service”)

Section 4: Agile Methods

Rütter knows agile methods mainly as iterative development with fixed teams.

Kanban: only known by name, viewed skeptically (“old methods under new names”).

Scrum: known through a course but not applied.

OKR: only known in name, not introduced.

In practice, the company uses classic project plans (“who does what by when and why”), supplemented by agile master plans instead of written protocols.

Reduction:

- Basic understanding of agile methods
- Kanban: known, not applied

- Scrum: known, no practical use
- OKR: not implemented
- Practice: classical project plans + agile master plans

Section 5: Agile Organizational Forms

The Spotify model was initially unknown to Rütter. After explanation, he acknowledged that some elements exist in modified form: advisory boards connect working groups, which in turn link project groups, ensuring communication. He therefore sees agile organizational structures as possible in logistics – but only in an adapted form.

Reduction:

- Spotify model unknown
- Elements implemented in modified form (advisory boards, project groups)

Section 6: Antifragility Concept

Rütter is familiar with the concept and supports its usefulness. He views redundancies and flexibility as key to coming stronger out of crises. Advantages include resilience, adaptability, and improvement through disruption.

Challenges: rigid structures make implementation more difficult. Nevertheless, he believes his organization is already partly on this path.

Reduction:

- Antifragility concept is meaningful and viable
- Advantages: resilience, flexibility, improvement through crises
- Challenges: rigid structures
- Already partly implemented

Section 7: Missing Aspects

Rütter sees a lack of internal competencies as a weakness. Companies should be more modular and flexibly integrate external expertise rather than trying to bind all knowledge internally.

Reduction:

- Lack of internal competence = weakness
- External know-how should be integrated flexibly

4.5 Findings from Interview 4 – Expert Boris (Digital Transformation Expert in logistics)

Section 1: Gaining Experience

Boris (Digital Transformation Expert in logistics) was “born into logistics,” coming from a forwarding family. From 1994–1996 he trained as a freight forwarding agent and later deepened his knowledge at the German Foreign Trade and Transport Academy in Bremen. After short stints at Nettler and Unitrans, he worked 23 years at Bertelsmann/Arvato Supply Chain, rising from Key Account Manager to the Board. He was responsible for large customer segments, particularly in automotive, banking, and insurance. Early on, he focused on digital transformation within marketing logistics. Scholz built a digital organization of up to 150 IT specialists and developed digital products and data solutions for supply chain clients. After 23 years, he moved to Fiege, initially leading the last-mile business as Managing Director, and later founded another digital organization to implement software-as-a-service products and data-driven solutions.

Reduction:

- Family background in forwarding/logistics

- Apprenticeship + logistics studies
- 23 years at Bertelsmann/Arvato → rose to Board level
- Focus: key account management, digital transformation, digital organization
- Joined Fiege: led last-mile + built digital organization

Section 2: Acting in Uncertain Times

In “normal times,” planning was strongly customer-driven: assets were aligned to long-term contracts (warehouses, IT, SAP). After the 2008 financial crisis, this approach shifted: strategic pre-investments in specific markets (France, Netherlands, Poland) independent of individual clients became necessary. Alongside annual budget rounds, strategic planning was introduced (industries, countries, IT systems).

Volatile years included the financial crisis (2008–2010) and the COVID-19 pandemic. Responses: hiring freezes, investment cuts, cautious spending, reduction of technical debt. While healthcare solutions provided opportunities during COVID, overall crises meant risks rather than growth. A positive outcome was that supply chains remained stable. In planning processes, shorter tactical cycles (2–3 months) worked well. What failed was the illusion that crises would bring major growth – only healthcare proved an exception. Another issue was mistimed planning, as crisis effects often reached the company later than expected. Improvement potential lies in more realistic timing.

Reduction:

- Earlier: client-driven planning tied to contracts
- Post-2008: strategic pre-investments in markets
- Volatile years: 2008–2010, COVID-19
- Responses: hiring freeze, investment cuts, debt reduction
- Positive: shorter planning cycles, stable supply chains

- Negative: illusion of growth potential, mistimed planning
- Improvement: more precise timing

Section 3: Company Structure & Best Practices

The companies Scholz worked for were strongly decentralized – typical for logistics, growing organically around clients and industries. Advantages (speed, customer proximity) repeatedly turned into disadvantages: duplicated IT development, lost synergies in HR, controlling, and marketing. A clear trend toward centralization emerged to capture economies of scale and fund large investments (automation, IT).

Best practices within the sector: a strong wave of innovation driven by start-ups and Amazon, which disrupted the industry. Examples include Seven Senders (digital cross-border, non-asset) and multi-carrier approaches. At the same time, consolidation increased: mid-sized players disappeared, while large companies or highly specialized niche providers remained. From other industries, he cites automotive and finance. Their best practices include active cash and cost management: rapid hiring freezes, four-day weeks, and drastic reduction of external spend. For logistics, this translated into asset-light models and stronger cooperation.

Reduction:

- Strong decentralization → disadvantages → trend to centralization
- Logistics best practices: innovation (start-ups, Amazon, Seven Senders, multi-carrier), consolidation
- Other industries: automotive/finance → active cash management, asset-light, cooperation

Section 4: Agile Methods

Scholz is familiar with and actively uses OKR, Scrum, and Kanban. Scrum is applied in software development with Product Owners, sprints, and backlogs. Kanban boards are used by some teams. OKR was introduced at both Arvato and Fiege. Agile methods play a central role in digital product development. Experience: adoption was challenging, as traditional logistics companies are rooted in waterfall models with fixed budgets and project endpoints. Agile teams come at high cost (approx. €1m/year). Challenges: mindset shift (product vs. project), CFOs' project-based thinking, and little awareness of intellectual property rights in software. His recommendation: build and own digital assets internally rather than relying only on outsourcing.

Reduction:

- Methods: OKR, Scrum, Kanban
- Applied in digital product development
- Challenges: cost, mindset, budget processes, IP awareness
- Recommendation: build own digital assets, secure ownership

Section 5: Agile Organizational Forms

Scholz knows the Spotify model well. At Fiege, his digital organization was structured similarly: several DevOps teams, totaling more than 280 staff. Chapter functions (discipline-based communities) were not formally introduced. He sees hybrid approaches as sensible: Spotify-style models for product development, waterfall for traditional projects (ERP rollouts, warehouse setups). Certain Spotify-inspired elements (e.g., Product Owners for inbound or dispatch processes) would also benefit logistics organizations.

Reduction:

Spotify model known, partly implemented (DevOps teams)

Hybrid approach: agility for innovation, waterfall for operations

Elements like Product Owners relevant even in traditional logistics

Section 6: Antifragility Concept

Scholz endorses the concept. He sees crises as catalysts for transformation – e.g., during the financial crisis when firms shifted from print to digital marketing. Advantages: crises as learning opportunities, redundancies, forecasting, and error culture. Challenges: hierarchical mindset, reflex toward centralization, lack of transparency. In logistics, implementation is partly feasible: at Fiege, IT tools analyze real-time tracking to anticipate risks (strikes, weather, carrier overload). Many firms now adopt dual-supplier strategies or build buffer stocks. Implementation depends on customer willingness to pay and competitive pressure.

Reduction:

- Antifragility is meaningful and viable
- Advantages: transformation, redundancies, forecasting, error culture
- Challenges: mindset, centralization, transparency
- Partial implementation: real-time tools, dual-sourcing, buffer stocks
- Success factors: customer demand, competition, generational change

Section 7: Missing Aspects

Scholz highlights financing antifragility as a missing aspect. There are no established budgeting processes for investments in redundancy or resilience, so these are often cut for lack of immediate returns. At Fiege, dependency analyses triggered investment in proprietary digital assets. Customer acceptance also helped gain internal support.

Nevertheless, antifragility remains a “bet on the future,” which is hard to reconcile with traditional waterfall structures.

Reduction:

- Missing aspect: financing antifragility
- Problem: no budgeting routines, investments often cut
- Solution: dependency analysis, build proprietary assets, client buy-in
- Challenge: future-oriented investments seen as risky

4.7 Interpretation of results and derivation of hypothesis

In the following interpretation of results, the expert interviews described in Chapters 4.2 to 4.5 are comparatively analyzed according to the interview guideline. The goal is to formulate a hypothesis as the central outcome of this study, and break the hypothesis down into sub-areas that can be assessed quantitatively. All interviewees possess decades of professional experience in the CEP and logistics industry, holding senior and strategic roles. They are therefore qualified as experts for answering the research question.

Acting in Uncertain Times

The interviews highlight that uncertainty and volatility have become the new normal in logistics. While the UPS representatives (Rössler, Kessler) emphasize the rigidity of traditional planning, Rütter and Scholz describe logistics as generally exposed to constant fluctuations. Across cases, crises were answered with cost-cutting, conservative budgeting, and short-term tactical adjustments. Positive aspects include the ability to react quickly (e.g., during COVID-19), while the lack of anticipatory flexibility remains a structural weakness.

Company Structure & Best Practices

The experts agree that logistics is a decentrally grown industry, where customer proximity and flexibility often flip into fragmentation and inefficiency. A strong trend toward centralization is observed, driven by rising IT and automation costs. Best practices within the sector include asset-light models, multi-carrier strategies, and digital platforms. External benchmarks come from the automotive and financial industries, particularly regarding cash management and flexible labor models.

Agile Methods & Organizational Forms

Differences between the experts are evident: At UPS (Rössler, Kessler), agile methods (Scrum, Kanban, OKR) are known but have failed to be implemented. Rütter has only superficial exposure to agile methods, relying on classical project plans. Scholz actively applied agile methods (Scrum, Kanban, OKR) in digital product development. There is consensus that hybrid models are most practical: agility in innovation and digital areas, waterfall models in core operations.

Antifragility

All experts recognize the concept and see crises as opportunities for learning and transformation. Rössler emphasizes strengthening through aggressive goal-setting at UPS. Kessler points to the tension between conservative shareholder expectations and antifragile opportunities. Rütter highlights redundancy and flexibility. Scholz describes concrete tools such as real-time tracking, dual-supplier strategies, and buffer stocks. Key challenges are: mindset and corporate culture, scalability, lack of transparency, and financing issues.

Synthesis

The interviews suggest that robustness, resilience, agility, and antifragility form a staged model in logistics:

- Robustness and resilience are well established,
- Agility exists only in pockets,
- Antifragility is emerging in specific areas but not yet widespread.

Hypothesis

- Achieving antifragility in the logistics industry depends on:
- a cultural shift toward openness, learning, and flexibility,
- the adoption of hybrid organizational forms (agile in innovation, traditional in operations),
- the systematic application of agile methods in selected functions,
- and increasing macroeconomic pressure that accelerates change.

Hypothesis of the study: Antifragility in the logistics industry emerges through the combination of robust and resilient core structures with targeted agility and cultural openness. External crises act as accelerators, driving the sector toward antifragility in the long term.

This overarching thesis can be broken down into seven subordinate sub-theses, which can be examined in a structured manner in Chapter 5:

H1 (Culture → Agility): Cultural openness (tolerance for learning and mistakes) positively predicts the introduction of agile methods (OKR, Scrum, Kanban) which effects again antifragility boosts.

H2 (Agility/Hybrid → Crisis Performance): Companies with (a) agile methods in digital areas and (b) hybrid organization (agile in innovation, waterfall in operations) achieve better crisis outcomes (e.g., service level, revenue rebound, lead time).

H3 (Digital/Transparency → Antifragility) The number of digital tools used by a company is positively associated with its perceived long-term strengthening effect of crises.

H4 (Centralization vs. Decentralization): Greater centralization (e.g., shared IT/automation) correlates positively with efficiency/economies of scale, but negatively with market proximity – net effect on crisis outcomes is nonlinear (U-shaped/hybrid best).

H5 (Asset-light & redundancy): The use of asset-light strategies and the extent of implemented redundancies are associated with the resilience assessments of logistics companies.

H6 (Financing): Clear financing mechanisms for digital/antifragile initiatives (budget line, Capex/Opex rules, IP ownership) increase the implementation rate (agile/digital products).

H7 (Macro Pressure): Perceived macroeconomic pressure (volatility) is a catalyst for agility/antifragility measures.

CHAPTER V: QUANTITATIVE RESEARCH PROJECT

5.1 Research design & survey procedure

The research design chosen for this study is a cross-sectional survey combining online questionnaires with supplementary telephone interviews with decision-makers in the logistics industry. Primary research is conducted via an online survey for reasons of research economy. This allows large amounts of data to be collected in a short time using electronic communication devices. Multiple participants can take part in the survey simultaneously, regardless of location and with flexible timing. This increases the response rate and makes the data available directly in digital form for further processing. Interviewer effects that could distort the objectivity of the results are eliminated by the standardized survey instrument.

One disadvantage of online surveys is the lack of identity checks for participants, which means that multiple responses or incorrect information are possible. To minimize this risk, filter questions, plausibility checks, and time stamps are used so that invalid data sets can be eliminated before analysis.

In order to also include companies in the logistics industry that are difficult to reach online, the online survey is supplemented by telephone interviews with freight forwarders, 3PL and 4PL service providers, and carriers. This approach enables broader coverage of the population and increases the representativeness of the sample. The planned survey period runs from October 1, 2025, to January 1, 2026. Each unit in the sample is to be surveyed once. The selection of survey objects is described in more detail in section 5.2 below.

5.2 Population, sampling units & selection procedures

Based on the above hypotheses, the study is based on a uniform population: employees of companies within the logistics industry. This includes, in particular, companies from the fields of freight forwarding, contract logistics, CEP service providers, 3PL and 4PL providers, and carriers.

In order to empirically represent the construct of “logistics companies,” abstraction is necessary, as organizations are not surveyed directly, but rather through their employees. Under this assumption, the samples of the population consist of individuals with job-related activities in the logistics industry who work in managerial or operational functions. The sample thus reflects the perspective of the organizations without the need for a complete survey. The samples are selected on the basis of a combination of online and telephone surveys;

Online survey: The online survey will be distributed via business networks (e.g., LinkedIn) and specialist groups on social media. In addition, logistics companies will be invited via project-related distribution lists.

Direct telephone contact: To supplement the online survey, a multi-stage selection process is used:

- First, regional stratification is carried out according to the 16 federal states.
- Then, 5 federal states are selected at random.
- Within these regions, lists of logistics companies are compiled using industry directories (e.g., “Who delivers what,” association lists).
- Companies are randomly selected from these lists (without replacement) and contacted by telephone to invite employees to participate.

This approach ensures that both digital reach and targeted outreach are used to achieve a sufficiently large and heterogeneous sample. The target size is a sample of at least $n =$

300 valid cases, which enables statistical evaluation based on hypothesis testing. This size is based on two methodological considerations:

- First, it provides sufficient statistical power to test hypotheses with categorical and metric variables (e.g., chi-square test, t-test, variance analyses, correlations).
- Second, a sample of this size allows for a differentiated analysis by subgroups (e.g., company size, functional area, experience with agile methods) without the cell frequencies becoming too small.
- Third, the number of cases is determined according to the principle of research economy: it is large enough to enable representative statements about the logistics industry, but at the same time remains within the bounds of practical feasibility.

Invalid or incompletely filled out questionnaires are excluded from the analysis (e.g., through filter questions, timestamp checks).

5.3 Development of the questionnaire

A standardized questionnaire was developed to test hypotheses H1–H7. The questionnaire is divided into several thematic sections based directly on the findings from the expert interviews. Its design is based on current recommendations for operationalizing qualitative results into quantitative variables.

A general survey section is included before the thematic sections on hypotheses H1–H7 in order to describe the sample and ensure that it belongs to the logistics industry. This section “Block A: General company data & industry affiliation (control variables)” serves as a filter and to record key structural characteristics of the participating companies. The purpose is to ensure that only individuals from the logistics industry (3PL, 4PL, carriers, freight forwarders, CEP service providers, contract logistics) participate. Also to Collecting information on company size and area of activity for later differentiation in the

evaluation (control variables) and it enables the sample to be described in the following “Descriptive representation” chapter 5.5.

Sample questions:

1. In which segment of the logistics industry is your company primarily active? (select category)
2. Company size (number of employees worldwide)
3. What is your position in the company? (select category)
4. Filter question – Industry affiliation – Does your company primarily operate in the logistics industry? (yes/no)

Evaluation methods:

Descriptive: frequencies, cross tables, median

Inductive: chi-square test (e.g., correlation between segment & use of methods), ANOVA (number of employees & crisis outcomes)

Objective: description of the sample, control variables for H1–H7

Block B: Corporate culture & error culture (Hypothesis H1)

Openness, learning and error culture, and the use of agile methods (Scrum, Kanban, OKR) are surveyed here. The aim is to test hypothesis H1: Culture promotes the introduction of agile methods.

Variable type: ordinal (Likert), categorical (methods yes/no)

Evaluation: mean values, standard deviations (descriptive); chi-square test (culture ↔ methods), t-test/ANOVA (cultural values between companies with/without agile methods)

Sample questions:

In my company (1 = strongly disagree ... 5 = strongly agree):

- Mistakes are seen as learning opportunities.
- Open communication in times of crisis is encouraged.
- Innovation and experimentation are actively supported.

Which agile methods do you use in your company? (Multiple selections possible)

☐ None ☐ Scrum ☐ Kanban ☐ OKR ☐ Other: _____

Block C: Agility & Hybrid Organization (Hypothesis H2)

Block C deals with determining whether agile methods (OKR, Scrum, Kanban) are used and in which areas of the company (digital projects vs. classic operations) in order to test H2, which states that agile methods + hybrid organization lead to better crisis outcomes.

Sample questions:

“Organizational structure of your company:”

- ☐ Traditional (waterfall, top-down)
- ☐ Hybrid (agile in innovation/IT, traditional in operations)
- ☐ Fully agile (operations also managed agilely)

“How would you rate your company’s crisis management over the last 3 years?” (1 = very poor ... 5 = very good):

- Service level maintained
- Decline in sales/volume compensated for
- Delivery times stabilized
- Customer satisfaction ensured

Variable type: categorical, ordinal

Evaluation: Chi-square test, ANOVA

Block D: Digital Transparency & Antifragility (Hypothesis H3)

In Block D, the use of digital systems (real-time tracking, KPI monitoring) and perception of crisis management will be recorded in order to establish a correlation between digital transparency and antifragility and thus clarify Thesis H3.

Sample questions:

“Which digital tools do you use? (Yes/No)”

- Real-time tracking for shipments
- KPI dashboards (service level, lead time, forecast accuracy)
- Automated forecasting/AI-supported planning

“Crises have strengthened our company in the long term (e.g., through new processes, innovations).” (1 = strongly disagree ... 5 = strongly agree)

Variable type: categorical, ordinal

Evaluation: correlation (Spearman/Pearson), regression analysis

Block E: Centralization vs. Decentralization (H4)

Records the structure and its evaluation. Hypothesis H4: U-shaped relationship, hybrid brings the best outcomes.

Sample questions:

„Structure of your company:“

- ☐ Highly centralized
- ☐ Somewhat centralized
- ☐ Hybrid
- ☐ Somewhat decentralized
- ☐ Highly decentralized

„How would you rate the following points?“ (1 = very poor ... 5 = very good)

- Efficiency / economies of scale
- Proximity to customers
- Overall crisis management

Variable type: ordinal

Evaluation: ANOVA

Block F: Asset-light & redundancy (H5)

The use of asset-light strategies and the extent of implemented redundancies are associated with the resilience assessments of logistics companies.

Sample questions:

“How strongly does your company rely on asset-light strategies?”

(1 = not at all ... 5 = very strongly)

“What redundancies have you implemented?” (Multiple choice)

- ☐ None
- ☐ Multi-carrier strategies
- ☐ Two-supplier strategies
- ☐ Buffer stocks
- ☐ Emergency/crisis plans

“How would you rate your company's resilience?” (1 = very low ... 5 = very high)

Variable type: ordinal, categorical

Evaluation: chi-square test, t-test

Block G: Financing (H6)

Covers budget mechanisms for digitalization/resilience. Hypothesis H6: Financing increases the implementation rate.

Sample questions:

“Does your company have special budget mechanisms for digitalization/resilience measures?”

☐ Yes, fixed budget line ☐ Yes, project-related ☐ No

“What is the implementation rate of digitalization/antifragility initiatives?”

(1 = very low ... 5 = very high)

Variable type: categorical, ordinal

Evaluation: Chi-square test, regression

Block H: Macroeconomic pressure (H7)

Asks about perception of pressure and measures taken. Hypothesis H7: Macro pressure catalyzes agility/antifragility.

Sample questions:

“How strongly have you perceived macroeconomic pressure in the last 3 years?”

(1 = not at all ... 5 = very strongly)

“Which measures have been introduced more intensively at your company as a result of macro pressure?” (Multiple choice)

☐ Agile methods ☐ Antifragility measures ☐ Cost reductions ☐ No specific measures

Variable type: ordinal, categorical

Evaluation: correlation, regression

Block I: Future orientation

Covers strategic future prospects (robustness, resilience, agility, anti-fragility). Serves as validation.

Sample question:

„Which scenario do you think is most likely for your company in the next 3–5 years?“

- ☐ Ensure stability (robustness)
- ☐ Get back on your feet quickly (resilience)
- ☐ Adapt flexibly (agility)
- ☐ Emerge stronger from crises (antifragility)

Variable type: categorical

Evaluation: Chi-square test

The questionnaire in Appendix J was created based on this structure.

5.4 Descriptive representation

The following section provides a descriptive analysis of the data collected from the 400 participants. The aim is to obtain a structured overview of company characteristics, cultural factors, organizational structures, and the extent of agility, resilience, and potentially anti-fragile practices in the logistics industry. The descriptive analysis not only serves to provide a basic description of the sample, but also provides initial empirical evidence of existing patterns and correlations within the industry.

The evaluation follows the structure of the research blocks (A–I) introduced in Chapter 5.1, which represent key dimensions of organizational action and crisis management. Block A describes the characteristics of logistics companies and their size distribution, thereby providing an understanding of the operational starting point of the respondents. Blocks B and C cover cultural characteristics and agile working methods, which are

considered in the literature to be essential prerequisites for adaptability and organizational learning. In addition, blocks D and E highlight the degree of digitalization and structural characteristics (centralization vs. decentralization), which are often regarded as determinants of efficiency, response speed, and crisis stability. Block F focuses on redundancy and asset-light strategies as classic risk management tools, while Block G analyzes financial frameworks that serve as indicators for the actual implementation of transformation-oriented measures. Finally, blocks H and I capture the perception of macroeconomic pressure and the strategic future orientation of companies. This enables an initial assessment of the extent to which external volatility acts as a driver of organizational change and what orientation (robustness, resilience, agility, or antifragility) companies are planning for the coming years. Combining these descriptive sub-analyses creates a comprehensive profile of the current organizational realities in the logistics industry. The insights gained form a necessary basis for the inferential statistical hypothesis testing in Chapter 5.5 and enable a contextualized classification of the later test results.

Block A: Company profile

To describe the sample, the structural characteristics of the participating companies were first evaluated. This analysis forms the basis for the subsequent classification of the hypothesis tests, as company size and logistical orientation are key influencing variables for organizational capabilities, agility, and crisis behavior.

The data was analyzed using simple frequency tables in R. The following command was used:

```
> table(df$`welche Art von Logistikdienstleister beschreibt Ihr  
Unternehmen am besten?`)
```

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as well as for the size classes:

```
> table(df$`Unternehmensgröße (Mitarbeiter gesamt):`)
```

A1: Distribution by logistics segment

The evaluation shows a clear focus on certain areas of the logistics industry:

Logistics segment	Frequency
CEP service providers	151
Internal company logistics (intralogistics)	71
▲ 3PL (traditional freight forwarding/transport/distribution)	42
Outbound within the company	41
Contract logistics/warehousing	23
4PL/LLP	21
▲ Carrier (air/sea/rail/truck)	16
Industry	11
Reseller	10
▲ Warehouse/WE/WA/Intra (industrial operation)	9
Integrator	5

The sample is heavily influenced by CEP service providers (151 mentions), which is in line with current market structures, as these companies are particularly affected by volatility. With 71 mentions, intralogistics is the second-largest segment, indicating that not only external logistics service providers but also internal industrial companies took part in the surveys. Traditional freight forwarders (3PL) are well represented with 42 mentions. Smaller clusters (carriers, integrators) are less numerous, but contribute valuable perspectives for subsequent hypothesis testing (especially for H5 Asset-Light & Redundancy). The broad segment distribution therefore enables a valid and differentiated analysis of overarching logistics patterns.

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A2: Distribution by company size

The company size was analyzed using the following R command:

```
> table(df$`Unternehmensgröße (Mitarbeiter gesamt):`)
```

The results:

Company size	Frequency
≥ 5.000	204
50–249	68
< 50	68
250–999	48
1.000–4.999	12

The sample is clearly dominated by large companies (204 out of 400 respondents = 51%).

→ This is crucial because large organizations tend to be more formalized, centralized, and process-oriented—variables that will later become relevant for H1–H4. Small and medium-sized enterprises are also represented (50–249 and < 50 with 68 mentions each), which ensures a certain degree of heterogeneity. Only a few companies have between 1,000 and 4,999 employees (12 mentions), which means that this group has less statistical weight.

Implications for later hypothesis testing

The high number of large companies could influence the results on centralization (H4) and budget mechanisms (H6), as large companies tend to have clearer financing structures, use more digital tools, have more centralized control models.

The significant proportion of small companies, on the other hand, allows conclusions to be drawn about the differences between classically robust and agile forms of organization in small and medium-sized enterprises.

Block A shows that the sample is widely diversified according to logistical field of activity, strongly influenced by large companies, and methodologically clearly classifiable. This characteristic structure is important for further analysis, as organizational size, logistical activity, and structural form can be significant predictors of agility, crisis management, and anti-fragile potential.

Block B: Corporate culture & learning/error culture (H1)

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Block B examines the cultural characteristics of the participating companies, in particular openness, error culture, and willingness to innovate. These variables are central components of hypothesis H1, which postulates that an open and learning-oriented corporate culture increases the likelihood of implementing agile methods.

The descriptive analysis is based on the following Likert scales (1 = “strongly disagree” to 5 = “strongly agree”). The following commands were executed in R for the calculation:

```
> kultur_vars <- df[, c(
  "In meinem Unternehmen gilt [Fehler werden als Lernchance
  verstanden.]",
  "In meinem Unternehmen gilt [Offene Kommunikation in
  Krisenzeiten wird gefördert.]",
  "In meinem Unternehmen gilt [Innovation und Experimentieren
  wird aktiv unterstützt.]"
)]
> describe(kultur_vars)
```

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B1: Mistakes are seen as learning opportunities

Statistic	Value
Mean	3.94
Median	4
SD	1.04
Min-Max	1-5
Skewness	-0.71
Kurtosis	-0.45

The mean value of 3.94 shows that the majority of respondents perceive mistakes as learning opportunities. A negative skewness value confirms that many responses are in the upper range of the scale. This indicates a predominantly constructive and mature understanding of culture, which is an important prerequisite for agile methods — a key touchstone for hypothesis H1.

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B2: Open communication in times of crisis

Statistic	Value
Mean	3.48
Median	4
SD	1.18
Skewness	-0.22

With an average score of 3.48, the trend is also positive, but less pronounced. Some companies do not yet seem to be structurally capable of communicating openly and

transparently in times of crisis. This is a relevant indicator in the context of resilience and anti-fragility, as a lack of openness hinders the rapid flow of information.

B3: Enthusiasm for innovation and experimentation

Statistic	Value
Mean	3.36
Median	3
SD	1.21

The lower average value shows that the innovation climate is heterogeneous. A significant proportion of companies still operate with a traditional, stability-oriented mindset. This value is particularly important for H1, as agile methods can hardly be implemented sustainably without a willingness to experiment.

The results paint a mixed picture:

Cultural dimension	Average score	Interpretation
Error culture	3.94	Clearly positive
Crisis communication	3.48	Moderately positive, potential for improvement
Willingness to innovate	3.36	Only average, partly traditional structures

The results show an overall positive cultural profile. The error culture (“errors are seen as learning opportunities”) has the highest mean value ($M = 3.94$), accompanied by a moderate standard deviation ($SD = 1.04$). Open communication in times of crisis is also rated above average ($M = 3.48$), while the promotion of innovation and experimentation

is slightly below average ($M = 3.36$). All three variables show negative skewness values (between -0.16 and -0.71), which means that higher, i.e., culture-friendly values occur more frequently in the sample than lower ones. The results illustrate that companies perceive a culture that is more learning-oriented, open to dialogue, and innovation-friendly, even if the promotion of innovation is somewhat less pronounced than the culture of error and communication. An actively practiced culture of error and innovation is an important basis for agile methods such as Scrum, Kanban, or OKR, which directly relates to hypothesis H1: Companies with a more pronounced learning and error culture are more likely to use agile methods. The descriptive data thus already supports the theoretical expectation that cultural elements are indeed present in the logistics industry, but that the introduction of agile approaches is likely to vary and different degrees of maturity can be identified. Block B thus provides a central cultural diagnostic starting point, which is further deepened in the inductive part through correlation analyses (chi-square, correlations).

Block C: Crisis management & organizational performance (H2)

Block C examines companies' ability to successfully manage crises over the past three years. This includes several performance indicators such as service levels, delivery times, customer satisfaction, and the stability of KPI achievement. This block is directly related to hypothesis H2, which assumes that companies with hybrid and/or agile organizational forms achieve better crisis management. The descriptive metrics were generated in R using the following command:

```
> krise_vars <- df[, c(
  "wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in
  den letzten 3 Jahren? [Servicelevel gehalten]",
```

```
"wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in  
den letzten 3 Jahren? [Umsatz-/Volumen-Rückgang kompensiert]",
```

```
"wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in  
den letzten 3 Jahren? [Lieferzeiten stabilisiert]",
```

```
"wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in  
den letzten 3 Jahren? [Kundenzufriedenheit gesichert]",
```

```
"wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in  
den letzten 3 Jahren? [Individuelle KPI's gehalten]"
```

```
)]
```

```
> describe(krise_vars)
```

C1: Service level maintained

Statistic	Value
Mean	3.40
Median	4
SD	1.21
Skewness	-0.49

With an average score of 3.40, many companies rate their service quality as stable, despite crisis factors such as the pandemic, geopolitical tensions, and capacity bottlenecks. The slightly negative skewness value shows that many companies were able to maintain their service levels at a stable level that was above average. This supports the assumption that at least basic operational robustness exists in many organizations.

C2: Decline in sales/volume offset

Statistic	Value
Mean	3.12
Median	3
SD	1.18

The ability to economically compensate for triggered volume fluctuations is in the middle range. This shows that many companies were able to compensate partially, but not completely, which is typical for logistics markets with highly fluctuating demand and high fixed costs. For H2, we will examine later whether agile/hybrid organizations show higher values in this area.

C3: Delivery times stabilized

Statistic	Value
Mean	3.16
Median	3
SD	1.17

Participants rated delivery times as average to slightly positive on average. This is remarkable given the global supply chain problems that have been observed – nevertheless, the average value shows that many companies were working at the limits of their operational flexibility.

C4: Customer satisfaction assured

Statistic	Value
Mean	3.15
Median	3
SD	1.17

Customer satisfaction, like delivery times, is in the middle range. This shows that companies have been able to maintain a basic level of stability, but often under increased pressure.

C5: Individual KPIs maintained

Statistic	Value
Mean	3.38
Median	3.5
SD	1.05

The ability to meet internal KPIs is slightly above average and is the most stable of all crisis management variables. The data shows a consistent pattern: all aspects of crisis management surveyed—including service level, volume and revenue retention, delivery time stability, customer satisfaction, and KPI achievement range from moderate to slightly positive. The mean value for the service level maintained is $M = 3.40$, which is the highest value of all five items. The stabilization of individual KPIs is also rated relatively positively, with a median of 3.5 and a mean value of $M = 3.38$. At the lower end of the scale is the indicator “Compensation for decline in sales or volume” ($M = 3.12$), followed by stabilization of delivery times ($M = 3.16$) and ensuring customer satisfaction ($M = 3.15$). All variables show a slightly negative skew (between -0.20 and -0.49), which means that ratings tended to be on the high side. At the same time, the standard deviations are moderate (between 1.05 and 1.21), indicating a heterogeneous

perception of crisis stability – a finding that is typical for an industry with widely varying business models, such as logistics. The results thus show that companies perceive their own crisis management as satisfactory overall, but that there are clear weaknesses: in particular, the compensation of volume and revenue losses. The results show that companies perceive their own crisis management as satisfactory overall, but that there are clear weaknesses: in particular, compensation for declines in volume and sales, and delivery time stability. Both are direct expressions of logistical performance and show that operational challenges during crises were not fully offset by organizational measures. Block C provides an essential basis for subsequent hypothesis testing: the performance indicators serve as dependent variables in H2, which examines whether companies with agile or hybrid organizational forms achieve significantly better crisis results. The descriptive analysis already shows structural differences in variability, which are tested in the inductive phase using ANOVA and regression analyses.

Block D: Digitalization & Transparency (H3)

Block D examines the degree of digitalization within logistics companies and its relationship with their perceived ability to learn from crises or emerge stronger. This block operationalizes digitalization as the number of digital tools used (e.g., real-time tracking, KPI dashboards, automated forecasting systems). In line with the hypothesis H3, the analysis investigates whether a higher level of digital tool usage is associated with a stronger perceived long-term strengthening effect of crises. Thus, the focus is not on objectively measured improvements, but on the subjective assessment of whether crises have contributed to organizational learning, development, and improvement. **The descriptive evaluation was performed using the describe() function from the psych**

package for the scale question and frequencies for the multiple-choice questions in this block.

```
> describe(df$`wie bewerten Sie die Aussage „Krisen haben unser  
Unternehmen langfristig gestärkt (z. B. durch neue Prozesse,  
Innovationen)`.“`)
```

Evaluation of the statement: “Crises have strengthened our company in the long term.”

The Likert scale (1 = strongly disagree, 5 = strongly agree) shows a moderate to slightly positive picture:

D1: Perceived long-term strengthening through crises

Statistic	Value
Mean	3.50
Median	3
SD	0.93
Min-Max	1-5
Skewness	-0.14

The mean value of 3.50 shows that:

- A large proportion of companies perceive crises as moderate drivers of improvement.
- The median = 3 shows a symmetrical distribution between “neutral” and “slightly positive.”
- The low negative skewness value indicates that the responses tend slightly toward the higher values.

The industry is not anti-fragile, but shows tendencies in this direction, especially in digitally advanced companies (tested in H3).

D2: Use of digital tools (real-time tracking, dashboards, AI forecasts)

Since the column in the data set is a combined text variable with multiple entries, it was not evaluated descriptively with `describe()`. It will be recoded as a categorical variable later in the inductive section (Section 5.5) and analyzed using the Chi² test.

Although Block D comprises several digital tools, only the general pattern can be described in the descriptive section, as the individual tools (real-time tracking, dashboards, etc.) are available as text variables in their raw form. However, it is striking that the vast majority of companies in the data set report using digital tools – an observation that emerges from the raw data, even if it is not reflected in the numerical indicators evaluated here. This is an important signal: the logistics industry has a high level of digitalization, at least in terms of transparency tools. This creates the functional prerequisites for anti-fragile behaviors such as early fault detection, data-driven decision-making systems, and automated response mechanisms. The descriptive results provide an initial indication that digital transparency already supports a certain ability to strengthen after crises in practice albeit not to a pronounced extent. Block D thus represents a central basis for the subsequent inductive analysis, in which possible correlations are examined using Pearson/Spearman correlations and linear regression, e.g.:

```
> cor(df$digital_index, df$antifragilität_score)
lm(antifragilität_score ~ digital_index)
```

The descriptive level shows that digitalization is widespread, the self-perception of anti-fragile effects is moderately positive and the variance between companies is large enough to test statistical correlations.

Block E: Organizational structure – centralized vs. decentralized (H4)

Block E examines how logistics companies are structured and how this structure relates to efficiency, customer proximity, and crisis management. The analysis serves to test hypothesis H4.

H4: The relationship between centralization and crisis performance is not linear:

- Strong centralization → efficiency gains, but loss of market proximity
- Strong decentralization → customer proximity, but low economies of scale
- Hybrid models achieve the best crisis outcomes.

The descriptive analysis shows how the companies in the sample are positioned structurally.

E1: Distribution of organizational forms

The following command was used:

```
> table(df$`Wie ist die Struktur Ihres Unternehmens?`)
```

Organizational form	Number
Rather centralized	121
Highly centralized	103
Hybrid (centralized + decentralized)	122
Rather decentralized	40
Highly decentralized	14

Over 55% of companies are centralized (“somewhat centralized” + “highly centralized”). 31% operate a hybrid model. Only 13.5% are decentralized. This means that the logistics

industry is clearly dominated by centralization – which is typical for capital-intensive infrastructures, standardized processes, and globally integrated networks. Noteworthy: The hybrid share (122 companies) is almost identical to the “somewhat centralized” group, which shows that the industry is increasingly moving toward balanced control models.

E2: Evaluation of key success factors (efficiency, customer proximity, crisis management)

The following R command was used:

```
> describe(df$`wie bewerten Sie folgende Punkte (1 = sehr schlecht ... 5
= sehr gut): [Effizienz / Skaleneffekte]`)
> describe(df$`wie bewerten Sie folgende Punkte (1 = sehr schlecht ... 5
= sehr gut): [Nähe zum Kunden]`)
> describe(df$`wie bewerten Sie folgende Punkte (1 = sehr schlecht ... 5
= sehr gut): [Krisenbewältigung insgesamt]`)
```

Evaluation dimension	Mean	Median	SD	Min-Max	Interpretation
Efficiency / economies of scale	3.24	3	1.04	1-5	Solid, slightly positive
Proximity to customers	3.43	3	1.17	1-5	tends to be rated higher than efficiency
Overall crisis management	3.31	3	1.08	1-5	moderately good,” stable average level

An analysis of organizational structures initially shows that the logistics industry continues to be strongly centralized. The majority of companies classify themselves as either moderately or highly centralized, while purely decentralized models account for only a very small proportion of the sample. However, it is striking that a similarly large group of companies (122) pursue a hybrid model. This suggests that the industry is undergoing a structural transformation process: while classic centralized models – such as those commonly used by global logistics service providers – work well in stable market phases and offer efficiency advantages in particular, times of crisis have increasingly shown that decentralized decision-making capabilities are indispensable for rapid responses and operational flexibility. The growing number of hybrid structures can thus be interpreted as an attempt to resolve the conflict of objectives between economies of scale and market proximity. The assessment of key performance areas is also noteworthy. Although it is often assumed in logistics that centralized control models promote efficiency but come at the expense of customer proximity, the data set paints a more nuanced picture. The companies surveyed rate their efficiency with an average score of 3.24, while customer proximity is rated slightly higher at 3.43. This suggests that many central organizations are actively trying to compensate for potential disadvantages in terms of customer proximity – for example, by setting up decentralized hubs, specialized service or key account teams, or by using digital transparency tools that simulate or operationalize customer proximity. It can therefore be assumed that centralization in modern logistics does not necessarily lead to a distancing from the customer, provided that companies implement appropriate countermeasures. Crisis management is rated as average overall, with a mean value of 3.31. This shows that companies do not consider themselves to be either poorly or particularly well positioned

for crises. The result indicates a fundamentally solid but not outstanding level of crisis stability, which can be interpreted as a starting point for further anti-fragile or resilience-enhancing measures.

With regard to hypothesis H4, the descriptive results support the theoretical assumption of a nonlinear, U-shaped relationship between organizational structure and performance. Highly centralized companies tend to achieve efficiency gains but lose market proximity, while highly decentralized companies operate close to their customers but realize lower economies of scale. The particularly large group of hybrid companies suggests that organizations are trying to combine both advantages—and may therefore achieve better crisis results. Whether hybrid structures are actually superior is then examined using inductive methods. In particular, an ANOVA is planned to test mean differences between structural forms with regard to overall crisis management, post-hoc analyses to identify the most effective organizational form, and nonlinear regression models to empirically confirm a potential U-shaped relationship.

Block F – Asset-light strategies & redundancies (H5)

Block F examines two central elements of logistical resilience and anti-fragility:

- Asset-light strategies (outsourcing, flexible networks instead of own fleets/warehouses)
- Implemented redundancies (e.g., multi-carrier, two suppliers, safety stocks)

These factors are the focus of Hypothesis H5, which posits that the use of asset-light strategies and the extent of implemented redundancies are associated with the resilience assessments of logistics companies.

F1. Asset-light strategies

The variable is a 5-point Likert scale (1 = not at all, 5 = very strongly).

Key figure	Number
N	400
Mean	3.36
Median	3
SD	1.29
Skewness	-0.11
Kurtosis	-1.23
Standard error	0.06

The mean value of 3.36 indicates moderate to slightly increased use of asset-light models. The standard deviation (1.29) is relatively high → the industry is heterogeneous. Some companies operate almost complete outsourcing, others hardly any. The almost symmetrical distribution (skewness –0.11) shows that both extremes (1 & 5) occur. This corresponds to the reality of the logistics industry, where large contract logistics providers operate on an asset-light basis, while traditional freight forwarders continue to own their own assets.

F2. Redundancies

The variable was a multiple selection, which is why the data was split using `separate_rows()` in R.

R command:

```
> Red <- df %>%
> tidyr::separate_rows(`welche Redundanzen haben Sie implementiert?`
(Mehrfachwahl)`, sep = ", ")
> table(Red$`welche Redundanzen haben Sie implementiert?`
(Mehrfachwahl)`)
```

Redundancy type	Numbers
Multi-carrier strategies	203
Emergency/crisis plans	197
Buffer stocks / Safety stocks	135
Two-supplier strategies	110
No redundancies	75

The large proportion of redundant measures (325 mentions excluding “none”) illustrates that companies in the industry are actively trying to minimize supply chain risks. However, “no redundancies” at 75 respondents (~19%) shows that a relevant part of the industry is potentially fragile.

F3. Connection to resilience assessment

Resilience was surveyed separately using a 5-point Likert scale.

Key figure	Number
N	400
Mean	3.88
Median	4
SD	0.88
Skewness	-0.49
Kurtosis	-0.56
Standard error	0.04

The companies surveyed rate themselves as above average in terms of resilience (mean 3.88). The skewed distribution to the left (-0.49) is striking → many companies rate their resilience highly.

The descriptive analysis of asset-light strategies shows that these are widespread in the logistics industry, but are not used to a dominant extent. The mean value of 3.36 on a five-point Likert scale indicates that although many companies use flexible, asset-light networks, they do not fully exploit this strategy. This reflects the structural developments in the industry in recent years, which have been characterized in particular by volatile market conditions, increasing congestion among individual transport service providers, and variable cost and capacity structures. Companies are therefore focusing on flexibility, but at the same time maintaining a certain attachment to their own resources in order to reduce dependencies.

The picture is clear when it comes to redundancies: the majority of companies have implemented various forms of safeguards. Multi-carrier strategies and formalized emergency or crisis plans are particularly common, indicating that robust basic mechanisms for securing supply chains are firmly established in the industry. At the same time, however, there is a significant minority of 75 respondents that do not use any redundancies. This group deviates from modern resilience and anti-fragility principles and is potentially more vulnerable to disruptions.

It is also noteworthy that companies rate their own resilience higher than would be expected based on the results for crisis performance (Block C). An average score of 3.88 on the resilience scale suggests that many organizations rate themselves as more resilient than their actual crisis management performance would suggest. This gap between subjective assessment and objective performance is a key finding and suggests that self-perception and actual organizational capabilities are not always congruent.

The findings provide clear descriptive support for hypothesis H5, which posits that the use of asset-light strategies and the extent of implemented redundancies are associated with the resilience assessments of logistics companies. The data shows that a large majority of companies implement redundancies such as multi-carrier models, safety stocks, or contingency plans. At the same time, asset-light characteristics are in the middle range, indicating an advantageous balance between flexibility and risk diversification. The overall high resilience rating of the companies (mean 3.88) underpins this structure. The group of 75 respondents who do not use any redundancies is particularly significant. It represents the most critical area for hypothesis testing, as theory clearly predicts that the combination of low redundancy and potentially high asset-light levels can lead to increased fragility. Overall, Block F thus provides a sound empirical basis for systematically testing Hypothesis H5 and evaluating the extent to which the combined use of flexibility strategies and redundancies contributes to building logistics-specific crisis resilience and anti-fragile structures.

Block G: Budget mechanisms & implementation rate (H6)

G1: Budget mechanism

The budget mechanisms were recorded using a nominal variable. The frequency distribution is derived from the following R command:

```
> table(df$`Gibt es in Ihrem Unternehmen spezielle Budgetmechanismen  
für Digitalisierung / Resilienzmaßnahmen?`)
```

Budget mechanism	Numbers
Yes, fixed budget line	113
Yes, on a project-by-project basis (case-by-case)	227

Nein	60
------	----

The majority (227) pursue project-related, case-by-case budgeting. 113 companies have dedicated budget lines, an indicator of strategic prioritization. 60 companies have no structured budgets at all, which is usually associated with low digitalization and resilience maturity.

G2: Implementation rate

The implementation rate was recorded using a Likert scale (1–5).

It was calculated as follows:

```
> describe(df$`wie hoch ist die Umsetzungsquote von Digital-/Agilitäts-Initiativen?`)
```

Key figure	Number
N	389*
Mean	3.37
Median	3
SD	0.94

* Note: 11 missing values (NA), typical for questions that are only answered by respondents who have already implemented initiatives.

Analysis of budgeting mechanisms shows that the logistics industry has highly heterogeneous financing structures in the areas of digitalization and resilience. The clear majority of respondents in companies pursue a project-based financing practice, in which investments are approved on a case-by-case basis and as needed. This form of budgeting reflects a more operational than strategic orientation, as it makes long-term innovation programs more difficult. At the same time, 113 respondents have formally

institutionalized budget lines, which signals a higher degree of strategic planning and facilitates the continuous implementation of digital and anti-fragile initiatives. The 60 respondents in companies without any dedicated budget mechanisms form a contrasting pole: in this group, a structural deficit in terms of digital transformation and systematic resilience building is to be expected. In terms of implementation rates, the overall level of performance is moderate. With an average score of 3.37, the companies surveyed are slightly above the midpoint of the scale, which indicates that digitization and agility measures are generally in place but are by no means consistently implemented. The low variance within the responses suggests that the industry is relatively homogeneous in this regard and that extreme performances – neither particularly high nor very low – are rather rare. This indicates a broad level of maturity in the middle range, where transformation processes are in place but not comprehensively institutionalized. Together, both variables illustrate that existing budget mechanisms have a significant influence on the speed and quality of implementation. Companies with fixed budget lines are structurally better positioned for predictable growth, continuous innovation, and more resilient process design, while project-based or missing budgets increase the likelihood that measures will be fragmented, delayed, or not implemented at all.

Block H: Macroeconomic pressure & response measures (H7)

H1: Macroeconomic pressure

Calculated using:

```
> describe(df$`wie stark haben Sie in den letzten 3 Jahren  
makroökonomischen Druck wahrgenommen (Pandemie, Krieg, Inflation,  
Engpässe)?`)
```

Key figure	Number
N	400
Mean	4.12
Median	4
SD	0.96
Min	2
Max	5
Skewness	-0.72

The majority of companies are feeling very strong macroeconomic pressure

H2: Measures taken

```
> H_actions <- df %>% + tidyr::separate_rows( + welche Maßnahmen wurden
infolge des Makrodrucks bei Ihnen verstärkt eingeführt? (Mehrfachwahl),
+ sep = ", " + ) %>% + dplyr::filter( + welche Maßnahmen wurden infolge
des Makrodrucks bei Ihnen verstärkt eingeführt? (Mehrfachwahl) != "" +
) > > table(H_actions$welche Maßnahmen wurden infolge des Makrodrucks
bei Ihnen verstärkt eingeführt?)
```

The four actual response categories can be reconstructed from the table (H_actions\$...):

Agile methods (Scrum, Kanban, OKR) → 29 respondents (because “Agile methods (Scrum” = 29, ‘Kanban’ = 29, “OKR)” = 29 – these are the three parts of the same response option) Antifragility measures (redundancies, scenarios, forecasts) → 166 respondents (because “Antifragility measures (redundancies” = 166, ‘scenarios’ = 166, “forecasts)” = 166 – three parts of the same option) Cost reductions / classic robustness measures → 342 respondents No specific measures → 28 respondents

Measure	Count (n)	Share of Sample
Cost reductions / classic robustness measures	342	85,5%
Antifragility measures (redundancies, scenarios, forecasts)	166	41.5%
Agile methods (Scrum, Kanban, OKR)	29	7.3%
No specific measures	28	7.0%

With 400 respondents, this results in the following frequency overview (multiple selections, therefore >100%):

The results of the macro block paint a clear picture of a logistics industry under severe pressure. With an average score of 4.12, respondents confirm that macroeconomic stress factors such as the pandemic, geopolitical crises, energy prices, and structural bottlenecks have been omnipresent in recent years. The distribution of responses is clearly skewed toward the upper end of the scale, indicating that almost all companies are feeling considerable pressure to adapt. This perception forms a key foundation for understanding organizational response patterns in volatile environments.

Analysis of the measures taken shows that companies primarily resort to classic robustness tools, in particular cost reductions and efficiency improvements. This defensive strategy points to a traditional management approach that remains firmly anchored and primarily pursues stabilization and risk minimization. At the same time, however, there is a remarkable proliferation of anti-fragility measures such as redundancies, scenario planning, and data-based forecasting tools. This illustrates that part of the industry has begun to view crises as potential drivers of development and to build proactive structures that go beyond mere resilience.

Agile methods are used, but mainly on a situational basis and less as part of a strategic cultural change. Their use is therefore often reactive to external shocks rather than an integral part of continuous organizational development. Another striking feature is the small group of companies that have not implemented any measures in response to macroeconomic pressure. This group represents a structurally vulnerable segment of the industry and will be an important reference for risk comparisons in the subsequent inductive analysis.

Overall, Block H shows that macroeconomic pressure is a significant driver of organizational adjustments, but at the same time there are major differences in the strategic maturity of companies. While some companies consciously invest in anti-fragile mechanisms, others remain in a reactive, cost-oriented mode.

Significance for hypothesis H7

H7 states: “Macroeconomic pressure acts as a catalyst for the introduction of agile and anti-fragile measures.”

The descriptive results clearly support this hypothesis:

Evidence	Interpretation
Very high macro pressure (MV = 4.12)	Strong external trigger present
High frequency of anti-fragile measures	Companies respond strategically
Average use of agile methods	Partial introduction, often reactive
Small no-action group	Control group for later tests

Block I: Future orientation of companies

This chapter analyzes which strategic development model companies prefer for the next 3–5 years. The response options correspond to four central concepts from the literature:

- Robustness (“Ensuring stability”)
- Resilience (“Getting back on your feet quickly”)
- Agility (“Adapting flexibly”)
- Antifragility (“Emerging stronger from crises”)

The evaluation was carried out using:

```
> table(df$`welches der folgenden Szenarien erscheint Ihnen für Ihr Unternehmen in den nächsten 3-5 Jahren am wahrscheinlichsten? (Bitte nur eine Option wählen)`)
```

Future strategy (concept)	Numbers
Flexible adaptation (agility)	144
Emerging stronger from crises (antifragility)	188
Quickly get back up (resilience)	39
Ensuring stability (robustness)	29

Antifragility is the most prevalent ($\approx 47\%$ of respondents). Agility ranks second ($\approx 36\%$). Traditional resilience and robustness models are chosen significantly less often (only 17% combined). This already shows a remarkable strategic orientation in the industry. The future orientation of the companies surveyed paints a clear picture of transformation. Almost half of the respondents (188 out of 400) state that they intend to pursue an antifragile strategy in the next three to five years. This implies that crises should no longer be seen merely as disruptions, but as potential accelerators of development. Respondents and their companies that take this perspective expect volatile markets to present not only risks but also structural opportunities, for example through expansion,

innovation, or process realignment. Another 144 respondents and their companies prioritize an agile future strategy that emphasizes flexibility, speed, and adaptability above all else. Taken together, this means that around 83% of respondents are turning away from purely stability-oriented models. The logistics industry appears to be moving in a direction that is characterized more by dynamism than by static efficiency. In contrast, only relatively small groups focus on classic resilience (39 mentions) or robustness (29 mentions). The clear preference for anti-fragile and agile development models is an indicator of profound sectoral change that requires not only operational adaptability but also cultural and structural transformation.

Descriptive overview of the sample

The descriptive analysis of the 400 data sets collected provides a consistent picture of the current organizational and cultural orientation of logistics companies of various sizes and segments. The sample is heterogeneous: CEP service providers and internal logistics structures of large companies are particularly well represented, while traditional freight forwarders, contract logistics providers, and industrial companies are proportionally smaller but sufficiently represented. Company sizes also vary significantly, with very large companies ($\geq 5,000$ employees) representing the largest group. At the cultural level, there is a rather positive learning and communication culture. All three indicators—error learning culture (mean = 3.94), crisis communication (mean = 3.48), and innovation promotion (mean = 3.36)—are above the scale mean. This indicates a fundamentally open attitude toward change, although not all facets are equally pronounced. The results suggest that companies are willing to reflect on and deal openly with mistakes, but do not yet actively promote innovation across the board. Crisis management capabilities are rated as moderate for the most part. The mean values of the five performance dimensions

examined range between 3.12 and 3.40, which is in the middle range. Companies therefore do not see themselves as clearly crisis-resilient or highly crisis-prone. It is striking that subjectively assessed R. Crisis management capabilities are generally rated as moderate. The mean values for the five performance dimensions examined range between 3.12 and 3.40, placing them in the middle range. Companies therefore do not see themselves as either clearly crisis-resilient or highly crisis-prone. It is striking that subjectively assessed resilience (mean = 3.88) is significantly higher than the objectively assessed performance indicators, an indication of possible misjudgments or diverging internal assessment standards.

In the area of digitalization, many companies use central tools such as real-time tracking and KPI dashboards. At the same time, the statement that crises have strengthened the company in the long term is only moderately confirmed (mean = 3.50). This suggests that digitalization is widespread but does not necessarily lead to systemic learning or innovation capabilities. The organizational structure of the companies surveyed is predominantly centralized (121 mentions) or hybrid (122 mentions). Decentralized models are in the minority. Efficiency (mean = 3.24) and customer proximity (mean = 3.43) are rated positively on average, with the slightly higher customer proximity despite centralized structures suggesting compensatory measures such as decentralized service units or digital transparency.

Analysis of operational flexibility mechanisms shows that asset-light strategies are moderately prevalent (mean = 3.36). Redundancies are widespread—particularly multi-carrier strategies (203 mentions), contingency plans (197), and safety stocks (135). Only 75 companies completely forego redundancies, which can be interpreted as a significant deviation from the modern understanding of resilience.

Flexible project-related budgets (227) dominate the financing of digital or resilience-related measures. Fixed budget lines (113) are less common, while 60 companies do not use any structured budgeting model at all. At the same time, the implementation rate of digital and agile initiatives is estimated to be moderate, with an average value of 3.37. Macroeconomic pressure is perceived as above average (MW = 4.12). The most common responses are classic cost reductions, but anti-fragile measures and agile methods are also used. This points to a mixture of traditional and modern coping strategies.

The future orientation of companies shows a clear signal of transformation: anti-fragility (188 mentions) and agility (144) clearly dominate over resilience (39) and robustness (29). This means that over 80% of companies are focusing on adaptable or even growth-oriented strategies in crises. Overall, the descriptive results highlight an area of tension: structurally, a classic

The future orientation of companies shows a clear signal of transformation: anti-fragility (188 mentions) and agility (144) clearly dominate over resilience (39) and robustness (29). This means that over 80% of companies are focusing on adaptable or even growth-oriented strategies in crises.

Overall, the descriptive results highlight an area of tension: structurally, a classic, centralized logistics model continues to dominate, while cultural attitudes, redundancy mechanisms, and future orientations are increasingly geared toward agility and anti-fragility. The industry is thus in a transitional phase between traditional structures and modern, highly dynamic organizational logics.

5.5 Inductive analysis

Following the descriptive presentation of the sample and the central research variables, the next step is to conduct an inductive data analysis. The aim is to empirically test the

hypotheses derived in Chapter 4 and to evaluate whether the observed correlations are statistically significant and thus appear to be transferable to the overall population.

For each hypothesis, a suitable statistical test is applied (t-test, ANOVA, correlation analysis, or regression model), depending on the scale level and model structure. The results are interpreted on the basis of test statistics, p-values, and confidence intervals. The inductive analysis follows the structure of hypotheses H1 to H7 and builds directly on the previously formed indices and variables.

H1 – Relationship between corporate culture and the use of agile methods

Objective of the hypothesis

H1 assumes that companies with a more pronounced culture of learning, communication, and innovation use agile working methods more frequently (and more intensively).

Operationalization - Corporate culture (metric)

- Culture index (Kultur_Index) consisting of three items:
- Mistakes are seen as learning opportunities.
- Open communication in times of crisis is encouraged.
- Innovation and experimentation are actively supported.

R-Code:

```
> df$Kultur_Index <- rowMeans(df[, c(
  "In meinem Unternehmen gilt [Fehler werden als Lernchance
verstanden.]",
  "In meinem Unternehmen gilt [Offene Kommunikation in
Krisenzeiten wird gefördert.]",
  "In meinem Unternehmen gilt [Innovation und Experimentieren
wird aktiv unterstützt.]")])
```

```
)], na.rm = TRUE)
```

Agile methods (binary):

0 = no agile method

1 = at least one agile method

```
> df$Agile_JaNein <- ifelse(
  df$`welche agilen Methoden setzen Sie in Ihrem Unternehmen ein?
  (Mehrfachwahl möglich)` == "keine",
  0, 1
)
```

Number of agile Methods (metrisch)

```
df$Agile_Count <- sapply(
  strsplit(df$`welche agilen Methoden setzen Sie in Ihrem Unternehmen
  ein? (Mehrfachwahl möglich)`, ","),
  function(x) length(x)
)
```

Statistical approach

(a) t-test:

Comparison of the culture index between companies with and without agile methods:

```
t.test(Kultur_Index ~ Agile_JaNein, data=df)
```

(b) Pearson correlation:

Correlation between culture index and number of agile methods:

```
cor.test(df$Kultur_Index, df$Agile_Count)
```

Results

t-Test

Group	Mean Cultur_Index
No agile methods	3.21
At least one agile method	3.82

$t = -5.52$, $df \approx 227$

$p\text{-value} = 9.09 \times 10^{-8}$

95% confidence interval = $[-0.83; -0.39]$

Companies that use agile methods exhibit significantly higher cultural values.

The hypothesis of a cultural difference is clearly confirmed.

Pearson Correlation

$r = 0.144$

$p = 0.0039$

95 %- Confidence interval = $[0.047; 0.239]$

There is a significant positive correlation, albeit of moderate strength: The stronger the learning, communication and innovation culture, the more agile methods are actually used.

Overall interpretation H1

The results of the inductive analysis show a clear and statistically highly significant correlation between the strength of corporate culture and the use of agile methods. Companies that have a stronger culture of learning, communication, and innovation use agile approaches significantly more often. The t-test carried out clearly confirms this correlation: Organizations without agile methods achieve an average culture value of 3.21, while companies with at least one agile method have a significantly higher average value of 3.82. The very low p-value ($p < 0.000001$) makes it clear that these differences are not random. The supplementary correlation analysis also shows a consistent picture. There is a positive, statistically significant correlation between cultural maturity and the number of agile methods used ($r = 0.144$; $p < 0.004$). Companies with a more pronounced tolerance for error, open communication, and innovation orientation not only tend to integrate agile methods, but also tend to use several of these practices in parallel. In summary, it can be said that a “modern” organizational culture—characterized by a focus on learning, transparency, and a willingness to innovate—acts as an important driver for the introduction and use of agile working methods. The data thus confirms the theoretical assumption that agility cannot be implemented in isolation, but rather builds on a cultural foundation. Hypothesis H1 is therefore clearly supported.

H2: Influence of agile organizational forms on crisis management

Following the descriptive analysis, we now proceed to the inductive testing of hypothesis H2. The aim is to determine whether companies with different organizational forms also exhibit significantly different crisis management capabilities. To this end, an aggregated crisis management index (Krise_Index) was first created, consisting of five individual

indicators (service level, volume compensation, delivery times, customer satisfaction, KPI stability). A variance analysis was then performed.

Since the question covers several groups (different organizational forms), two statistical tests were used that build on each other:

ANOVA – analysis of variance

ANOVA tests whether at least two organizational forms differ significantly from each other in terms of their average crisis management.

Intuitively, ANOVA examines whether the differences between the groups are greater than what would be expected from random fluctuations. A significant p-value means that the organizational form as a factor has a statistical influence.

R command:

```
> anova_H2 <- aov(Krise_Index ~ `welche Organisationsform herrscht in  
Ihrem Unternehmen?`, data=df)  
  
summary(anova_H2)
```

Tukey-HSD – Post-hoc test

Since ANOVA only indicates that differences exist, the Tukey-HSD test then checks between which specific groups these differences exist.

R command:

```
TukeyHSD(aov(Krise_Index ~ `welche Organisationsform herrscht in Ihrem  
Unternehmen?`, data=df))
```

This allows pair comparisons to be made, e.g., classic vs. hybrid or hybrid vs. fully agile, without increasing the probability of error through multiple comparisons.

This combination is necessary in order to scientifically validate both the existing difference (ANOVA) and its direction and localization (Tukey-HSD).

Results of the analysis of H2

ANOVA

The analysis of variance shows a highly significant influence of organizational form on crisis management:

$F(2, 397) = 95.33, p < 0.001$

This means that the groups differ very significantly in terms of their crisis management. The organizational form therefore plays a measurable role in how well companies survive crises.

Post-hoc comparisons (Tukey-HSD)

The Tukey test shows in detail which organizational forms differ:

Classic – Hybrid: $-0.996, p < 0.001$

Fully agile – Hybrid: $+0.730, p < 0.001$

Fully agile – Classic: $+1.726, p < 0.001$

The effect sizes are very pronounced: Purely traditional or highly centralized companies are well below the mean, while agile organizational forms are clearly above it.

In detail in R:

Tukey multiple comparisons of means

95% family-wise confidence level

```
      $orgform
diff      lwr      upr      p adj
Classical (waterfall, Top-Down) – Hybrid (agile in innovation/IT,
classical ops)    -0.9963   -1.2183   -0.7741   0.0000000
Fully agile (incl. operations) – Hybrid (agile in innovation/IT,
classical ops)      0.7297    0.3112    1.1482   0.0001469
```

Fully agile (incl. operations) – Classical (Waterfall, Top-Down)

1.7259 1.3358 2.1161 0.0000000

Significant differences ($p < .001$)

Only three meaningful contrasts emerged:

Hybrid > Classical (Waterfall)

- Hybrid organisations show substantially better crisis performance.
- Difference = +0.996, $p < .001$.

Fully agile > Hybrid

- Fully agile organisations outperform even hybrid structures.
- Difference = +0.730, $p < .001$.

Fully agile > Classical

- Fully agile companies show the strongest crisis capabilities overall.
- Difference = +1.726, $p < .001$.

Interpretation of results H2

The results clearly **confirm** hypothesis H2:

The greater the organizational flexibility, the better the crisis management.

Traditional hierarchical organizations react more slowly, are less adaptable, and on average perform worst in crises. Hybrid organizations, which combine central control with decentralized decision-making, are in the middle range and already show clear advantages over purely traditional structures. Fully agile companies achieve the highest scores and cope with crises significantly better than all other groups.

These results are consistent with both the theoretical foundations of agile organizational research and current practical observations from the logistics industry, where flexible teams and decentralized decision-making processes are considered to increase resilience.

H3: A higher degree of digitalization goes hand in hand with a stronger anti-fragile effect of crises.

After testing hypotheses H1 and H2, we now turn to the inductive investigation of hypothesis H3, which examines the relationship between the degree of digitalization and the long-term effects of crises (antifragility). The aim is to determine whether companies that are more digitally advanced are more likely to report that crises have strengthened them in the long term.

To test this hypothesis, two variables were operationalized:

Digital_Count

Number of digital tools used

determined by:

```
df$Digital_Count <- sapply(strsplit(df$`welche digitalen Tools nutzen Sie?`, ","), function(x) length(x))
```

Antifragility indicator

Evaluation of the statement:

“Crises have strengthened our company in the long term.”

Since both variables are metric scaled, a Pearson correlation coefficient was calculated.

This test measures whether a linear relationship exists between two numerical variables and how strong it is.

R command used:

```
cor.test(df$Digital_Count,  
         df$`wie bewerten Sie die Aussage „Krisen haben unser  
Unternehmen langfristig gestärkt (z. B. durch neue Prozesse,  
Innovationen).“`)
```

The Pearson test yielded the following results:

Correlation coefficient: $r = 0.225$

p-value: $p < 0.00001$

95% confidence interval: $[0.129; 0.316]$

The analysis shows a significant positive correlation between a company's degree of digitalization (operationalized as the number of digital tools used) and its assessment that it has been strengthened in the long term by crises. The correlation coefficient of $r = 0.225$ indicates a weak to moderate but statistically significant effect ($p < 0.001$).

This means that companies that use more digital tools – such as real-time tracking, KPI dashboards, or automation – are more likely to report that crises have given them impetus for lasting improvement. The correlation suggests that companies with higher digital adoption tend to report stronger perceived learning and improvement effects after crises. Since the effect is significant but not very strong, it can be concluded that digitalization is a relevant but not the only driver of anti-fragile development. Factors such as corporate culture, leadership, organizational structure, and redundancy mechanisms probably have a complementary effect.

Overall, H3 thus provides empirical support for the theoretical assumption that digitalization is an element of anti-fragile organizational development.

H4: Hybrid-organized companies cope better with crises than highly centralized or highly decentralized companies.

Following the examination of the degree of digitization (H3), hypothesis H4 now analyzes the effect of organizational form on crisis management performance. The aim is to determine whether certain structural forms—centralized, decentralized, or hybrid—are systematically associated with better crisis performance.

Here, the hypothesis ties in directly with theory-based models that assume a nonlinear relationship: Centralization promotes efficiency, decentralization promotes adaptability – a hybrid model could therefore offer the best crisis compensation.

Operationalization

Crisis_Index (Krise_Index) (dependent variable):

Average of five crisis indicators (service level, volume compensation, delivery times, customer satisfaction, KPI compliance)

Created with:

```
df$Krise_Index <- rowMeans(df[, c(
  "wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den
  letzten 3 Jahren? [Servicelevel gehalten]",
  "wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den
  letzten 3 Jahren? [Umsatz-/Volumen-Rückgang kompensiert]",
  "wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den
  letzten 3 Jahren? [Lieferzeiten stabilisiert]",
  "wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den
  letzten 3 Jahren? [Kundenzufriedenheit gesichert]",
  "wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den
  letzten 3 Jahren? [Individuelle KPI's gehalten]"
)], na.rm = TRUE)
```

Organizational form (independent categorical variable)

Levels: Somewhat centralized, Highly centralized, Hybrid, Somewhat decentralized,
Highly decentralized

Variance test (ANOVA)

Since several groups are being compared, a one-way ANOVA is used.

R command:

```
df$Struktur_Group <- factor(df$`Wie ist die Struktur Ihres
Unternehmens?`)

anova_H4 <- aov(Krise_Index ~ Struktur_Group, data=df)

summary(anova_H4)
```

Post-hoc comparisons (Tukey HSD)

The Tukey test is used to identify exactly which groups differ from each other.

R command:

```
TukeyHSD(anova_H4)
```

Results

ANOVA

$F(4, 395) = 32.08,$

$p < 2e-16$

→ Very strong significant difference between the organizational forms.

Tukey HSD – key findings

Comparison	Result
Hybrid > Highly centralized	Significantly better
Hybrid > Rather centralized	Significantly better
Fully agile > Centralized	Highly significant
Rather decentralized ≈ Hybrid	No significant difference
Highly decentralized vs. Hybrid	No significant difference

In detail (excerpt from R output):

Tukey multiple comparisons of means

95% family-wise confidence level

```

Fit: aov(formula = Crisis_Index ~ Structure_Group, data = df)

$Structure_Group

diff      lwr      upr      p adj
Rather centralised-Rather decentralised
-1.18599174 -1.6139847 -0.7579988 0.0000000
Hybrid (central + decentralised)-Rather decentralised
-0.15581967 -0.5833766 0.2717372 0.8558728
Highly decentralised-Rather decentralised
-0.21928571 -0.9479864 0.5094150 0.9229291
Highly centralised (central control, standard IT)-Rather decentralised
-0.96325243 -1.4004379 -0.5260669 0.0000000
Hybrid (central + decentralised)-Rather centralised
1.03017206 0.7290956 1.3312486 0.0000000
Highly decentralised-Rather centralised
0.96670602 0.3042508 1.6291612 0.0007210
Highly centralised (central control, standard IT)-Rather centralised
0.22273931 -0.0918609 0.5373395 0.2978021
Highly decentralised-Hybrid (central + decentralised)
-0.06346604 -0.7256396 0.5987075 0.9989508
Highly centralised (central control, standard IT)-Hybrid (central +
decentralised)-0.80743276 -1.1214396 -0.4934260 0.0000000
Highly centralised (central control, standard IT)-Highly decentralised
-0.74396671 -1.4123978 -0.0755356 0.0205166

```

The Tukey post-hoc comparison identifies which organisational structures differ significantly in crisis performance. The key findings are:

Significant differences ($p < .001$ or $p < .01$)

These are the contrasts that truly matter statistically:

- Rather centralised < Hybrid

Hybrid organisations show significantly higher crisis performance than traditional

centralised companies

(diff = +1.03, $p < .001$).

- Highly centralised < Hybrid

Hybrid structures again outperform strongly centralised organisations

(diff = +0.81, $p < .001$).

- Fully agile / Highly decentralised > Rather centralised

More decentralised or agile organisations score higher than classic centralised ones

(diff = +0.97, $p = .0007$).

- Fully agile > Classic Top-Down

Fully agile structures perform best overall

(diff = +1.73, $p < .001$).

These results support the hypothesis that hybrid and agile structures handle crises better than strongly centralised models.

Non-significant differences ($p > .05$) These contrasts show no statistical difference, meaning the crisis performance is comparable:

- Hybrid vs. Rather decentralised ($p = 0.856$)
- Highly decentralised vs. Rather decentralised ($p = 0.923$)
- Highly centralised vs. Rather centralised ($p = 0.298$)
- Highly decentralised vs. Hybrid ($p = 0.999$)

These non-significant results indicate that partial decentralisation behaves similarly to hybrid models, while extreme centralisation or decentralisation does not consistently offer additional crisis advantages.

The results show a clear and statistically highly significant influence of organizational form on crisis management capabilities. The ANOVA shows that the groups differ greatly ($F = 32.08$; $p < 0.001$). The Tukey-HSD test shows that hybrid organizational structures in particular are superior in a crisis. Hybrid companies that combine central control with decentralized flexibility achieved significantly better results than highly or moderately centralized companies. This finding supports the theoretical assumption that purely centralized models offer efficiency advantages but lose responsiveness in dynamic or crisis-ridden environments. Even highly centralized companies perform significantly worse than hybrid and fully agile structures. Interestingly, hybrid organizations do not differ statistically from more decentralized or highly decentralized structures. This suggests that the common feature—greater autonomy—is the decisive advantage in times of crisis. In summary, H4 empirically confirms that companies with balanced or flexible structural models are better able to deal with crises than those with very rigid, centralized forms of organization. This underscores the relevance of organizational ambidexterity as an anti-fragile structural feature.

H5 – Asset-light & redundancy → resilience

Hypothesis H5:

“The use of asset-light strategies and the extent of implemented redundancies are associated with the resilience assessments of logistics companies.”

A linear regression model was estimated for H5:

$$\text{Resilience / Antifragility} = \beta_0 + \beta_1(\text{Asset-Light}) + \beta_2(\text{Redundancy count})$$

R commands used:

```
df$Redundanz_Count <- sapply(
  strsplit(df$`welche Redundanzen haben Sie implementiert?
(Mehrfachwahl)` , ","),
```

```

function(x) length(x)
)

lm_H5 <- lm(
  `Wie würden Sie die Resilienz (Widerstandsfähigkeit) Ihres
  Unternehmens einschätzen?` ~
  `Wie stark setzt Ihr Unternehmen auf „Asset-Light“-Strategien (z.
  B. Outsourcing, flexible Netzwerke statt eigener Flotten/Lager)?` +
  Redundanz_Count,
  data=df
)
summary(lm_H5)

```

Regression results

Predicor	Estimate	p-Value	Interpretaion
Asset-light	-0.073	0.0238	Higher asset-light value → slightly lower resilience
Rdundanz_Count	-0.059	0.201	no significant effect
Intercept	4.229	>0.001	Average resilience is very high

Additional model metrics:

$p = 0.0666 \rightarrow$ model not quite significant

$R^2 = 0.0136 \rightarrow$ explains approx. 1.4% of the variance

Standard error = 0.783

The analysis of hypothesis H5 examines the influence of asset-light strategies and redundancy measures on the resilience assessed by companies. The regression model shows that the use of asset-light structures has a significant negative correlation with the

resilience assessment ($\beta = -0.073$, $p = 0.0238$). This means that companies that place greater emphasis on asset-light strategies in the survey tend to rate their own resilience slightly lower than companies with a lower asset-light share. However, the data does not allow any conclusions to be drawn about why this correlation exists; only the direction and significance of the relationship can be determined. On the other hand, the number of redundancies implemented has no statistically significant effect on the resilience rating ($\beta = -0.059$, $p = 0.201$). The resilience in the available data does not systematically differ between companies with many redundancies and companies with few redundancies. The mere number of redundancy measures is therefore not a recognizable predictor of the resilience rating in the data set. With a p-value of 0.066, the overall model shows only a marginal significance trend and explains only a small part of the variance in resilience ($R^2 = 0.0136$). The results thus show that the two factors examined make only a very limited contribution to explaining the resilience rating. With regard to hypothesis H5, which expects a positive correlation between asset lightness in combination with redundancies and resilience, the data does not provide clear confirmation. While asset lightness correlates significantly negatively with resilience, no significant effect can be seen for redundancies. The data therefore suggests that resilience in the sample examined does not increase in the expected manner through the combination of the two factors. The hypothesis is thus not supported by the available empirical findings.

H6 Correlation between financing mechanisms and implementation rate

“Clear budget mechanisms for digitization and resilience measures increase the implementation rate of digital/agile initiatives.”

This hypothesis is based on the assumption that structurally anchored financing models—such as fixed budget lines or project-related capex/opex rules—reduce organizational hurdles and thus enable more consistent implementation.

Two variables from the data set were used to test H6:

Independent variable:

Budget mechanism - (Does your company have special budget mechanisms for digitalization/resilience measures?)

three characteristics:

- (1) Yes, fixed budget line,
- (2) Yes, project-related (case-by-case),
- (3) No.

Dependent variable:

Implementation rate (What is the implementation rate of digital/agility initiatives?)

– metric, 1–5 Likert scale.

Since the independent variable comprises three groups, a simple one-factor ANOVA model was estimated. This procedure tests whether the mean values of the implementation rate differ significantly between the budget groups. A significant F-value would indicate that budget mechanisms have a statistical influence on the implementation rate.

The corresponding R command is:

```
> anova_H6 <- aov(`wie hoch ist die Umsetzungsquote von Digital
/Agilitäts-Initiativen?` ~
                    `Gibt es in Ihrem Unternehmen spezielle
Budgetmechanismen für Digitalisierung / Resilienzmaßnahmen?`,
                    data=df)

summary(anova_H6)
```

TukeyHSD(anova_H6)

R Output:

Df	Sum Sq	Mean Sq	F value	Pr(>F)
Budget	2	14.17	7.086	15.88 2.36e-07 ***
Residuals	386	172.26	0.446	

A significant F-value does not indicate which groups differ, but only that at least one group mean is different. The F-value is 15.88, which is significantly higher than would be expected by chance with three groups. The p-value is 2.36×10^{-7} , or 0.000000236, well below the usual significance threshold of $p < 0.05$. This means that there is an extremely low probability that the observed differences in the group means are random. The budget mechanism has a clear and statistically highly significant influence on the implementation rate of digital/agile initiatives. This justifies further post-hoc analysis. Since the ANOVA was significant, the Tukey HSD test was performed to check which groups differ from each other.

R Output:

\$Budget			diff
lwr	upr	p adj	
Ja, projektbezogen (Case-by-Case)-Ja, feste Budgetlinie			0.1983
0.0109	0.3856	0.0351	
Nein - Ja, feste Budgetlinie			-0.3373 -
0.5930	-0.0815	0.0058	
Nein - Ja, projektbezogen (Case-by-Case)			-0.5355 -
0.7637	-0.3074	0.0000	

The post-hoc tests show clearly differentiated effects of the various budget mechanisms: Companies with project-related budgets have a significantly higher implementation rate (diff = 0.20, $p = 0.035$). This suggests that flexible, needs-based allocation of funds supports the implementation of digital and agile measures. Companies without specific financing mechanisms achieve a significantly lower implementation rate (diff = -0.34, $p = 0.006$). A lack of financial structure has an inhibiting effect on digital and agility initiatives. This comparison of no budget mechanisms vs. project-based financing shows the greatest effect size: companies without budget mechanisms perform significantly worse than companies with project-based financing (diff = -0.54, $p < 0.001$). Project-based budget models show the best values, while a lack of budgets shows the worst.

The results clearly confirm hypothesis H6. Companies that have clear financing mechanisms, especially in the form of project-related budgets, implement digital and agile initiatives significantly more intensively. The ANOVA indicates a highly significant overall effect, and the post-hoc analysis clearly shows that both fixed and project-related budget structures have a positive influence on the implementation rate. The difference between companies with project-related financing mechanisms and those without defined budgets is particularly pronounced.

This leads to the following conclusion:

Budget clarity and flexible allocation of funds are key drivers for the successful implementation of digital and agile measures.

Companies without budget mechanisms systematically lag behind, which shows that a lack of financial structure leads to low implementation.

H7 Correlation between economic pressure and anti-fragile measures

“The more companies perceive macroeconomic pressure, the more frequently they introduce anti-fragile measures.”

Two statistical methods were used to test this hypothesis: Pearson correlation between perceived macro pressure and the number of anti-fragile measures introduced (Antifragil_Count). Linear regression to quantify the strength of the correlation.

R-Command:

```
> cor.test(df$Makro, df$Antifragil_Count)
```

Correlation coefficient: $r = 0.186$

t-value: 3.780

p-value: 0.00018

95% confidence interval: [0.0898 ; 0.2791]

The Pearson correlation between perceived macro pressure and the number of anti-fragile measures is $r = 0.186$. This value describes the strength and direction of the linear relationship between the two variables. A positive value means that higher values of one variable tend to be associated with higher values of the other. With $r = 0.186$, the correlation is weak but clearly positive. The significance test yields a p-value of 0.00018, which is well below the usual significance level of 0.05. This rules out the possibility that the observed correlation is random. The 95% confidence interval [0.0898; 0.2791] also shows that the true correlation is also highly likely to be positive and not close to zero. Overall, these figures prove that there is a statistically reliable linear correlation between macro pressure and the number of measures introduced.

R-Command:

```
> lm_H7 <- lm(Antifragil_Count ~ Makro, data=df)
```

summary(1m_H7)

Parameter	Estimate	Std. Error	t-Value	p-Value
Intercept	0.988	0.380	2.600	0.0097
Makro-Druck	0.340	0.0899	3.781	0.00018

$R^2 = 0.0347$

Model p = 0.00018

The regression analysis confirms the pattern previously identified by the correlation: an increase in perceived macroeconomic pressure by one unit is associated with an average increase of 0.34 measures introduced. This correlation is evident in two key statistical indicators: First, the regression coefficient for macro ($\beta = 0.3397$) is positive, which means that higher pressure is associated with more measures. Second, the corresponding p-value ($p = 0.00018$) is highly significant, showing that this result is statistically robust and not random. The correlation ($r = 0.186$) further supports this finding, as it also shows a positive, albeit moderate, relationship between the two variables. The data thus clearly shows that companies that perceive higher external pressures tend to report more measures. Although the model explains only a small part of the total variance, the consistent positive correlation clearly shows that macro pressure is a relevant driver for the introduction of additional measures. Overall, hypothesis H7 can therefore be considered supported: companies that perceive stronger macroeconomic pressure are more likely to implement a larger number of anti-fragile measures.

Summary of inductive analysis

The inductive analysis reveals several clear and statistically significant correlations between organizational characteristics and the observed effects of agility, resilience, and anti-fragility. First, it confirms that a more pronounced culture of learning,

communication, and innovation goes hand in hand with greater use of agile methods (H1). The results also show that the type of organizational form is significantly related to crisis management (H2): Classic, hierarchical structures perform significantly worse than hybrid and fully agile models. Second, the analysis indicates that a higher degree of digitalization—measured by the number of tools used—is associated with more strongly perceived positive learning effects from crises (H3). Structural aspects (H4) also play a role: Centralized organizations show lower crisis performance than hybrid or decentralized structures. Third, the study provides mixed results for H5: Neither the intensity of asset-light approaches nor the number of redundant measures convincingly explain resilience; only asset-light shows a slight negative correlation. In contrast, more pronounced effects can be seen in financial conditions (H6). Companies with clear budget mechanisms—especially project-related ones—have higher implementation rates for digital and agile initiatives than companies without defined budgets. Finally, a significant correlation between perceived macroeconomic pressure and the number of measures introduced (H7) is confirmed. Higher external pressure is consistently associated with greater activity in the introduction of measures.

Overall, the inductive analysis shows a consistent pattern: culture, degree of digitalization, organizational form, budget structures, and external pressure are empirically verifiable influencing factors for agility, crisis management, and anti-fragile development, while the expected effects of redundant measures are not clearly supported.

CHAPTER VI: SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

6.1 Recommended action & Practical Implications

The empirical results of the hypothesis tests allow for a series of clear practical conclusions that can be drawn directly from the statistically verified correlations without speculation. Overall, it is evident that anti-fragile characteristics do not arise from individual isolated measures, but rather from an interplay of culture, structure, digitalization, and reliable budget mechanisms. Companies that systematically develop these elements demonstrably achieve better results in terms of agility, crisis management, and long-term organizational development. First, the analysis shows that the organizational culture has a big impact on how agile ways of working are used. Companies with a strong learning and communication culture are way more likely to use agile methods. This means it's important to consciously strengthen this kind of culture, for example by promoting an open error culture, transparent communication processes, and institutionalized spaces for innovation and experimentation. A strong focus on learning measurably increases the likelihood of embedding agile processes in the organization and using them across the board. The findings on organizational structure show an equally clear correlation. Traditional, highly centralized top-down models achieve the weakest scores in crisis management, while hybrid and fully agile organizational forms perform significantly better. This suggests that companies can substantially increase their responsiveness in crises through partial decentralization, the creation of cross-functional decision-making spaces, and the introduction of hybrid control models. Hybrid structures offer empirically proven advantages because they combine efficiency and flexibility. Furthermore, there is a significant positive correlation between a company's digital maturity and its assessment that it has been strengthened in the long term by crises. A higher degree of digitalization—measured by the number of tools used, such as real-time tracking, KPI dashboards, or forecasting systems—is

associated with a higher anti-fragile effect. This makes it clear that creating digital transparency is a key lever for supporting learning processes, adaptability, and innovation. A particularly clear practical consequence emerges from the results on budget mechanisms. Companies that have clearly defined financing structures for digitalization and resilience measures, especially project-related budget models, implement digital and agile initiatives significantly more often. Conversely, companies without specific budget mechanisms perform significantly worse. This clearly shows that financial structuring is a key driver of transformational capability and that establishing clear, flexible budget processes significantly increases the speed of implementation. The analysis of asset-light strategies and redundant capacities reveals a nuanced picture. Neither the number of redundancies nor the extent of asset-light structures show a significant positive correlation with perceived resilience. This suggests that such measures should be evaluated not in terms of quantity, but in terms of their suitability. Companies should therefore focus less on the number of redundancies implemented and more on their strategic relevance and quality in the process context. Finally, the study on macroeconomic pressure confirms that increasing external pressures are accompanied by the introduction of additional measures. Companies therefore respond empirically to external uncertainties by expanding their portfolio of measures. This underscores the importance of an institutionalized approach to external signals, for example through systematic scenarios, stress tests, and mechanisms that automatically trigger organizational developments in times of increased uncertainty.

In summary, a consistent overall picture emerges: Organizations become measurably more resilient and adaptable when they strengthen a learning-oriented culture, establish hybrid or agile structures, expand digital transparency, and create clear financial

frameworks for transformation initiatives. The statistical results show that these factors are not just theoretical concepts, but have a demonstrable impact on crisis management, agility, and anti-fragile development in practice.

6.2 Research quality criteria

The quality of this study is based on compliance with key scientific quality criteria, which were systematically taken into account for both the qualitative and quantitative parts of the research. The combination of Mayring's content analysis approach and a standardized quantitative survey method ensures that the results are comprehensible, reliable, and theoretically compatible.

Objectivity in the qualitative part is guaranteed by a rule-based approach according to Mayring, in which paraphrasing, generalization, and reduction are carried out using a transparent category system. The evaluation follows fixed analysis guidelines and is not based on the subjective impressions of the researcher. In the quantitative part, objectivity is ensured by the use of a standardized online questionnaire, which is completed without interviewer influence and whose evaluation is based exclusively on statistical procedures. Reliability results qualitatively from the consistency of the evaluation steps:

Paraphrasing, generalisation and reduction are carried out according to clearly defined rules, which supports the repeatability of the analysis. In the quantitative part, reliability is increased by using several items per construct (e.g. culture index, crisis index), thereby reducing random measurement errors in individual questions. The large sample size of $n = 400$ also stabilises the statistical estimates.

Validity is addressed on several levels. Content validity is ensured by the close link between the questionnaire and the expert assessments collected previously: The constructs of digitalization, agility, crisis management, culture, and antifragility were derived directly from the qualitative results and anchored theoretically. Construct validity

is demonstrated quantitatively by correlations that meet expectations, such as the positive correlation between culture and agility (H1) or the influence of organizational structure on crisis performance (H4). Criterion validity is supported by significant relationships between explanatory and dependent variables that reflect empirically verifiable performance differences.

Transparency and replicability are ensured by the complete documentation of the research process. For the qualitative analysis, all steps of category formation were disclosed, while in the quantitative part, all statistical procedures (data preparation, index formation, test procedures, models) are traceable through complete R documentation. This allows the analysis to be replicated or critically reviewed by other researchers. Sample quality and generalizability are based on a combined selection process: The qualitative phase uses targeted expert interviews to develop theoretically sound hypotheses. The quantitative phase uses a multi-stage, broad-based sample design consisting of online distribution and telephone contact. A sample size of $n = 400$ enables robust inferential statistical analyses. At the same time, potential biases are reflected, as online surveys do not offer complete control over identity and multiple participation; however, plausibility-based exclusions minimize this effect. Statistical adequacy is ensured by the selection of hypothesis-appropriate test procedures. The t-test was used for metric differences, variance analyses with Tukey-HSD post-hoc tests for group comparisons, and correlations and linear regression for correlations. As a result, the results are methodologically correct and meaningful.

Overall, the study meets essential quality criteria for empirical social research. The qualitative part provides theory-driven structuring and hypothesis-generating in-depth information, while the quantitative part tests these hypotheses with a large number of

cases and statistically validates them. The combination of both approaches increases the internal validity of the results and enables a comprehensive, empirically sound evaluation of anti-fragile organizational principles in the logistics industry.

6.3 Goal achievement

The objectives of the study were to assess the current state of resilience and anti-fragility practices in the logistics industry, identify key areas of application for anti-fragility principles, and derive concrete strategies that enable a shift from pure robustness to anti-fragile organizational design. These objectives were systematically achieved by combining a qualitative hermeneutic approach according to Mayring with quantitative hypothesis testing based on an extensive data set ($n = 400$). In the qualitative part, key structural weaknesses in the industry—in particular, low organizational agility, historically grown centralization, and a pronounced focus on efficiency—were clearly identified. At the same time, the interviews provided initial indications of areas in which antifragile principles can be effectively implemented in principle, such as flexible organizational forms, decentralized decision-making processes, or digital transparency mechanisms. These findings enabled the precise derivation of hypotheses H1 to H7. The quantitative study largely confirmed these hypotheses and provided robust empirical evidence that key drivers of anti-fragile development are already in place in the industry: A more pronounced culture of learning and innovation promotes the introduction of agile methods (H1), agile and hybrid organizational forms achieve significantly better crisis performance (H2 and H4), and a higher degree of digitalization is measurably associated with stronger long-term improvements after crises (H3). In addition, it was found that clearly defined budget mechanisms significantly increase the implementation rate of digitally agile initiatives (H6) and that perceived macroeconomic pressure leads to a more intensive introduction of anti-fragile measures (H7). Only H5, which assumed a positive

influence of asset-light strategies and redundancies on resilience, could not be empirically confirmed.

Overall, the central research objective was achieved: The study provides an empirically based picture of how companies in the logistics industry currently deal with crises, which structural and cultural factors contribute to anti-fragile behavior, and in which areas targeted interventions can be expected to have the greatest effect. The results close a previous research gap by systematically applying anti-fragile principles to the logistics context and demonstrating their effectiveness using quantitative evidence. At the same time, they form the basis for a practice-oriented framework that can serve as a guide for organizations in developing anti-fragile structures.

6.4 Critical consideration and perspective

This study combines qualitative and quantitative methods to provide a comprehensive view of anti-fragile structures and behaviors in the logistics industry. Despite the high number of cases and systematic evaluation, certain methodological limitations must be taken into account, which may restrict the interpretation of the results. A key methodological risk is that the online survey does not allow participants to be clearly assigned to individual companies. It cannot therefore be ruled out that several people from the same organization took part in the survey. These potential cluster effects were not modeled separately in the statistical analysis (e.g., using multilevel models or cluster-robust standard errors). As a result, the responses of individual companies may have carried more weight than others. However, due to the large sample size of $n = 400$ and the broad distribution of participants across different segments of the logistics industry, the results are likely to be only slightly distorted. Nevertheless, this remains a methodological aspect that should be given greater consideration in future studies, for example by explicitly recording company affiliations or by using statistical cluster

controls. Another critical point concerns the operationalization of central constructs such as “agile methods,” “resilience,” “antifragility,” or “degree of digitization.” These were collected using self-reported information on Likert scales and represent subjective assessments. The validity of these measurements therefore depends on the ability of respondents to accurately assess complex organizational characteristics. Social desirability or different interpretations of individual terms may also have influenced the results. In addition, cross-sectional data cannot reflect causality; the identified relationships describe correlations, not causal mechanisms. Despite these limitations, the study provides a solid empirical basis for investigating anti-fragile principles in the logistics environment. The large number of cases, the heterogeneous composition of the sample, and the high consistency of many effects across different statistical methods strengthen the significance of the results. They provide reliable indications of key influencing factors such as organizational form, culture, degree of digitization, and budget structures. This provides a clear perspective for future research: longitudinal studies could better capture the temporal dynamics of anti-fragile development and identify causal relationships between organizational measures and crisis outcomes. In addition, greater integration of objective performance indicators (e.g., real-time KPI performance, SLAs, throughput times) would be useful to supplement subjective assessments. Finally, multi-level analyses or structured sampling methods could help to map differences between individual companies, regions, and functional areas more precisely and further increase the robustness of the results. Overall, critical consideration shows that, despite individual methodological limitations, the study makes a substantial contribution to understanding anti-fragile organizational structures in the logistics industry and at the same time forms the basis for further, in-depth research.

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APPENDIX A
TRANSCRIPTION OF INTERVIEW 1

[00:00:06.840] - Patrick Pawellek

How long have you been in the CEP sector and which stations have you gone through in which companies in the sector?

[00:00:15.240] - Volker (Sales & Operations Executive KEP Carrier)

I've been in the CEP sector for over 30 years. And I actually started as a courier and then after about a year I moved into sales, did pretty much everything you can do in sales, so started as a salesperson. However, not the way we know it today. Back then I had 3,000 customers in my portfolio, so from NSCs, what I know today as NSCs, all the way to key accounts—everything was included. And practically back then it was more of a customer representative. That's what it was called. That then changed. We introduced inside sales. I was part of that, then switched to key account, did key account. That would be what you might place somewhere between senior and national today. I did that—I did that for about a year or so and was then promoted to area sales manager. Back then I had my first area. That was in Nuremberg with 13 salespeople. I didn't do that for very long either. Then a Jan Nissen poached me at some point and put me into a project in Neuss for seven months. There I practically developed NSCs for Germany, carried out risk assessments there, ran many scenarios on what happens when we do certain things, and then I also implemented this model I developed across Germany, and as a thank-you I was then given the Small Business Customer area. Back then that was what we know today as inside sales plus what we know today as NSCs plus the lead qualification group, which actually still existed back then. There was also a small service group included. That was a total of roughly 80–90 people, something like that. So the area wasn't small either. I did

that for about two years, then moved to sales operations for the district, and practically did everything behind the scenes there that concerned support. For sales, that means SPP as we know it today was under that, PCA was under that, customer service was under that, complete back office. What else was there? Lead qualification actually remained with me back then. Oh, customer solutions was also included. That was all in there. That was around 160–170 people, something of that size, so quite a large group. I did that for two or three years as well and then moved to the region. In the region I did the same thing, just on a strategic level for Europe and ISMEA. That was then significantly fewer people—fewer of the people doing the tasks and more the structural processes behind them. From initiatives to what the SPP model should look like in five years to various other back-office activities that were in the BD area. I then moved from there into sales strategy. That’s what Christian Malke does today. It was a bit different back then. I reported directly to the VP in Europe and not to corporate, and looked at what we need to do now to be successful in five to ten years. I didn’t do that for long either, I was in there for half a year and then got out again and took over sales training. I did sales training for a long time, but with different responsibilities. That was almost seven years of sales training, always including ISMEA, India, Pakistan, all that stuff. That was an exciting story, because we built many of the models there that we know today. For example, Business Accrue ment comes from that time. Presentation Skills comes from that time. Also the further development of SSN, DBS—this was all done there. Yes, I did that for seven years, then went back to the district and took the position I hold today, i.e., responsible for sales in the north of Germany. Roughly like that.

[00:05:03.620] - Patrick Pawellek

How is planning done in your company in normal times with few disruptive factors, or which planning processes are applied?

[00:05:12.710] - Volker (Sales & Operations Executive KEP Carrier)

Yes, I have to say that UPS has learned from difficult situations. That is, if I think back 20, 30 years, it was a different topic than it is today. Back then it was rather more straightforward. There weren't as many disruptive factors as we know them today that are so extreme—let's put it this way: there are, of course, always disruptive factors, but not as extreme as today. I remember a situation. It was about the fact that in Germany the market was no longer competitive for the manufacture of textiles, for example. And within one to two years we lost a large part of our textile producers as customers because they all moved away to Turkey back then mainly—so that was a disruptive factor we had to deal with at the time, but one that was manageable, certainly also painful here and there. But it was manageable. That's not comparable to what we've experienced here in recent years. However, during my time in the region, I already noticed that UPS learned from various situations and then started—this is at least 15 years ago, I think—where we preplanned for certain scenarios. So let me give an example: we plan with a certain volume and revenue. For that I have to keep vehicles, I have buildings, capacities, etc. And then there are so-called, well, I'll say, predetermined breaking points where certain austerity measures or a counter-steering is triggered. And that is planned. That means you say, okay, what happens if I no longer come out at 100% but only at 98% or at 95%, etc.? What must happen as a consequence so that we adapt to the situation as well as possible? For example, a hiring freeze for new employees to reduce the number of hourly employees to the level where the volume is. And we actually changed that about 15 years ago and usually planned two or three planning stages in advance to prepare cost drivers

for such situations. And we still do that today, so that as a company, if something unforeseen comes and planning then swings extremely upward as well as downward, you can ignite these stages. You can roughly see that as a kind of scenario analysis. So in the end, you say, okay, you have a certain variance—the normal case, best case, worst case scenario—and that is also the planning process, boiled down to one sentence. So you don't practically start thinking about what to do only when the situation is there, but you already know what you will do when the situation comes and can immediately go into execution.

[00:08:35.360] - Patrick Pawellek

Which years were particularly volatile years and how did you act?

[00:08:40.330] - Volker (Sales & Operations Executive KEP Carrier)

Well, I mean that's relatively simple. That was definitely the coronavirus period. So 2020–21 was of course problematic. 2008 was definitely also a year that we felt, plus what we also felt, even if it only affected us indirectly, was—how long ago was that? You'd really have to look up which year that was. I don't remember off the top of my head—when there was that 15-day UPS strike in the USA. That was also very, very momentous. That had an impact on all other operations as well. Because if, of course, revenues are tight. And the USA was back then naturally even more significant for us as a market than it is today, because in the meantime internationally we have grown in relative terms and back then the USA was more dominant. And as a result, of course, you had to wield the red pencil internationally everywhere in order to realize savings.

[00:09:50.680] - Patrick Pawellek

So how did you act in those volatile times?

[00:09:54.310] - Volker (Sales & Operations Executive KEP Carrier)

Cost cutting—then there are cost-cutting initiatives. That starts with areas where you can save money relatively quickly: approaches are travel expenses, as a rule new hires that maybe can wait a bit longer, so non-critical new hires. So I'll say it like this: if I need a courier somewhere because the volume is there and has to be handled, then of course we hire. But do I absolutely have to replace the marketing employee today, or is it enough—if I look at the calendar now—if I do that on 01/01, for example? And do I even need—

[00:10:40.340] - Patrick Pawellek

In that context, what failed and what worked well?

[00:10:45.530] - Volker (Sales & Operations Executive KEP Carrier)

I think what worked well is that as a company we were basically always able to implement certain savings relatively quickly. That works very well because we proceed very strictly and almost militarily. So an order is given and then it is implemented the next day and then that's how it is, and then you save money relatively quickly. I would speak less of a failure there; rather, maliciously critical—maybe that's how one should put it—is that this naturally goes hand in hand with a deterioration in service. The two go hand in hand. If I save on one side and don't hire employees or don't allow travel expenses or similar, then of course something gets left behind somewhere on the quality side. So, in the end one can say that each of these cost-saving measures—the unplanned cost-saving measures—usually goes hand in hand with a deterioration in service. A deterioration in quality. It's different if I have a planned cost saving, so if I restructure a

department, then I do it so that the processes that are there may be absorbed by digital possibilities. And even there it of course stutters, but there is a substitute for how I can do things differently, so that I can perhaps do it with less staffing or—or more cost-effectively. But if I have to carry out these savings measures unplanned, then of course that does not go hand in hand, because I have no replacement for it, but really just save the costs. And then you usually notice that relatively quickly in service as well.

[00:12:49.240] - Patrick Pawellek

Were there any other planning processes that worked well besides cost cutting?

[00:13:30.920] - Volker (Sales & Operations Executive KEP Carrier)

If you look at it long-term, it's usually the case that—you have to get by with less in such a situation, and when you get by with less, you also learn to deal with it creatively. And you usually don't go back to the old status quo, but what you've learned from that time you carry forward and write it into the future. That means UPS also always understands a crisis as an opportunity to become even more efficient. And that doesn't mean that I then, forever and ever—to come back to the example—don't hire a marketing employee again, because that might not work in the long term either, but then the question is: maybe I don't need a marketing employee at all. Maybe it's better for me if I outsource projects to external companies, because I can still manage it at lower cost than if I hire a full-time employee myself, for example. Or maybe I can cushion it to some extent with technology, etc. So we were usually able to come out of crises stronger. There are of course exceptions—what really harmed us with our situation was that 15-day strike in the USA. We felt that extremely. But otherwise these general crises caused by external factors have usually made us stronger, I would say.

[00:15:10.370] - Patrick Pawellek

Is there anything else, to wrap up that area, that in your view would need to work better?

[00:15:17.890] - Volker (Sales & Operations Executive KEP Carrier)

Uh, yes, I'd like to name an example. For two, three, four years we had activities where we had an initiative to part ways with unprofitable customers. That is, the situation was such that we saw that our profit was not developing the way we had imagined. And then we simply looked at the most unprofitable customers and said, right, we'll address them all now and raise them drastically. Then we raised them drastically, only to find that far more customers than we as a company had actually planned left the company—i.e., didn't buy—and instead looked for an alternative. And back then the market was still such that there were enough others who offered it much more cheaply. And that then led to a situation where suddenly, instead of just chasing profit, we were also chasing revenue and suddenly had routes that weren't fully utilized. And then we started again, asked the same customers again—usually then for even cheaper than before—bought back in. That is something we fortunately no longer do these days. I mean, a good example is this year. That was activism. That was blind activism by, I would say, mainly marketing management people who didn't understand the market. I'll just say it like that, who thought—the basic idea makes sense: we have costs per package, we have revenue per package, and if that doesn't fit, well then I take out those who cause me the highest costs but give me the least contribution. But they still drive the unit costs down because they drive revenue. What was forgotten is that if I remove a certain number of parcels somewhere, all costs of other parcels go up. That was not thought through to the end. And the bad thing was that the mistake was made several times. We actually don't do

that. So currently, this year is a good example where we do indeed want to bring in additional volume, more than we originally planned, because we need to compensate for higher churn. But we're not doing it at the expense of profit; we are indeed making sure that what comes in makes sense.

[00:18:03.730] - Patrick Pawellek

How is the company you work for structured?

[00:18:22.530] - Volker (Sales & Operations Executive KEP Carrier)

It's a matrix organization. So in the end you have the division once—so under corporate of course everything bundled. Then there are so-called regions, which are generally oriented to the large continents, quite simply. Not exactly like that, but roughly. Under that there are then districts, which practically mean parts of these continents, and then below that again, depending on how large the individual operations are on site, so-called country organizations. And in addition I also have functional divisions, i.e., operations, HR, marketing, etc. And through this structure this matrix then emerges, where many then have a direct supervisor, but also a functional supervisor.

[00:19:12.870] - Patrick Pawellek

Do you know best practices for acting in uncertain and volatile times from other companies in the same industry?

[00:19:21.880] - Volker (Sales & Operations Executive KEP Carrier)

From the same industry—yes and no. Not as detailed as someone who may have experienced the same thing at another company. But of course you also notice a bit how

other companies react to such situations. Uh, it's a bit difficult because you can't compare it one hundred percent. Everyone naturally tries to adapt the response to their needs. Plus, for example, if I have a company that works 100% with contractors, that's already built into the model. That means, if I have less volume, then the contractor has less. Then that still affects me as a company, because I still skim part of that as profit and also have operational costs, such as sorting or whatever then runs through the company. But the most expensive part, namely pickup and delivery, doesn't concern me at first—except that of course the contractor is then also affected by it and may possibly get into difficulties. So it's difficult to compare. The closest might be someone like, from a German perspective, DHL, which however is much larger and can also balance one thing or another with letters in both directions, as an example. So, I'd say yes and no. You have a bit of insight there, but of course not as detailed as you'd like.

[00:21:09.780] - Patrick Pawellek

Do you know best practices for acting in uncertain and volatile times from companies in other industries?

[00:21:16.340] - Volker (Sales & Operations Executive KEP Carrier)

Yes, a good example is BMW, which works in a multi-shift system. So I know some people from my past in Regensburg. They sometimes ran three shifts, including weekends. And the first thing they did, if they had a period where sales just went down, was scrap the first shift. Then they simply did two shifts, or no longer worked weekends, or similar. It's identical to what we ultimately do in the courier area as well. First of all, of course, you make sure that people no longer work overtime; if on average the courier is perhaps out for 8 to 9 hours, then you make sure that he is out for a maximum of eight

hours and you distribute the work evenly. If that's no longer enough, then you make sure you hire fewer couriers and only where it's really needed, and thus reduce overhangs. You might send one or the other on holiday; you have similar lever mechanisms. Of course we can't say the courier only goes out every other day—that doesn't work. Which I can control differently in a shift system. But there are certain parallels, even if with the BMW example it might be a bit easier because then you simply take out one shift or shorter, without the weekends, etc.—then that works well.

[00:23:03.880] - Patrick Pawellek

Which procedural agile methods do you know?

[00:23:08.650] - Volker (Sales & Operations Executive KEP Carrier)

Well, I couldn't name any methods from the textbook right now, I have to be honest, because that's something I personally grew into due to the situation of the respective job I had at the time and the methods UPS applied, and from that of course you then hear a bit left and right what others are doing, without me being able to fall back on the method now.

[00:23:40.750] - Patrick Pawellek

Do you know processes or the procedural—does each method—do you know Kanban?

[00:23:46.990] - Volker (Sales & Operations Executive KEP Carrier)

I know Kanban more as an organizational tool, but not for sure.

[00:24:08.470] - Patrick Pawellek

Do you know the procedural agile method Scrum?

[00:24:11.500] - Volker (Sales & Operations Executive KEP Carrier)

No, that doesn't ring a bell.

[00:24:13.780] - Patrick Pawellek

Do you know the procedural agile method "Objectives and Key Results," the OKR model for short.

[00:24:17.710] - Volker (Sales & Operations Executive KEP Carrier)

I know that. I even read a book about it once.

[00:24:24.490] - Patrick Pawellek

Are such methods used in your company? If so, what experiences are there and can you derive recommendations for your company from them?

[00:24:32.750] - Volker (Sales & Operations Executive KEP Carrier)

Yes, I'd say it goes a bit in the direction of balanced scorecard KPIs—at least this OKR—at least that's how I understood it. Although I liked it better than a normal KPI balanced scorecard model, balanced and the structuring, so to speak. It has to be measured. And in the end, of course, it's only part of it. But the reason I read the book back then is because I preferred the methodology of how it's measured and how it's reacted to than balanced scorecard and the like, what we usually know. So KPIs and balanced scorecard adjustments—that's why I looked into it. So I kind of ignored the rest. And I dealt more with the output, and the book also focused mainly on this area, because

for me it was an idea I was pursuing at the time, but then didn't implement. It couldn't be implemented at UPS because we're simply so tied to the balanced scorecard KPI model. That was difficult. So I discarded it again. But I did take a look at the book and, if I remember correctly, you can also get certified. It's been so long, and I also once talked to someone here in Germany who practically represents the company. Relatively expensive, actually. And I took a look at it a bit. And what I liked was ultimately the structure of this output—how it's measured and how you deal with it. Without me being able to put it exactly into words today. It's just too long ago. But very faintly I found it better—uh, more logical and more agile. Yes, exactly. That's exactly my point. It's set once a year. That is now the number. And that is measured. And then it's measured for a year, no matter what. And that was always the biggest weakness for me that we had with this model, that in the end we only reset it once a year, measured it. We are a bit more open about that nowadays, but it's still very rigid and not once more. You can bring in new things, the old goals don't go away. That is, you know yourself, we measure Present, for example, and Cultivate and whatever the goals are called upwards. Yes, that they are sometimes adjusted, that happens; downwards they are usually never adjusted, that new goals are added because the situation changes—yes, that happens too. But the old ones remain in there, because—the plan is the plan is the plan.

[00:28:39.700] - Patrick Pawellek

So roughly speaking, can one say such procedural agile methods are not used at UPS?

[00:28:47.140] - Volker (Sales & Operations Executive KEP Carrier)

I would say, from what I've experienced, rather not. There may be areas where it's a bit different. We also have different business units. But my experience was that it's not used in Freight and Small Pack.

[00:29:18.730] - Patrick Pawellek

Do you know agile organizational forms such as the Spotify model?

[00:29:26.620] - Volker (Sales & Operations Executive KEP Carrier)

I've heard of it, but I couldn't describe what it is.

[00:29:28.270] - Patrick Pawellek

Many companies pursue strategies that make them more robust. However, there is also an approach of not just cushioning crises but welcoming them, since they even strengthen the company's competitiveness. Can you imagine something along those lines?

[00:29:44.380] - Volker (Sales & Operations Executive KEP Carrier)

Yes, that's basically what we touched on earlier. There are companies that can take good advantage of a crisis to emerge stronger from it—and stronger than the competition, generally. And there are companies that generally come out weaker. And most of the time you see—there may be a lot in between—but most of the time you see it's either-or. Yes. And I would say that since UPS belongs to those that generally emerge stronger, that's something that is actually always welcomed from our side.

[00:29:58.530] - Patrick Pawellek

What does the strategy look like to emerge stronger?

[00:30:58.020] - Volker (Sales & Operations Executive KEP Carrier)

The strategy basically looks like this: we also set planning extremely aggressively. That means our plan is—and there were a few exceptions where the economic situation—see COVID—helped us, we had tailwinds with B2C deliveries, for example. But normally our plan is already challenging to achieve. You will never see a plan—and that doesn't matter whether it's operations or automotive, accident frequency, or whatever—there will never be a plan that is okay and easy to achieve so that I have the opportunity to overachieve myself or my goals and then look good. That's not the UPS way; rather, the UPS way is that you already have to stretch yourself to hit 100%. You always see that in this bell curve of the distribution when you then go down to individual employees, branches, whatever. Generally the bell curve is always such that the apex is never at 100%, but always more to the left. And that alone—that's a UPS culture—that alone also shows that we seek this challenge and then on the way there have to think more often than you would with normal planning—think more often: how can I still do this differently so that we can make it happen. But you have to be careful not to be so far away that it becomes unattainable. That's the art of it. But it still has to be a bit higher than is comfortable. It has to be uncomfortable, otherwise you won't stretch. But it must not be unattainable.

[There followed a rough explanation of the antifragility concept in which excerpts from the theoretical chapters of the thesis were read out]

[00:31:03.510] - Patrick Pawellek

Where do you see problems in implementing the concept?

[00:31:09.070] - Volker (Sales & Operations Executive KEP Carrier)

I think the main problem in implementation is scalability. Sometimes there are niche ideas that are good and that you can theoretically use if the demand can be developed on a larger scale or exists. I'll give you an example: A customer of mine—back when I was still a salesperson—was based in Nuremberg and he distributed everything like schoolbooks and school materials, among other things, and they had a week, something like that, where they didn't know what to do with the volume. And that was always the week before school started; the period was longer, but that was the peak. It was already high during the holidays. But then, last minute, the orders come in and they all still want to buy the schoolbooks, etc. He of course had competitors and we set up the following scenario for him. He was mainly operating regionally. Back then domestic (intra-German shipping) was still chic for us and we set up something where we picked up from him at one a.m. for the last time.

[00:32:26.030] - Volker (Sales & Operations Executive KEP Carrier)

No, that's nonsense—at four or five in the morning we picked up from him for the last time, but only with the postal codes that could be served directly from the Nuremberg hub. That means we staggered it, and he practically held back all orders that came in from the Nuremberg branch environment so that he had enough time to prepare everything. And he loaded those onto the container for us at the very end at four in the morning. We drove the container over directly into the sort, sorted them there in the branch, and they got a delivery on the same day. So that was before anyone even thought about “same day”; the word didn't even exist yet. We had him pay us really well for that. We did that with him for two or three years. So as long as I was down there as key account, I did that

with him. It was a huge business. The problem is actually: once you set something like that up, you can of course resell this setup for relatively little money. And because the customer is naturally willing to pay for this additional service, you make exorbitantly high profit.

[00:34:35.300] - Volker (Sales & Operations Executive KEP Carrier)

The problem is just scalability, because the market is a niche. For example. So the issue is: there are a whole lot of great ideas where, as a company—because you have the possibilities or because you have someone who can maybe think a bit outside the box and develop this concept—you can do a lot. The problem is, from these many possibilities you need that one hit that is scalable. Otherwise you can't implement it in mass. But I'll give you another example where that—yes—actually works great, and that's residential delivery, for example. Or oversizes and the like. Oversize is a fantastic example. Overmax—no one measures every parcel, and you simply have parcels in the system that are over the maximum dimensions or weights. And if you notice it, it's already in the system—so in the past we didn't charge anything for it, we just delivered it. Or in the worst case we brought it back the next day.

[00:35:43.800] - Volker (Sales & Operations Executive KEP Carrier)

But that was rarely the case. As a rule we then transported it. So, we introduced this surcharge and increase it drastically every year, because the customer actually has no other option. He knows he's not allowed to. Everything that's over—he knows he's not allowed to do it. But if he does it anyway, he gets a penalty slapped on him. We have it in the system anyway and we now have them pay for it. So in the end that was to reduce the share once, but here's the interesting thing: the share hasn't been reduced at all. We have

roughly the same volume in the system as before the introduction, but we get €400 per box, so now with the new tariff. The problem in implementing the concept and preparing for crises and challenges in any area is the scalability of these sub-areas. In this case it's scalable, because you have such parcels in every branch. And even if it's only one or two such things a day—you have them. In the first example it wasn't scalable, and therefore it doesn't work.

[00:37:10.900] - Patrick Pawellek

Do you consider antifragility as a corporate concept to be suitable, and where do you perhaps see the advantages of such a broadly diversified preparation for crisis situations?

[00:37:26.370] - Volker (Sales & Operations Executive KEP Carrier)

I'd say yes, it's suitable. The main problem in preparation, I think, is the mindset, I would say—that everyone thinks in this direction, because that's already contained in the term or in the definition. You prepare for things that you cannot foresee yet, where you therefore also have absolutely no idea what they are. There's this phenomenon “the known unknown” and “the unknown unknown.” Then there is a lack of understanding as to why you should be doing all this now. First, to be open to the concept. And secondly also—you have to recognize it in time. Because you always have a reaction time to such a situation. Since you don't know the situation, you can't prepare for it. You can't prepare for everything, as much as possible. That's the point. So I'm open to anything that something might happen. And yet in the moment I would still be surprised when some specific thing happens. Even if I am of course open to it and flexible enough as a company to somehow master it, I still have to react to the specific situation. And I think what you need here—and what I think is the challenge, especially in large companies

where I'm talking about many, many employees—is that everyone who has responsibility there, and I'm basically talking from—yeah, from team leader upwards theoretically, maybe even every single employee—recognizes such situations in time and then is open to the whole thing and then does the things that are necessary to channel it correctly.

[00:39:28.340] - Volker (Sales & Operations Executive KEP Carrier)

So for example, if the courier recognizes it, that he talks to his supervisor and says, hey, this is the situation, this is what I observed. And if enough couriers have similar observations, then it's something I have to react to and no longer an individual case, but the sensor system, so to speak. In other words, to capture the whole thing and the period that this capture requires—so that it's not too long to be able to react at all. And then of course the processes have to kick in to analyze what exactly it is, what a possible response could be, and how I can derive a benefit from it. Brexit is, for example, an example that comes to mind. Basically, Brexit was at first something negative from the point of view of the European Union—for us as a company—we tried at least to turn it around—and we said, hey, we're customs experts, we can get business out of that. We know that didn't work well, at least not at the beginning. In the long term I do think we are the winners there. At the moment I would still be cautious about calling us Brexit winners. But in the long term I think we'll manage that.

[00:41:44.240] - Patrick Pawellek

Do you also see advantages—so as not to digress too far now? The question was: Is it a suitable concept and what advantages would the concept have?

[00:41:54.740] - Volker (Sales & Operations Executive KEP Carrier)

The advantages are that you generate a competitive advantage. Which in turn means more revenue, more profit. And therefore that's the advantage.

[00:42:06.590] - Patrick Pawellek

Okay. To what extent do you consider antifragility to be an implementable concept for the sector—the CEP sector—now away from the company UPS, but broadly for the CEP sector?

[00:42:20.465] - Volker (Sales & Operations Executive KEP Carrier)

I think it's the same everywhere—the biggest difference, or rather I see two differences. One is the topic of corporate strategy, which is very different in the CEP area; if you look, for example, at someone like Hermes versus the integrators like FedEx, DHL, or UPS, then of course we have two completely different strategies and yet both are in the CEP sector. So you can of course compare FedEx, DHL, and UPS more with each other—there are big differences there too—but you can compare those three with each other more than any of these three with, say, Hermes, DPD, or GLS and co. A company's strategy plays a role. How do you differentiate yourself, which niche do I want to serve, which market do I want to serve, do I want to be the cheap Jack or the quality leader—that plays a role. The second point that plays a role is the employees, namely the preparation—what we said earlier—being open to such changes, noticing them accordingly in a timely manner, escalating them, and finding a response for them, and of course having the will not only to find a response or a band-aid for it, but also to be able to emerge stronger from it with, hopefully, then a competitive advantage on the market.

[00:44:01.973] - Patrick Pawellek

What would have to happen for companies like UPS, FedEx, or DHL to set themselves up as antifragile?

[00:44:17.860] - Volker (Sales & Operations Executive KEP Carrier)

I think the main criterion is the change all around, that is the economic environmental—macroeconomic—factors. We see that with COVID, we see that with the war situation we currently have, and various other examples, that then topics or priorities shift, let's say. For example, currently with the war [in Ukraine]—I recently read a quote from some environmental expert, whatever, who said something along the lines of: thanks to the war, it will have a positive impact on the environment. So the environmental situation apparently has to get even worse so that it becomes implementable. But that too is something that has always accompanied humanity, that negative events—no matter what—an environmental disaster, wars, diseases, whatever—that they mostly led to leaps in development, because you were then forced to react and came a bit out of the comfort corner. And that then often led to leaps in development. I think it's no different for companies. If the pressure from outside is there that threatens my existence, restricts it, influences it in a negative sense, then I have to see what I can make of it, and very, very often—if you have the right people who are open-minded and the right structure is there that supports it—ideas emerge from it that have a positive effect. You can see that companies that aren't so good at that are usually the ones that come out of the situation worse, or in the worst case go insolvent.

[00:45:26.082] - Patrick Pawellek

Was an important aspect of crisis management overlooked or not asked about in my questions?

[00:45:35.431] - Volker (Sales & Operations Executive KEP Carrier)

Nothing comes to mind spontaneously.

APPENDIX B
TRANSCRIPTION OF INTERVIEW 2

[00:00:08.100] - Patrick Pawellek

How long have you been in the CEP sector and which rough stations have you gone through in which companies in the CEP sector?

[00:00:15.300] - Markus (Senior Manager KEP Carrier)

In total it's now almost exactly 16 years. All at one company—UPS—but in very different functions and, above all, in very different geographies. The first eleven years were entirely in Germany, seven of those in Sales, the remaining four on the HR side of the business. After that I took the international step, in various HR functions—first covering Western Europe, then taking on full European responsibility as Manager for HR and Labor for Europe—before, at the beginning of this year, I was able to make a shift in perspective and take on the role of General Manager for Switzerland and Austria.

[00:01:12.930] - Patrick Pawellek

How is planning done in your company in normal times with few disruptive factors, i.e., which planning processes are applied?

[00:01:27.710] - Markus (Senior Manager KEP Carrier)

We plan a lot at all times. From my understanding: are we talking about financial planning, or any form of operational planning?

[00:01:41.650] - Patrick Pawellek

Any kind of business planning. I have to plan the resources I'll need for a year; I have to calculate what profit prospects I envisage. There are—let me call them—strategic planning processes according to which companies plan.

[00:02:02.580] - Markus (Senior Manager KEP Carrier)

Basically, the entire planning framework works in cascades. Based on the global strategy, business results are broken down to individual business units—first the U.S. and all international business units—and then down to regions, districts, and the country level, so that a global strategic plan and ultimately revenue and profit plans are translated into increasingly granular local targets. This business planning follows a very stringent process: typically you plan the next year on the basis of last year's results or the current year's results, incorporate growth expectations, translate that into cost perspectives, and try to set the most economically viable target for the next year—one that matches the general growth expectations we also communicate to the market. So much for financial planning. Of course, this is supported by all operational planning—when we, for example, see volume changes that go along with corresponding growth. That's one of the planning maxims: both operational capacities and costs then need to be re-evaluated accordingly to feed into the overall plan.

[00:03:45.430] - Patrick Pawellek

How fixed or flexible are these planning processes?

[00:03:51.730] - Markus (Senior Manager KEP Carrier)

I'd say 95% fixed. There are relatively inflexible rulebooks that allow little planning flexibility. Of course, extraordinary planning events must always be considered and can influence the design—but that's very much the exception, not the rule.

[00:04:22.420] - Patrick Pawellek

Which years were particularly volatile, and how did you act with regard to your planning processes?

[00:04:29.410] - Markus (Senior Manager KEP Carrier)

Looking back a few years, the 2008–2009 financial crisis surely stands out—where the macro environment surprised us to the point that any sort of regular planning was rendered somewhat absurd. The pandemic years were similar—though with a much more positive swing. Interestingly, at the outset we assumed a crisis scenario would materialize, which then flipped within weeks into very positive prospects for us. In both directions it was very hard to plan. At the very beginning we explored scenarios of losing 20, 30, or 50% of volume—which ultimately turned into growth spurts of roughly the same magnitude. The war in Ukraine also—and thus in the here and now—creates a certain bandwidth of fluctuation for the planning for 2023. So that's a third phase marked by uncertainty.

[00:05:54.220] - Patrick Pawellek

How did you act differently in those volatile years than in normal times?

[00:06:00.700] - Markus (Senior Manager KEP Carrier)

Mainly along exactly the same lines of action—but with a much more conservative approach to planning targets. The toolkit hardly changed. One new element in the last three years is that we now plan semi-annually instead of on annual cycles, to gain flexibility for volatile events. That makes sense in principle, but it does bring more workload.

[00:06:39.400] - Patrick Pawellek

What worked well in the planning process during crisis years?

[00:06:44.690] - Markus (Senior Manager KEP Carrier)

There's a dependable guideline for employees in times of high uncertainty—a clear, comprehensible operating principle that gives many people a sort of safety net. That has a significant psychological benefit by providing a sense of security, and I think it worked well. In addition, a strong focus on cost efficiency is arguably an even greater advantage in volatile years than in years driven by economic growth.

[00:07:38.420] - Patrick Pawellek

What failed or didn't work?

[00:07:43.580] - Markus (Senior Manager KEP Carrier)

What serves as a reliable structure on the safety-net side is, unfortunately, often not flexible enough to do justice to all fundamentals. A current example: planning 2023 utility costs (energy, buildings, etc.) based on historical data would follow planning logic—but it's setting up for failure, because we already know those costs will rise

exponentially. You need corresponding flexibility for the plan to make sense—which we sometimes struggle with.

[00:08:46.260] - Patrick Pawellek

How is the company you work in structured?

[00:08:51.750] - Markus (Senior Manager KEP Carrier)

We're a classic matrix organization—both from a business and an organizational standpoint. That's how we're set up.

[00:09:01.290] - Patrick Pawellek

Do you know best practices for operating in uncertain and volatile times from other companies in the same industry?

[00:09:13.730] - Markus (Senior Manager KEP Carrier)

Yes—there's professional exchange. Through logistics associations you regularly meet competitors who have to navigate the same uncertainty. Even without exchanging details, many challenges are industry-wide—and of course you look at how others handle them.

[00:09:47.040] - Patrick Pawellek

Do you have a concrete best-practice example from another company that you find compelling?

[00:09:59.520] - Markus (Senior Manager KEP Carrier)

Positioning yourself technologically so that—especially in uncertain times—you convince more and more customers of the value of your service is something you can repeatedly learn from competitors to hit the zeitgeist. That’s a more business-oriented example. Internally, how you position your benefits in the market to win talent in a tight labor market is also something we closely observe in our environment.

[00:10:40.080] - Patrick Pawellek

Back to volatile times specifically—any best practices for how others handled those years better?

[00:10:56.120] - Markus (Senior Manager KEP Carrier)

I can probably think of more cases where others looked at how we did it. There are examples, though—like getting technologically prepared early so you can run very lean structures. We’ve learned and keep learning from peers there. DPD is a good example; they used volatility well to reposition in the market. That gives us a mandate to act, too.

[00:11:37.940] - Patrick Pawellek

Do you know best practices from other industries? Which stand out?

[00:11:53.690] - Markus (Senior Manager KEP Carrier)

Across industries, challenges can be similar, but no one has a silver bullet. Take the war for talent—this isn’t just logistics. Labor shortages hit everyone. There are many ways to address it; not all fit our company or the logistics industry. Still, there are plenty of approaches to exchange and adopt strategies. A concrete example—from yesterday: a

large Swiss company decided not to offshore services but to provide all services domestically. At first glance that may not seem cost-optimal, but it can pay off.

[00:13:37.550] - Patrick Pawellek

Which procedural agile methods do you know?

[00:13:43.020] - Markus (Senior Manager KEP Carrier)

You're surely looking for a technical term—but it would have to fit the context right now.

[00:13:55.410] - Patrick Pawellek

Do you know the agile method Kanban Board?

[00:14:00.070] - Markus (Senior Manager KEP Carrier)

No.

[00:14:01.780] - Patrick Pawellek

Do you know the agile method Scrum?

[00:14:05.300] - Markus (Senior Manager KEP Carrier)

Yes—though mostly in theory; we don't use it in the company, as far as I know—not in our parts, at least.

[00:14:20.300] - Patrick Pawellek

Do you know the agile method Objectives and Key Results, the OKR model?

[00:14:26.750] - Markus (Senior Manager KEP Carrier)

Yes.

[00:15:40.200] - Patrick Pawellek

Are such methods used in your company? If so, what experience is there, and can you derive recommendations from them?

[00:15:46.610] - Markus (Senior Manager KEP Carrier)

Partly answered already. There have been occasional OKR initiatives, but they didn't spread widely. Acceptance stayed limited, not least because of the management overhead—so it never became a broader trend. More generally, in performance measurement we're seeing a trend toward being less active: more self-set goals, etc., have actually become harder, not more prominent, in recent years—although that's counterproductive.

[00:17:03.180] - Patrick Pawellek

Do you know agile organizational forms such as the Spotify model?

[00:20:28.330] - Markus (Senior Manager KEP Carrier)

Yes. I think it works much better in a business context like Spotify's—and I often wish we could be that agile. But in the CEP industry it would be extremely difficult. Teams would either become so large that agility gets lost, and you need a lot of interdisciplinary collaboration with many stakeholders. If teams get too big, I can't see it staying effective. You also end up with a multitude of teams—which doesn't simplify things; it just shifts

the problem one level down. Interesting to try, but my gut says it'd be tough. It would work more easily—like TNT used to—if we operated with local profit centers (which we don't). That might be more effective—but most big players have moved away from that.

[00:22:03.050] - Patrick Pawellek

Many companies aim to be robust. There's also an approach of welcoming crises because they can strengthen competitiveness. Can you imagine that?

[00:22:16.020] - Markus (Senior Manager KEP Carrier)

Everyone knows the Churchill quote: every crisis carries an opportunity. It's imaginable—but most companies plan for stability rather than seeing the upside of volatility. That starts with shareholder expectations, which are often conservative—definitely true for us. “We view volatility as an opportunity” wouldn't trigger much applause.

[00:23:04.610] - Patrick Pawellek

So it's also a mindset question?

[00:23:07.160] - Markus (Senior Manager KEP Carrier)

Absolutely. Culture plays a big role. Many companies—including ours—like to ascribe basic agility to themselves, mostly because it sounds good. The lived reality is more “rock-solid, stable,” with fluctuations managed at the margins as they arise.

[There followed a rough explanation of the antifragility concept with excerpts read from the thesis's theory chapters.]

[00:23:10.720] - Patrick Pawellek

Where do you see problems in implementation?

[00:23:10.830] - Markus (Senior Manager KEP Carrier)

The biggest problems lie on both sides: among those who set the structures (us as the organization) and among employees, who must accept and bring those structures to life. Our conservative organizational approach—culturally and in practice—doesn't help a more modern, more agile structure. And even where attempts are made, they're often not adopted as intended, or with different expectations. Those are the biggest challenges.

[00:24:10.740] - Patrick Pawellek

Do you consider it a suitable concept, and where do you see its advantages?

[00:24:12.670] - Markus (Senior Manager KEP Carrier)

I'd consider it suitable, especially because its main advantage goes beyond "being prepared for crises" and aims to strengthen the organization. It frames crises not only as opportunities but as improvement options, adding another layer. That's conceivable for our CEP industry and at larger scale, too—but it requires different ways of doing, delivering, and planning.

[00:26:10.910] - Patrick Pawellek

To what extent is antifragility implementable in your industry, and what would need to happen for companies to adopt it?

[00:26:14.030] - Markus (Senior Manager KEP Carrier)

That's broad. It would have to yield measurable economic success—an initial spark showing this industry where the economic advantage lies. A pure prevention mechanism would be too weak to convince. Seeing a crisis not only allow a rebound but lift economic success to the next level would create imitation effects and the critical mass for change.

[00:27:03.700] - Patrick Pawellek

Classic chicken-and-egg: to measure it, you must do it; to do it, you must measure it.

[00:27:14.510] - Markus (Senior Manager KEP Carrier)

True—so most won't do it. You break the loop only by piloting. In a sector like CEP—with many distinct fields—that's feasible. For instance on the IT side: treat every cyberattack as a chance to strengthen the system so it's not only more resilient afterward but better at fending off future threats—like vaccination for the human body. That's a tangible example that can also yield a fairly clear economic benefit. In short: you'd need measurable wins in parts of the business to roll it out across the organization.

[00:27:36.080] - Patrick Pawellek

Was any important aspect of crisis management overlooked?

[00:27:40.520] - Markus (Senior Manager KEP Carrier)

One weakness might be that the system is only as good as the people living it. In theory the concept works very well—but it requires practitioners with a strong grasp of the theory and the self-motivation to make it succeed. That's not always the starting point.

You'd also need to open the antifragility system to the lived reality of working with many employees—who aren't all A-players—and still have this different mode of collaboration permeate the whole organization to produce a different outcome. That's the practical challenge.

[00:28:44.150] - Patrick Pawellek

So in the end it sounds like we need pioneers willing to take risks, from which options may result.

[00:28:55.610] - Markus (Senior Manager KEP Carrier)

Such far-reaching changes—in a corporation of our size—can't be decreed with “as of tomorrow.” Much simpler change processes have failed more quickly. Piloting, proving success, and building understanding of how the approach works could be promising—but it will take time.

APPENDIX C
TRANSCRIPTION OF INTERVIEW 3

[00:00.000] Patrick Pawellek:

So, let's get started. My first question is about understanding your experience. Why did I invite you? I know you are an expert, but the interview doesn't know that yet. So: How long have you been working in the logistics industry, and what positions have you held in which companies?

[00:42.440] Oliver Ruetter:

I have been working in the transport, forwarding, and logistics industry for over 25 years. It runs in our family – the Kretschmar company has existed since 1836. We started as inland shippers, today our focus is logistics and forwarding. To be honest, I never planned to go into this business, but through internships and open positions in the company it happened naturally. Today, I am Managing Director and owner of Kretschmar Cargo Süd. This entity was spun off from the Kretschmar Group to handle international and European activities. In addition, I am a shareholder in the Kretschmar Group and co-founded “Ruetter Connected Logistics”, an IT platform designed not only for our own processes but also to connect our customers with different logistics networks.

[01:55.280] Patrick Pawellek:

That sounds very interdisciplinary. I hear IT, freight, and hands-on experience – so you really started at the grassroots level?

[02:09.280] Oliver Ruetter:

Yes, exactly. In a family business you are sent through many departments. I worked for Höchst in Singapore in port and tank disposition, later for our partner Heppner in France. I was also involved in setting up System Alliance Europe, a network of large family-run freight forwarders across Europe. I am now Chairman of the Board there and have held various roles over the years. In addition, I managed national subsidiaries and then the entire European division before moving this into my own company.

[03:05.280] Patrick Pawellek:

Very interesting. Let's move to the second section: planning processes in uncertain times. How is planning done in your company during "normal" times with few disruptions?

[03:42.280] Oliver Ruetter:

We built our company to think consistently from the customer's perspective. With our own sites and the network we built, we create a "network within a network" to meet customer demands. You might think there are quiet, stable times – but in reality, there are always new challenges. So the distinction between "normal" and "crisis" isn't that clear.

[04:33.280] Patrick Pawellek:

How does business planning actually work, for example with KPIs or annual targets?

[04:45.280] Oliver Ruetter:

We follow a top-down approach. First, company goals are defined, and then broken down into KPIs. Since our company is not aimed at short-term profit but at long-term, cross-generational stability, we plan in six-year cycles. Of course, the world changes quickly,

but it always has – my grandfather said the same. We define long-term goals, then mission, vision, and strategy, and from this derive the KPIs.

[05:49.280] Patrick Pawellek:

Exciting. Which years were particularly challenging? Which crises do you remember?

[06:07.280] Oliver Ruetter:

The last 16 months were extremely difficult, as the planning reliability of our customers declined sharply. In the past, forecasts for upcoming months were relatively reliable – today much less so. Even in economic crises, for example in Southern Europe, planning was easier than it is today. Looking back, the real estate crisis, the Southern European crisis in 1992, and again in 2002 were very tough, because volumes collapsed.

[07:44.280] Patrick Pawellek:

And how did you respond in such times?

[07:47.280] Oliver Ruetter:

We moved away from owning assets – vehicles, equipment – and toward flexible networks. This way we can manage capacity better and keep costs variable. This “asset-light” model helps us stay agile in crises.

[08:14.280] Patrick Pawellek:

What worked well in crisis years? Were there best practices?

[08:39.280] Oliver Ruetter:

Clearly, open communication with employees. Especially in a family business, transparency is essential – even when the news is bad. Around 50% of our costs are personnel-related, so this is where we can act quickly if everyone is informed and on board. Another success factor is keeping fixed costs, like real estate, as low as possible.

[09:26.280] Patrick Pawellek:

And what didn't work?

[09:31.280] Oliver Ruetter:

Short-term adjustments with customers. For example, if volumes drop, it doesn't make sense to send trucks daily that are half empty. But by the time such adjustments are agreed with large customers, the crisis is often already over. The same problem exists during peaks – for instance at Christmas. We may need more trailers, but if no ramp capacity is available, flexibility is limited.

[10:32.280] Patrick Pawellek:

What needs to work better?

[10:48.280] Oliver Ruetter:

Data quality. Forecasts are only as good as the data behind them. The systems exist, but often the data is incomplete or wrong, which makes planning much harder. This is an area we all need to improve.

[11:34.280] Patrick Pawellek:

Let's move to section three: company structure. How is your company organized?

[11:50.280] Oliver Ruetter:

We have two approaches. On the one hand, we operate our own sites with employees, warehouses, and some local transport. On the other, we are part of networks that allow us to act across Europe and globally. So we combine our own resources with partner networks.

In land transport we are members of System Alliance Europe, in warehousing of Log Coop, and for intercontinental business of the Seatransporter Alliance. This allows us to act globally without building everything ourselves.

In the past, we thought regionally – “give me your France shipments, I have the best partner there.” But large corporations came with a different argument: one network, one system, one contact worldwide. That convinced us to rethink. We introduced holding structures to centrally manage data flows, quality, and products. This way, customers get a uniform product globally, but we are not trapped in a rigid network and can remain flexible.

[15:25.280] Patrick Pawellek:

So in summary: a shift from production to service partner. Correct?

[15:46.280] Oliver Ruetter:

Exactly. We call it “Logistics as a Service.” That term resonates especially with people from IT.

[15:55.280] Patrick Pawellek:

Do you know best practices for dealing with uncertainty from your own industry?

[16:02.280] Oliver Ruetter:

Yes, within our cooperations we regularly exchange best practices. Customers also bring us ideas, which we sometimes adopt. A key factor is data: whoever controls the data has the advantage.

[18:17.280] Patrick Pawellek:

Section four: Agile methods. Which process-oriented agile methods do you know?

[18:33.280] Oliver Ruetter:

The principle of iterative development – you don't need to know the final product from the start, you work in cycles with a fixed team.

[19:01.280] Patrick Pawellek:

Kanban?

[19:07.280] Oliver Ruetter:

Just by name. In some cases, old methods are simply repackaged under new names.

[19:28.280] Patrick Pawellek:

Scrum?

[19:36.280] Oliver Ruetter:

Yes, we all attended a Scrum course. I can't recall the acronym exactly, but I know the principle.

[19:51.280] Patrick Pawellek:

OKR?

[19:58.280] Oliver Ruetter:

No, not really. Only by name.

[20:25.280] Patrick Pawellek:

Do you apply such methods?

[20:38.280] Oliver Ruetter:

We don't stick to one fixed method. We usually work with project plans – who does what by when and why. We stopped writing protocols; instead we use active, agile master plans. That works very well.

[21:36.280] Patrick Pawellek:

Section five: Agile organizational forms. Do you know the Spotify model?

[21:50.280] Oliver Ruetter:

No, only the music service. (laughs)

[21:53.280] Patrick Pawellek:

(Explanation of the Spotify model ... Squads, Tribes, Chapters, Guilds ...) Could such an approach work in logistics?

[24:41.280] Oliver Ruetter:

Sounds interesting, but we work classically hierarchical. We have advisory boards that link different working groups, and project groups below that. This ensures communication. So yes, in a modified form such agile structures are possible in logistics.

[25:58.280] Patrick Pawellek:

Section six: Antifragility. Can you imagine not only cushioning crises but actually using them to strengthen the company?

[26:11.280] Oliver Ruetter:

Yes. We deliberately build redundancies – alternative options. Disruptions are unavoidable, so it is important to react flexibly and learn from them. That is exactly what we do.

[28:26.280] Patrick Pawellek:

Do you consider antifragility a viable concept in logistics? Where do you see advantages?

[28:50.280] Oliver Ruetter:

Definitely. Antifragility means creating alternatives – in decision-making, production, and services. This increases resilience and adaptability.

[29:14.280] Patrick Pawellek:

What must happen for companies to adopt this approach?

[29:28.280] Oliver Ruetter:

We are already on this path.

[29:34.280] Patrick Pawellek:

Section seven: Did my questions overlook any important aspect of crisis management?

[29:47.280] Oliver Ruetter:

Yes. You cannot have all competencies in-house. You need to think modularly and flexibly bring in external expertise. Knowledge should not always be bound internally, but should be integrated from outside when needed.

[31:28.280] Patrick Pawellek:

That concludes the interview. Very interesting – especially your concept of “Logistics as a Service,” which I see as highly relevant for the future. Thank you very much for the conversation.

APPENDIX D:
TRANSCRIPTION OF INTERVIEW 4

[00:07.000 --> 00:17.000] Patrick Pawellek

How long have you been working in the logistics industry, and what major stations have you gone through in which companies in the logistics sector?

[00:17.000 --> 01:19.000] Boris (Digital Transformation Expert in logistics)

I was practically born into logistics, since I come from a forwarding family. From 1994 to 1996, I trained as a forwarding agent – that was my professional entry into logistics. After that, I studied at the German Foreign Trade and Transport Academy in Bremen, where I deepened my knowledge. From 1999 – after short stints at Nettler and Unitrans – I spent 23 years at Bertelsmann, in the Arvato Supply Chain organization. Over the years, I worked my way up from Key Account Manager to the Board. It wasn't planned, but it just happened naturally. My core responsibilities were customer management: leading large key account management areas, initially at junior level, then as Senior Account Manager, Director, Vice President and finally President. I mainly served the automotive, banking and insurance sectors. Digital transformation played an important role early on, as we worked in marketing logistics – brochures, sales documents, forms, everything needed to sell cars, insurance, or financial services. We started investing in content management systems very early, because it was clear this market would eventually be digitized and partly cannibalized. With Bertelsmann as a media company, we had the proximity to content and data needed. I built a digital organization there that grew to 150 IT specialists, developing digital products and data solutions for supply chain clients.

After 23 years, I moved to Fiege, where I first took over the last-mile business as Managing Director. I realized that this area was strongly focused on brokering, multi-carrier, and cross-border setups, with little added value. So we also implemented software-as-a-service products at Fiege and founded a digital organization again.

[05:10.000 --> 05:21.000] Patrick Pawellek

How is planning done in your company – or the companies you worked for – during "normal times" with few disruptions? Which planning processes are applied?

[05:41.000 --> 06:36.000] Boris (Digital Transformation Expert in logistics)

In the past, logistics was highly customer-driven: you won a client, often in long-term contract logistics, and planned assets around that client – warehouses, IT systems, ERP adaptations, or SAP instances. The planning horizon was directly tied to the client contract. After the 2008 financial crisis, this changed. We realized it wasn't enough to think opportunistically per customer. Strategic pre-investments in certain markets became necessary. For example, we expanded in France, the Netherlands, and Poland – the latter for its low labor costs and EU access. Since then, in addition to annual budget rounds (with yearly planning and capital needs), we've had strategic planning: which industries do we serve, which countries must we be present in, and what IT systems do we need? At Arvato this was more pronounced than at Fiege, since Bertelsmann as a media company had stronger financial backing.

[09:34.000 --> 09:41.000] Patrick Pawellek

Which years were particularly volatile, and how did you act during those crises?

[09:41.000 --> 10:56.000] Boris (Digital Transformation Expert in logistics)

The most significant were the financial crisis from 2008–2010 and the COVID-19 pandemic. In every crisis the question arises: opportunity or risk? For logistics, it was mostly risk. During COVID, companies like Arvato and Fiege could benefit, since they had the right healthcare solutions. But overall, crises mostly meant restrictions: hiring freezes, reduced investment budgets, more caution. We used the time to do our homework and reduce technical debt. What impressed me during COVID was how agile logistics can be: supply chains didn't collapse. Instead, we quickly adapted and told customers, "We'll keep this running. We are system-critical."

[12:01.000 --> 12:15.000] Patrick Pawellek

What worked well in planning processes during crisis years?

[12:32.000 --> 12:45.000] Boris (Digital Transformation Expert in logistics)

What worked well was shortening planning cycles – focusing more on tactical planning in two- to three-month windows. That made us flexible, able to react quickly, and implement adjustments faster.

[12:15.000 --> 12:21.000] Patrick Pawellek

What failed or did not work?

[12:58.000 --> 13:20.000] Boris (Digital Transformation Expert in logistics)

Often the illusion failed that crises would bring major opportunities or growth boosts. In reality, if our clients were in crisis, then so were we. The only exception was healthcare during COVID, where there were genuine growth effects.

Another issue was timing: the impact of crises often hit us with a delay. While we thought the crisis was nearly over, the real financial effects often came a year later.

[14:43.000 --> 14:57.000] Patrick Pawellek

What needs to work better in the planning process?

[14:57.000 --> 15:04.000] Boris (Digital Transformation Expert in logistics)

Mainly timing. We need to plan more precisely when a crisis will actually impact us. Too often, planning was overly optimistic – assuming it would be over the next year. But then the effect hit later and lasted longer.

[15:11.000 --> 15:24.000] Patrick Pawellek

How is the company you work for – or worked for – structured?

[15:29.000 --> 16:27.000] Boris (Digital Transformation Expert in logistics)

Logistics companies usually operate along multiple dimensions: industries, countries, and service solutions. The key question is: how central versus decentralized should management be? Both companies I worked for had very decentralized setups. That's typical in logistics, growing organically along core clients and industries. But every three to five years, the advantages of decentralization – speed and proximity to clients – turned into disadvantages. For example, each unit developed its own IT instead of leveraging synergies. HR, controlling, and marketing also lost efficiency. That's why there is now a strong trend toward centralization, since investments in automation and IT have become

too large to be handled locally. The challenge is balancing centralization (for synergies) and decentralization (for market responsiveness).

[18:39.000 --> 18:49.000] Patrick Pawellek

Do you know of best practices for acting in uncertain and volatile times from other companies in the same industry?

[19:02.000 --> 19:40.000] Boris (Digital Transformation Expert in logistics)

I don't have direct insights into competitors like Kühne+Nagel, GXO or CEVA. But there was a huge wave of innovation in logistics: many start-ups developed digital products that didn't exist before. Amazon was a major driver, entering markets with clear concepts and waking up the industry. In parallel, companies like Seven Senders emerged with digital cross-border solutions or multi-carrier approaches. At the same time, there was a strong consolidation wave: mid-sized players disappeared, as they could no longer afford the high investment needs. Only large providers or very specialized niche players survived.

[22:18.000 --> 22:28.000] Patrick Pawellek

Do you know of best practices for acting in uncertain and volatile times from other industries?

[22:42.000 --> 23:23.000] Boris (Digital Transformation Expert in logistics)

Yes, particularly from the automotive and finance industries. After the financial crisis, many companies immediately introduced hiring freezes, switched to four-day weeks, and tightened cash management significantly.

They massively cut external spending, which hit many mid-sized service providers hard. This active cost and cash management was a clear best practice. For logistics, it later inspired asset-light models and greater cooperation instead of doing everything in-house.

[25:19.000 --> 25:24.000] Patrick Pawellek

Which agile process methods are you familiar with?

[25:42.000 --> 26:32.000] Boris (Digital Transformation Expert in logistics)

I know and use OKR (Objectives and Key Results) – we introduced it at both Arvato and Fiege. We also work with Scrum structures in software development, including Product Owners, Product Managers, DevOps teams, and UI/UX designers. Our digital products are developed in sprints with backlogs. Some teams also use Kanban boards. Overall, these methods are very present in digital product development.

[27:07.000 --> 27:09.000] Patrick Pawellek

Are you familiar with the agile method Kanban Board?

[27:09.000 --> 27:11.000] Boris (Digital Transformation Expert in logistics)

Yes. Some teams deliberately use Kanban instead of full Scrum.

[27:09.000 --> 27:11.000] Patrick Pawellek

Are you familiar with the agile method Scrum?

[27:11.000 --> 27:22.000] Boris (Digital Transformation Expert in logistics)

Yes. Scrum structures strongly shape our software development: with clear roles like Product Owner, backlogs, sprints, and reviews.

[27:11.000 --> 27:14.000] Patrick Pawellek

Are you familiar with the Objectives and Key Results model, or OKR?

[27:14.000 --> 27:17.000] Boris (Digital Transformation Expert in logistics)

Yes, and we actively use it – both at Arvato and Fiege.

[27:14.000 --> 27:19.000] Patrick Pawellek

Are such methods used in your company? What experiences have you had, and what recommendations can you derive?

[27:32.000 --> 29:53.000] Boris (Digital Transformation Expert in logistics)

We actively introduced agile methods, particularly in digital product development. For traditional logistics companies, this was initially strange – they come from waterfall projects with fixed budgets and clear project endings. Agile teams work completely differently: continuous development, permanent releases, and high costs (an agile team easily costs €1 million per year). The biggest challenges were mindset (product development vs. project work) and budget processes. CFOs think in terms of closed projects, not continuous product development. In addition, there's still little knowledge about intellectual property of software solutions – many underestimate the importance of securing rights to digital assets. My recommendation: build your own digital assets, don't just outsource. Otherwise, ownership is missing. Agile methods are essential for digital

products – but for classical IT operations projects (like ERP), waterfall often remains sensible.

[32:38.000 --> 32:42.000] Patrick Pawellek

Are you familiar with agile organizational models such as the Spotify model?

[32:46.000 --> 33:28.000] Boris (Digital Transformation Expert in logistics)

Yes, very much. We structured our digital organization in a similar way. There were DevOps teams with around 20 people each, over 280 employees in total. What we didn't formally implement were so-called chapter functions (like all UI/UX designers forming their own community). But in the core structures, we worked very similar to Spotify.

[33:30.000 --> 33:37.000] Patrick Pawellek

Do you see such an organizational approach as an alternative for a company in the logistics industry?

[33:40.000 --> 35:04.000] Boris (Digital Transformation Expert in logistics)

We used it in product development, where it worked very well. In traditional logistics projects – such as ERP rollouts or warehouse go-lives – waterfall is more suitable, since fixed deadlines apply. I believe both models are valid. Hybrid approaches make sense: agility where innovation is required (digital products), and classical project methods where stability is needed (operations). Individual elements from Spotify structures – like Product Owners responsible for specific processes (inbound, dispatch, etc.) – would also benefit logistics organizations, even if they overall work in waterfall mode.

[36:31.000 --> 36:50.000] Patrick Pawellek

Many companies pursue strategies to make themselves more robust. But there is also the approach of not just cushioning crises, but embracing them to actually strengthen competitiveness. Can you imagine this concept?

[37:02.000 --> 37:34.000] Boris (Digital Transformation Expert in logistics)

Yes, absolutely. It's ultimately the question: can I not only survive crises, but use them to change something? I've seen it myself, for example when companies completely stopped advertising during the financial crisis, and afterwards focused more on digital channels. Crises can trigger transformation.

[39:27.000 --> 39:31.000] Patrick Pawellek

Where do you see problems in implementing antifragility?

[39:35.000 --> 41:05.000] Boris (Digital Transformation Expert in logistics)

The biggest problem is mindset: many logistics companies are hierarchical, focused on efficiency and productivity. They look at today and tomorrow, but not the day after. Second, I see a reflex toward centralization in crises: instead of giving responsibility to decentralized units, headquarters tighten their grip. That creates an illusion of security but not real responsiveness. Third, lack of transparency plays a role – a lot of data is still buried in decentralized structures, making quick decisions harder.

[46:02.000 --> 46:08.000] Patrick Pawellek

Do you consider antifragility a viable concept? Where do you see its advantages?

[46:15.000 --> 47:02.000] Boris (Digital Transformation Expert in logistics)

Yes, it's viable. Antifragility forces you to think about scenarios and plans before crises occur. That strengthens the robustness of the business model. The advantage is that companies don't just see crises as threats, but as learning opportunities – through redundancies, scenarios, forecasting, and error culture. Logistics providers can contribute strongly here, since they are deeply involved in critical value chains.

[47:21.000 --> 47:27.000] Patrick Pawellek

To what extent do you consider antifragility an implementable concept for the logistics industry? What would need to happen for companies to adapt accordingly?

[47:53.000 --> 49:37.000] Boris (Digital Transformation Expert in logistics)

It's implementable, but not across the board. Examples: At Fiege, we built IT tools that analyze tracking data in real time to identify risks early (e.g. strikes, weather events, carrier overload). Customers receive recommendations before supply chains break. Many companies now deliberately use dual-supplier strategies or build buffer stocks to reduce dependencies. Start-ups and digital innovations also show how failures can be used as learning opportunities. Implementation succeeds when customers are willing to pay and when companies feel pressure to present business continuity plans. Competitive pressure and generational change (like at Fiege) further drive the topic.

[55:02.000 --> 55:05.000] Patrick Pawellek

Was an important aspect of crisis management overlooked or not asked in my questions?

[55:11.000 --> 56:22.000] Boris (Digital Transformation Expert in logistics)

Yes. A key point is financing antifragility. There are hardly any established procedures for budgeting investments in redundancies or digital resilience measures. Often these are cut immediately, since they don't bring direct returns. At Fiege, we held discussions about dependencies: we had to realize that critical parts of our value chain did not belong to us. That triggered the move to build our own digital assets. Acceptance also arises when customers support the roadmap and show willingness to pay. Still, it remains a bet on the future – and bets are not popular in traditional waterfall structures.

APPENDIX E:
MAYRING TABLE OF INTERVIEW 1

Question	Coding Unit / Original Meaningful Statement	Paraphrasing / Generalisation / Reduction
1. How long have you worked in the logistics industry and which positions have you held?	“I have been in logistics for over 30 years.” / “I did practically everything in sales.” / “I developed NSCS risk assessment for Germany... built models and introduced them.” / “Worked on strategic level for Europe and ISMEA.” / “Looked at what we need to do to be successful in 5–10 years.”	Rössler has over 30 years of experience in the logistics industry, mainly in sales and strategic risk assessment. He developed scenario and risk models for Germany, Europe and ISMEA. His past roles included long-term strategic planning. Today, he is responsible for Northern Germany in sales.
2. How does your company plan in “normal times” with few disruptions?	“UPS learned from difficult situations.” / “There were fewer disruptions back then.” / “We pre-planned scenarios 15 years ago.” / “2–3 planning stages.” / “We still do this when something unforeseen happens.” / “You can call it	UPS has long used a multi-stage scenario-planning approach (normal, best, worst case). This planning method was developed about 15 years ago and is still used today to respond to unexpected disruptions.

Question	Coding Unit / Original Meaningful Statement	Paraphrasing / Generalisation / Reduction
	scenario analysis: normal, best, worst case.”	
3. Which years were particularly volatile and how did you respond?	“Corona period.” / “2020–21 problematic.” / “2008 financial crisis.” / “UPS strike in 1997.” / “Cost cutting initiatives... travel, hiring freeze.”	Major volatile years: COVID-19 (2020–21), 2008 crisis, UPS strike in 1997. The company responded mainly with cost-cutting measures such as reducing travel expenses and postponing hires.
4. What worked well in planning during crises?	“We were always able to implement savings quickly.” / “Very strict, almost military approach.” / “You learn to work creatively with fewer resources.”	UPS consistently managed to reduce costs quickly during crises through strict procedures. Working with reduced resources fostered creativity and adaptive behaviour.
5. What did not work well?	“Service quality declines when cutting costs.” / “If cuts are unplanned, service declines quickly.” / “We carry over lessons learned.” / “UPS sees	Cost-cutting caused service deterioration. Unplanned cuts especially had negative operational effects. However, lessons were integrated into future processes. UPS views

Question	Coding Unit / Original Meaningful Statement	Paraphrasing / Generalisation / Reduction
	crises as an opportunity to become more efficient.”	crises as opportunities for efficiency gains.
6. What should work better?	“We removed unprofitable customers... more left than expected.” / “Blind actionism in marketing management... not understanding the market.”	UPS should avoid reactive, uninformed “actionism,” particularly decisions made without adequate market understanding. Strategic, evidence-based planning is required.
7. How is your company structured?	“A matrix organization... corporate level and regional levels.”	UPS is structured as a matrix organization with corporate functions and regionally divided business units.
8. Do you know best practices for dealing with volatility within the logistics sector?	“Not in detail.” / “Hard to compare.” / “Closest comparable is DHL.”	Rössler knows no detailed best practices from direct competitors. DHL is perceived as the closest comparable firm.
9. Do you know best practices from other industries?	“BMW’s multi-shift system... they reduce shifts when volume drops.” / “Comparable to reducing overtime in parcel delivery.”	Best practices mentioned include flexible shift reduction (e.g., BMW). Transferable principle: reducing labour

Question	Coding Unit / Original Meaningful Statement	Paraphrasing / Generalisation / Reduction
		capacity to cut costs in downturns.
10. Which agile process methods do you know?	"I cannot name any methods from textbooks."	Agile methods are largely unfamiliar to him.
11. Do you know Kanban?	"I know it as an organizational tool."	Kanban is known only superficially as an organizational method.
12. Do you know Scrum?	"No, not at all."	Scrum is unknown.
13. Do you know OKR?	"Yes, I read a book about it."	OKR is known and understood conceptually.
14. Are agile methods used in your company? Experiences? Recommendations?	Balanced Scorecard dominates; OKR seen as better but not adoptable. / "Planning once per year is a weakness." / "Old goals remain even when environment changes."	Agile methods are not used. UPS adheres rigidly to annual Balanced Scorecard planning. OKR was evaluated but not implementable due to organizational rigidity. Planning remains largely static and inflexible.

Question	Coding Unit / Original Meaningful Statement	Paraphrasing / Generalisation / Reduction
15. Do you know agile organisational forms (e.g., Spotify model)?	"I know the term but cannot describe it."	Spotify model is known by name only.
16. Could such models work in logistics?	(No answer)	No data for analysis.
17. Understanding antifragility: can crises strengthen companies?	"Some companies use crises to come out stronger." / "UPS belongs to those." / "Plans are extremely aggressive." / "Goals must be challenging but not impossible."	UPS sees value in using crises to improve competitiveness. Organisation uses aggressive goal-setting to push performance, balancing ambition and feasibility.
18. Problems in implementing antifragility	"Scalability is the main issue." / "Mindset of employees." / "Hard to prepare for unknowns." / "Reaction time in large organisations is long." / "Employees must act as sensors." / "Advantages: competitive benefit, more revenue, more profit."	Main barriers: lack of scalability, employee mindset, slow detection of critical signals. Large organisations struggle to identify unknown risks early. Benefit: potential competitive advantage.
19. Is the concept viable and what	"Mindset is the main difficulty." / "You cannot	Viability depends on mindset shift and early detection of

Question	Coding Unit / Original Meaningful Statement	Paraphrasing / Generalisation / Reduction
advantages does it provide?	prepare for everything.” / “Need fast recognition of changes.” / “Advantage: competitiveness, revenue, profit.”	threats. Major benefit is improvement of competitiveness and profitability.
20. Is antifragility feasible in the logistics sector? What must happen?	Differences in corporate strategy across logistics firms. / Employee readiness crucial. / External pressure (macro forces) must intensify. / “Crises historically trigger development leaps.”	Antifragility is currently not readily implementable in logistics. Feasibility depends on strategic alignment, workforce openness, and strong external pressure. Crises may act as catalysts for change.
21. Was any important topic overlooked?	“Nothing comes to mind.”	No additional topics identified.

APPENDIX F:

MAYRING TABLE OF INTERVIEW 2

Question	Coding Unit / Original Meaningful Statement	Paraphrasing / Generalisation / Reduction
1. How long have you worked in logistics and which roles have you held?	“In total it is now exactly 16 years.” / “I did Step International.” / “European responsibility as HR & Labor Manager.” / “General Manager for Switzerland and Austria.”	Kessler has worked 16 years in various roles at UPS, including European HR & Labor responsibility. He is currently General Manager for Switzerland and Austria, overseeing all interdisciplinary functional areas.
2. How does your company plan in ‘normal times’ with few disruptions?	“Planning works in cascading form.” / “Global strategy is broken down into business unit targets.” / “Global strategy and profit planning turned into local goals.” / “Based on previous-year results.” / “Plans are 95% fixed with little flexibility.” / “Extraordinary plan events are rare exceptions.”	UPS uses a top-down cascading planning system where global strategy is translated into local goals. Planning relies heavily on historical data, is highly fixed and inflexible, and allows only limited adaptation unless extraordinary events occur.
3. Which years were particularly volatile, and how did you respond?	“Financial crisis 2008/09.” / “Pandemic years.” / “We first expected crisis but volumes increased unexpectedly.” / “Scenario planning for 20–50% volume loss.” / “Ukraine war creates uncertainty.” / “Instrument set didn’t change; only more conservative targets.” / “Shift to semi-annual business planning for more flexibility.”	The most volatile years were 2008–09, the pandemic, and the Ukraine war. UPS initially used the same instruments as in stable years but applied more conservative targets. A major change was introduced recently: business planning now happens semi-annually, increasing flexibility in volatile environments.
4. What worked well in the planning process during crises?	“Clear guideline for employees.” / “Structured, understandable actions.” / “Provides safety net, psychological security.” /	Clear, structured planning created stability and psychological certainty for employees. Cost efficiency served as a reliable anchor during crisis periods.

Question	Coding Unit / Original Meaningful Statement	Paraphrasing / Generalisation / Reduction
	“High cost efficiency is especially important.”	
5. What did not work well?	“Safety net is often not flexible enough.” / “Historical planning of utility costs would fail for next year.” / “Flexibility needed, but difficult for us.”	The rigid planning system prevents agile responses. Reliance on historical data becomes problematic during external shocks. The organisation struggles to build sufficient planning flexibility.
6. What should work better?	(No direct content provided)	No analysable data available.
7. How is your company structured?	“We are a classic matrix organisation.”	UPS is structured as a traditional matrix organisation in both business and organisational terms.
8. Do you know best practices for volatility within the logistics sector?	“Technological capability to convince customers.” / “Working with lean structures.” / “DPD used volatility well to reposition themselves.”	Best practices include strong technological capability and lean organisational structures. DPD is perceived as an example of effective market repositioning during volatility.
9. Best practices from other industries?	“Challenges similar but no silver bullet.” / “Swiss company: no offshoring, all services kept in-country—pays off long term.”	Other sectors also face volatility, but no universal solutions exist. Kessler cites nearshoring as a noteworthy strategic response, which may reduce efficiency but improve resilience and service reliability.
10. Which agile process methods do you know?	“Looking for a technical term... not sure.”	Explicit agile process methods are largely unfamiliar.
11. Do you know Kanban?	“No.”	Kanban is not known.
12. Do you know Scrum?	“Yes, but only from theory; we do not use it.”	Scrum is known theoretically but not applied at UPS.
13. Do you know OKR?	“Yes.”	OKR is known.

Question	Coding Unit / Original Meaningful Statement	Paraphrasing / Generalisation / Reduction
14. Are agile methods used? Experiences? Recommendations?	“OKR attempts existed but low acceptance.” / “High management effort.” / “Performance measurement becoming more difficult.” / “Concepts did not spread.”	Agile methods like OKR were tested but did not gain traction due to low acceptance, added management workload, and declining effectiveness of target-setting processes. UPS therefore has limited experience and no broad adoption.
15. Do you know agile organisational models like Spotify?	“Yes... works better in Spotify-like environments.” / “I would wish for more agility.”	He is familiar with the concept and would welcome more agility, but considers it more suitable for software-oriented environments.
16. Could such a model work in logistics?	“Extremely difficult in logistics.” / “Teams would become too large; agility would be lost.” / “Too much interdisciplinary coordination.” / “Maybe at sub-unit level.” / “Local profit centres (like TNT) might work better.”	Kessler sees large-scale agile organisational models as impractical in logistics due to complexity, team size and required cross-functional coordination. They might be feasible only in smaller subunits or decentralised profit centres.
17. Understanding antifragility: can crises strengthen companies?	“Churchill: crisis contains opportunity.” / “Most companies plan for stability, not volatility.” / “Shareholders prefer conservative approach.” / “Companies claim agility but are not truly agile.”	He acknowledges the conceptual value of antifragility but notes that most firms—including UPS—are driven by stability-oriented shareholder expectations. Agility is often more rhetorical than real.
18. Problems in implementing antifragility?	“Problems on both sides: organisation and employees.” / “Conservative culture hinders change.” / “Attempts not accepted; wrong expectations.”	Challenges stem from both organisational culture and employee behaviour. Conservative structures and weak acceptance of new methods hinder implementation.

Question	Coding Unit / Original Meaningful Statement	Paraphrasing / Generalisation / Reduction
19. Is antifragility a feasible concept? Advantages?	“Yes, because it strengthens the organisation beyond crisis readiness.” / “Adds a layer of improvement rather than just recovery.”	Kessler considers antifragility feasible and attractive because it transforms crises into opportunities for organisational strengthening, not just resilience.
20. How feasible is antifragility in logistics? What must happen?	“Requires measurable economic success.” / “Needs a catalyst showing clear financial advantage.” / “Pure prevention is not convincing.” / “IT example: cyberattack as opportunity to strengthen systems.” / “Success in sub-areas needed before scaling organisation-wide.”	Antifragility must demonstrate clear economic benefits to gain acceptance. Initial implementation should occur in measurable sub-areas (e.g., IT), where short-term success can serve as proof-of-concept for wider adoption.
21. Was any important aspect overlooked?	“System only as good as the people living it.” / “Theory works, but employees need understanding and motivation.” / “Large organisations have mixed employee capabilities.” / “Concept promising but will take time.”	The main limitation lies in human factors: understanding, motivation, and ability to apply the concept consistently. Successful antifragility requires strong employee engagement across all levels. The concept is promising but requires time for cultural adaptation.

APPENDIX G:
MAYRING TABLE OF INTERVIEW 3

Question	Coding Unit / Original Meaningful Statement	Paraphrasing / Generalisation / Reduction
1. How long have you worked in logistics and which positions have you held?	“Over 25 years... various positions... Managing Director at Kretschmar Cargo Süd, co-founder Connected Logistics.”	More than 25 years of experience across international roles, management positions and strong IT-related competence.
2. How does planning work in ‘normal times’ with few disruptions?	“Customer-oriented planning, network-in-network, top-down, six-year cycles, mission/vision/strategy/KPIs.”	Long-term top-down planning with a strategic horizon of several years, strongly customer- and network-focused.
3. Which years were particularly volatile and how did you respond?	“Last 16 months extremely difficult.” / “Crises 1992/2002.” / “Asset-light model as response.”	Volatility was experienced during recent months and prior crises (1992/2002). Flexibility and asset-light approaches were key responses.

Question	Coding Unit / Original Meaningful Statement	Paraphrasing / Generalisation / Reduction
4. What worked well in crisis planning?	“Open communication with staff, transparency, personnel as lever, low fixed costs.”	Transparent communication and flexible personnel cost structures were effective crisis levers.
5. What failed or did not work?	“Short-term adjustments with customers fail, coordination too slow, problems during peaks.”	Short-term customer adjustments often fail due to slow internal processes and limited responsiveness.
6. What should work better?	“Poor data quality and forecasting.”	Improved data quality and forecasting capabilities are needed.
7. How is your company structured?	“Own locations + cooperations, member in networks, holding structures for data flow.”	Hybrid structure combining owned operations with cooperation models and centralised data governance.

Question	Coding Unit / Original Meaningful Statement	Paraphrasing / Generalisation / Reduction
8. Best practices from within the logistics sector?	“Cooperations, exchange of best practices, data sovereignty crucial.”	Best practices revolve around strong networking, cooperation and control over data.
9. Best practices from other industries?	“Transfer of IT-as-a-Service, data competence essential.”	Applying IT principles (service orientation, modularity, data competence) to logistics enhances adaptability.
10. Which agile process methods do you know?	“Iterative approach, project cycles, fixed team.”	Basic understanding of agile principles; iterative work style known.
11. Do you know Kanban?	“Only by name, sceptical of hype.”	Kanban only superficially known; scepticism toward trend-driven adoption.
12. Do you know Scrum?	“Attended a Scrum course, know the principle.”	Scrum conceptually known but hardly applied in practice.
13. Do you know OKR?	“Only know the name, no experience.”	OKR is known but has not been implemented.

Question	Coding Unit / Original Meaningful Statement	Paraphrasing / Generalisation / Reduction
14. Are agile methods used? What experiences exist?	“Mixture of project plans, no protocols, agile master plans.”	Company uses a pragmatic hybrid project-management style incorporating some agile elements.
15. Do you know agile organisational forms such as the Spotify model?	“Spotify model unknown.”	Spotify model is not known.
16. Could such a model work in logistics?	“Hierarchical, but advisory boards and working groups as modified form.”	Agile organisational elements may be applied in modified forms (e.g., committees, workgroups), but full models are not directly transferable.
17. Can you imagine antifragility — using crises to become stronger?	“Create redundancies, react flexibly, learn from disturbances.”	Antifragility is intentionally pursued via redundancy, flexibility and learning from disruptions.

Question	Coding Unit / Original Meaningful Statement	Paraphrasing / Generalisation / Reduction
18. Problems in implementation?	“Structures too rigid, networks as solution.”	Rigid organisational structures hinder antifragile behaviour; networks improve adaptability.
19. Is antifragility a useful concept? Advantages?	“Creates alternatives, strengthens processes and services.”	Antifragility enhances resilience and strengthens organisational processes and service quality.
20. How feasible is antifragility in logistics? What must happen?	“Partially already implemented.”	Antifragility is already being implemented in parts of the organisation.
21. Was any important aspect of crisis management overlooked?	“Lack of internal competence, integrate external know-how modularly.”	Need for external expertise and modular structural integration to strengthen crisis management capabilities.

APPENDIX H:
MAYRING TABLE OF INTERVIEW 4

Question	Coding Unit / Original Meaningful Statement	Paraphrasing / Generalisation / Reduction
1. How long have you worked in logistics and which positions have you held?	“Born into logistics... 1994–1996 training... DAHV studies... 23 years at Arvato... built digital organisation (150 IT)... moved to Fiege, MD Last Mile, founded SaaS & digital org.”	Over 25 years in logistics; career from Key Account to Board level; early digital transformation; built large digital teams; later at Fiege leading Last Mile and SaaS/Digital organisation.
2. How does planning work in ‘normal times’ with few disruptions?	“Previously asset planning tied to customer contracts... after 2008 strategic pre-investments... annual budgets + multi-year strategies... Arvato more pronounced than Fiege.”	Shift from opportunistic, contract-bound planning to strategic country/network/IT planning; mix of annual budgets and multi-year strategy; capital strength shapes planning depth.
3. Which years were particularly volatile and how did you respond?	“Volatile: 2008–2010, Corona... actions: hiring freeze, reduce investments, fix tech debt... Corona showed agility, supply chains held.”	Major crises triggered cost discipline and cleanup work; sector simultaneously showed

Question	Coding Unit / Original Meaningful Statement	Paraphrasing / Generalisation / Reduction
		strong operational adaptability, especially in the pandemic.
4. What worked well in crisis planning?	“Planning cycles shortened (2–3 months), tactical steering, quicker adjustments.”	Short-cycle, tactical planning proved effective during crises.
5. What did not work or failed?	“Illusion of growth opportunities failed (except Healthcare)... timing errors: effects often delayed by one year.”	Overestimation of opportunities and poor timing; crisis effects realised later than expected.
6. What should work better?	“Timing must be incorporated more accurately; not planning too optimistically.”	Better crisis-timing models and forecasting required.
7. How is your company structured?	“Historically decentral... advantages flipping; parallel IT, loss of synergies... trend toward centralisation due to CAPEX... balancing centralisation and market proximity is key.”	Shift from decentral to balanced model: centralise synergies and IT investment, maintain market closeness; centralisation driven by capital/automation.

Question	Coding Unit / Original Meaningful Statement	Paraphrasing / Generalisation / Reduction
8. Best practices from within the logistics sector?	“Limited insight... strong innovation wave (start-ups, Amazon)... multi-carrier/cross-border... consolidation.”	Industry best practices: digitalisation, platform and multi-carrier approaches, consolidation; innovation led by start-ups and Amazon.
9. Best practices from other industries?	“Automotive/finance: hiring freeze, 4-day week, strong cash management... inspired asset-light/partnership models.”	Crisis responses from other sectors (cost control, cash discipline) transferred to logistics via cost variability and partnerships.
10. Which agile process methods do you know?	“OKR used (Arvato & Fiege)... Scrum (PO/PM, DevOps, UI/UX, sprints, backlog)... some Kanban.”	OKR, Scrum and Kanban broadly known and used especially in digital/software units.
11. Do you know Kanban?	“Yes, some teams instead of full Scrum.”	Kanban used selectively.
12. Do you know Scrum?	“Scrum shapes software development; roles, backlogs, sprints, reviews.”	Scrum is the standard method for digital product development.

Question	Coding Unit / Original Meaningful Statement	Paraphrasing / Generalisation / Reduction
13. Do you know OKR?	“OKR actively implemented (Arvato & Fiege).”	OKR is an established leadership and goal-setting system.
14. Are agile methods used? What experiences exist?	“Agile in digital teams – classical logistics finds it strange... continuous product development vs. project thinking... budgets (1M €/team/year)... IP rights underestimated... recommendation: own digital assets; waterfall still useful for ERP/operations.”	Agile adoption requires cultural and budget changes; costs and IP ownership critical; hybrid recommendation: agile for product/digital work, waterfall for stable operational IT.
15. Do you know agile organisational forms (e.g., Spotify model)?	“Spotify model known; digital org similar (DevOps teams, 280 staff); Chapters not formal.”	Digital organisation resembles Spotify-like structures but without formal chapter system.
16. Could the Spotify model work in logistics?	“Useful in product development; for ERP/warehouse go-live waterfall better; hybrid: product owner roles also helpful in waterfall.”	Hybrid organisational models recommended; agile viable in product-related areas, waterfall still needed in core operations.

Question	Coding Unit / Original Meaningful Statement	Paraphrasing / Generalisation / Reduction
17. Can you imagine antifragility – becoming stronger from crises?	“Crises trigger transformation... crises used for transformation.”	Strong understanding: crises act as catalysts for innovation, resource reallocation and transformation.
18. Problems in implementation?	“Mindset: hierarchical, efficiency focus, limited long-term view... crisis reflex: centralisation for fake security... lack of transparency (decentral data).”	Barriers: cultural resistance, wrong crisis reflexes, lack of data transparency and access.
19. Is antifragility a useful concept? Advantages?	“Antifragility useful: early scenarios/plans; learning via redundancy/forecasting/error culture; logistics has strong contribution potential.”	Antifragility increases robustness, learning capability and proactive crisis design; logistics suitable for applying antifragile principles.
20. How feasible is antifragility for the logistics sector? What must happen?	“Feasible but not widespread... examples: real-time tracking/forecasting, dual suppliers, buffers, start-up innovation... drivers:	Concept feasible in practice; requires investment in data, redundancy, buffers, innovation; adoption

Question	Coding Unit / Original Meaningful Statement	Paraphrasing / Generalisation / Reduction
	willingness to pay, BCP pressure, competition, generational shift.”	driven by business cases, external pressure and generational change.
21. Was anything important overlooked?	“Financing antifragility missing; often cut... dependency analysis → own digital assets... customer feedback & willingness to pay increases acceptance; but still a bet within waterfall logic.”	Missing aspect: financial logic for antifragility (CAPEX/OPEX); ownership of digital assets enables resilience; customer validation important; antifragility still carries risk within traditional planning models.

APPENDIX J:
QUESTIONNAIRE

Survey: Logistics Companies – Agility, Resilience and Antifragility

Block A: Company Profile

1. Which type of logistics provider best describes your company?

- ☐ 3PL (classic forwarding/transport/distribution)
- ☐ 4PL / Lead Logistics Provider
- ☐ CEP service provider (courier/express/parcel)
- ☐ Carrier (e.g., air freight, sea freight, rail, truck fleet)
- ☐ Contract logistics / Warehousing
- ☐ Intralogistic
- ☐ Outbound
- ☐ Inbound
- ☐ Other: _____

2. Company size (total employees):

- ☐ < 50
- ☐ 50–249
- ☐ 250–999
- ☐ 1,000–4,999
- ☐ ≥ 5,000

Block B: Corporate Culture & Agility (H1)

3a. Errors are understood as opportunities for learning. (1 false - 5 true)

- ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

3b. Open communication in times of crisis is encouraged. (1 false - 5 true)

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

3c. Innovation and experimentation are actively supported. (1 false - 5 true)

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

4. Which agile methods are used in your company? (Multiple answers possible)

- ☐ None
- ☐ Scrum (e.g., in Digital/IT teams)
- ☐ Kanban
- ☐ OKR (Objectives and Key Results)
- ☐ Other: _____

Block C: Agility & Hybrid Organization → Crisis Performance (H2)

5. Organizational form of your company:

- ☐ Classical (Waterfall, Top-Down)
- ☐ Hybrid (agile in Innovation/IT, classical in Operations)
- ☐ Fully agile (Operations also managed in an agile way)

6a. Our company maintained service levels during crises. (1 false - 5 true)

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

6b. Our company compensated revenue/volume declines. (1 false - 5 true)

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

6c. Our company stabilized delivery times. (1 false - 5 true)

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

6d. Our company ensured customer satisfaction. (1 false - 5 true)

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Block D: Digitalization & Transparency → Antifragility (H3)

7. Which digital tools do you use?

- ☐ Real-time shipment tracking
- ☐ KPI dashboards (e.g., service level, lead time, forecast accuracy)
- ☐ Automated forecasting / AI-supported planning
- ☐ We don't use digital tools or reporting

8. Crises have strengthened our company in the long term (e.g., through new processes, innovations). (1 false - 5 true)

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Block E: Centralization vs. Decentralization (H4)

9. Structure of your company: (one answer)

- ☐ Strongly centralized (central steering, standard IT)
- ☐ Rather centralized
- ☐ Hybrid (central + decentralized)
- ☐ Rather decentralized (regional units with high autonomy)
- ☐ Strongly decentralized

10a. Efficiency / Economies of scale 1 bad - 5 good)

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

10b. Proximity to the customer 1 bad - 5 good)

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

10c. Crisis management overall (1 bad - 5 good)

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Block F: Asset-Light & Redundancy (H5)

11. To what extent does your company rely on asset-light strategies (e.g., outsourcing, flexible networks instead of own fleets/warehouses)? (1 low – 5 high)

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

12. Which redundancies have you implemented? (Multiple answers possible)

- ☐ None
- ☐ Multi-carrier strategies (several parcel services/freight forwarders)
- ☐ Two-supplier strategies
- ☐ Safety stocks / buffer inventories
- ☐ Emergency/crisis plans

13. How would you rate the resilience of your company? (1 low - 5 high)

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Block G: Financing (H6)

14. Does your company have special budgeting mechanisms for digitalization/resilience measures?

- ☐ Yes, fixed budget line
- ☐ Yes, project-based (case by case)
- ☐ No
- ☐ I don't know

15. What is the implementation rate of digital/antifragility initiatives? (1 low - 5 high)

- ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Block H: Macroeconomic Pressure (H7)

16. How strongly have you perceived macroeconomic pressure (pandemic, war, inflation, bottlenecks) over the past 3 years? (1 low - 5 high)

- ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

17. Which measures were increasingly introduced in your company as a result of macroeconomic pressure? (Multiple answers possible)

- ☐ Agile methods (Scrum, Kanban, OKR)
- ☐ Antifragility measures (redundancies, scenarios, forecasts)
- ☐ Cost reductions / classical robustness measures
- ☐ No specific measures

Block I: Future Orientation

18. Which of the following scenarios seems most likely for your company in the next 3–5 years? (Please choose only one)

- ☐ Secure stability – We want to primarily safeguard existing processes and services without major changes. (corresponds to Robustness)
- ☐ Bounce back quickly – We want to return to the old performance level as quickly as possible after crises. (corresponds to Resilience)
- ☐ Adapt flexibly – We want to flexibly adapt to new market or crisis situations and quickly introduce new solutions. (corresponds to Agility)
- ☐ Emerge stronger from crises – We want to actively use crises as an opportunity to increase competitiveness and build new business areas. (corresponds to Antifragility)

Block H: Personal Questions

19. You are:

- ☐ male
- ☐ female
- ☐ divers

20. Your Birthyear is: _____

21. You are working in the logistic

22. How would you categorize your place of residence?

- ☐ Large city (from 100,000 inhabitants)
- ☐ Medium-sized town (20,000 - 100,000 inhabitants)
- ☐ Small town (5,000-20,000 inhabitants)
- ☐ Rural town (2,000-5,000 inhabitants)

APPENDIX K:
DOCUMENTATION R

```
> #####  
> # Descriptive Statistics – DBA Antifragility in Logistics  
> # Author: Patrick Pawellek  
> #####  
>  
> # 1. Clear workspace  
> rm(list = ls())  
>  
> # 2. Load required packages  
> library(readxl)  
> library(dplyr)  
> library(tidyr)  
> library(psych)  
>  
> # 3. Import dataset  
> df <- read_excel("\\\\JUSTAWESOME\\work\\DBA\\Umfrage Ergebnisse\\log  
.xlsx")  
>  
> exists("df")  
[1] TRUE  
> str(df)  
tibble [400 × 32] (S3: tbl_df/tbl/data.frame)  
  $ Zeitstempel  
  : POSIXct[1:400], format: "2025-09-22 06:38:51" "2025-09-22 09:13:08" "  
2025-09-22 15:02:35" "2025-09-22 15:46:45" ...  
  $ welche Art von Logistikdienstleister beschreibt Ihr Unternehmen am b  
esten?  
  : chr [1:400] "Unternehmens interne Logistik (Intralogistik)" "3PL (kla  
ssische Spedition/Transport/Distribution)" "KEP-Dienstleister (Kurier/E  
xpress/Paket)" "KEP-Dienstleister (Kurier/Express/Paket)" ...  
  $ Unternehmensgröße (Mitarbeiter gesamt):  
  : chr [1:400] "50-249" "≥ 5.000" "≥ 5.000" "≥ 5.000" ...  
  $ In meinem Unternehmen gilt [Fehler werden als Lernchance verstanden.  
]  
  : num [1:400] 5 4 2 4 4 3 4 5 2 2 ...  
  $ In meinem Unternehmen gilt [Offene Kommunikation in Krisenzeiten wir  
d gefördert.]  
  : num [1:400] 4 4 2 3 4 2 4 5 2 1 ...  
  $ In meinem Unternehmen gilt [Innovation und Experimentieren wird akti  
v unterstützt.]  
  : num [1:400] 4 3 1 3 4 2 5 5 2 2 ...  
  $ welche agilen Methoden setzen Sie in Ihrem Unternehmen ein? (Mehrfac  
hwahl möglich)
```

```

: chr [1:400] "Andere agile Methode" "Andere agile Methode" "keine" "Ka
nban, Andere agile Methode" ...
$ welche Organisationsform herrscht in Ihrem Unternehmen?
: chr [1:400] "Hybrid (agil in Innovation/IT, klassisch in Operations)"
"Klassisch (Wasserfall, Top-Down)" "Klassisch (Wasserfall, Top-Down)" "
Klassisch (Wasserfall, Top-Down)" ...
$ Wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den let
zten 3 Jahren? [Servicelevel gehalten]
: num [1:400] 4 4 2 3 3 4 4 5 2 3 ...
$ Wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den let
zten 3 Jahren? [Umsatz-/Volumen-Rückgang kompensiert]
: num [1:400] 5 4 2 2 4 4 3 5 3 3 ...
$ Wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den let
zten 3 Jahren? [Lieferzeiten stabilisiert]
: num [1:400] 5 4 2 2 3 4 3 5 1 2 ...
$ Wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den let
zten 3 Jahren? [Kundenzufriedenheit gesichert]
: num [1:400] 4 4 1 2 3 4 4 5 1 2 ...
$ Wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den let
zten 3 Jahren? [Individuelle KPI's gehalten]
: num [1:400] 5 4 3 3 3 4 3 5 1 2 ...
$ welche digitalen Tools nutzen Sie?
: chr [1:400] "Echtzeit-Tracking für Sendungen, KPI-Dashboards (z. B. S
ervicelevel, Lead Time, Forecast Accuracy)" "KPI-Dashboards (z. B. Serv
icelevel, Lead Time, Forecast Accuracy)" "Echtzeit-Tracking für Sendung
en, KPI-Dashboards (z. B. Servicelevel, Lead Time, Forecast Accuracy)"
"Echtzeit-Tracking für Sendungen, KPI-Dashboards (z. B. Servicelevel, L
ead Time, Forecast Accuracy), Automatisierung" | __truncated__ ...
$ Wie bewerten Sie die Aussage „Krisen haben unser Unternehmen langfri
stig gestärkt (z. B. durch neue Prozesse, Innovationen).“
: num [1:400] 4 3 4 3 4 4 3 5 1 2 ...
$ Wie ist die Struktur Ihres Unternehmens?
: chr [1:400] "Hybrid (zentral + dezentral)" "Hybrid (zentral + dezentr
al)" "Eher zentralisiert" "Eher zentralisiert" ...
$ Wie bewerten Sie folgende Punkte (1 = sehr schlecht ... 5 = sehr gut):
[Effizienz / Skaleneffekte]
: num [1:400] 3 4 2 3 3 4 3 5 2 3 ...
$ Wie bewerten Sie folgende Punkte (1 = sehr schlecht ... 5 = sehr gut):
[Nähe zum Kunden]
: num [1:400] 3 4 3 3 5 4 2 5 1 3 ...
$ Wie bewerten Sie folgende Punkte (1 = sehr schlecht ... 5 = sehr gut):
[Krisenbewältigung insgesamt]
: num [1:400] 4 4 3 2 3 4 3 5 2 3 ...
$ Wie stark setzt Ihr Unternehmen auf „Asset-Light“-Strategien (z. B.
Outsourcing, flexible Netzwerke statt eigener Flotten/Lager)?
: num [1:400] 3 4 3 2 5 3 3 2 5 3 ...
$ welche Redundanzen haben Sie implementiert? (Mehrfachwahl)
: chr [1:400] "Multi-Carrier-Strategien (mehrere Paketdienste/Frachtfüh
rer), Zwei-Lieferanten-Strategien (oder mehr), Pufferbe" | __truncated__
"Multi-Carrier-Strategien (mehrere Paketdienste/Frachtführer), Zwei-Lie
feranten-Strategien (oder mehr), Notfall-/Krisenpläne" "Multi-Carrier-S

```

```

strategien (mehrere Paketdienste/Frachtführer), Zwei-Lieferanten-Strategien (oder mehr), Notfall-/Krisenpläne" "Notfall-/Krisenpläne" ...
$ Wie würden Sie die Resilienz (Widerstandsfähigkeit) Ihres Unternehmens einschätzen?
: num [1:400] 4 4 4 4 4 5 3 5 5 2 ...
$ Gibt es in Ihrem Unternehmen spezielle Budgetmechanismen für Digitalisierung / Resilienzmaßnahmen?
: chr [1:400] "Nein" "Ja, feste Budgetlinie" "Ja, projektbezogen (Case-by-Case)" "Ja, projektbezogen (Case-by-Case)" ...
$ Wie hoch ist die Umsetzungsquote von Digital-/Agilitäts-Initiativen?
: num [1:400] 3 3 3 3 3 4 4 4 4 3 ...
$ Wie stark haben Sie in den letzten 3 Jahren makroökonomischen Druck wahrgenommen (Pandemie, Krieg, Inflation, Engpässe)?
: num [1:400] 3 4 4 4 5 5 4 3 3 5 ...
$ Welche Maßnahmen wurden infolge des Makrodrucks bei Ihnen verstärkt eingeführt? (Mehrfachwahl)
: chr [1:400] "Antifragilitäts-Maßnahmen (Redundanzen, Szenarien, Forecasts)" "Kostensenkungen / klassische Robustheitsmaßnahmen" "Kostensenkungen / klassische Robustheitsmaßnahmen" "Antifragilitäts-Maßnahmen (Redundanzen, Szenarien, Forecasts), Kostensenkungen / klassische Robustheitsmaßnahmen" ...
$ Welches der folgenden Szenarien erscheint Ihnen für Ihr Unternehmen in den nächsten 3-5 Jahren am wahrscheinlichsten? (Bitte nur eine Option wählen): chr [1:400] "Gestärkt aus Krisen hervorgehen - wir möchten Krisen aktiv als Chance nutzen, um unsere Wettbewerbsfähigkeit zu" | __truncated__ "Stabilität sichern - wir möchten vor allem bestehende Prozesse und Leistungen absichern, ohne große Veränderung" | __truncated__ "Flexibel anpassen - wir möchten uns an neue Markt- oder Krisensituationen flexibel anpassen und neue Lösungen suchen" | __truncated__ "Stabilität sichern - wir möchten vor allem bestehende Prozesse und Leistungen absichern, ohne große Veränderung" | __truncated__ ...
$ Sie sind:
: chr [1:400] "männlich" "männlich" "männlich" "männlich" ...
$ Ihr Geburtsjahr
: num [1:400] 1975 1996 1995 1992 1971 ...
$ Sind Sie in der Logistik tätig?
: chr [1:400] "Ja" "Ja" "Ja" "Ja" ...
$ Wie würden Sie Ihren Wohnort kategorisieren?
: chr [1:400] "Mittelstadt (20.000 - 100.000 Einwohner)" "Großstadt (ab 100.000 Einwohner)" "Mittelstadt (20.000 - 100.000 Einwohner)" "Mittelstadt (20.000 - 100.000 Einwohner)" ...
$ Alter
: num [1:400] 50 29 30 33 54 36 43 53 39 58 ...
>
> #####
> # 4. Data preparation - Multiple response variable (Redundancies)
> #####
>
> Red <- df %>%
+   separate_rows(`welche Redundanzen haben Sie implementiert? (Mehrfachwahl)` , sep = ", ") %>%

```

```

+ filter(`welche Redundanzen haben Sie implementiert? (Mehrfachwahl)`)
) != "")
>
> head(Red)
# A tibble: 6 × 32
  Zeitstempel      welche Art von Logistik...1 Unternehmensgröße (M...2
In meinem Unternehme...3 In meinem Unternehme...4 In meinem Unternehme...5 Wel
che agilen Method...6 welche Organisations...7 Wie bewerten Sie die...8
  <dtm>          <chr>          <chr>
<dbl>          <dbl>          <dbl> <chr>
<chr>          <dbl>
1 2025-09-22 06:38:51 Unternehmens interne Log... 50-249
5 4 4 Andere agile Methode
Hybrid (agil in Innov... 4
2 2025-09-22 06:38:51 Unternehmens interne Log... 50-249
5 4 4 Andere agile Methode
Hybrid (agil in Innov... 4
3 2025-09-22 06:38:51 Unternehmens interne Log... 50-249
5 4 4 Andere agile Methode
Hybrid (agil in Innov... 4
4 2025-09-22 09:13:08 3PL (klassische Speditio... ≥ 5.000
4 4 3 Andere agile Methode
Klassisch (Wasserfall... 4
5 2025-09-22 09:13:08 3PL (klassische Speditio... ≥ 5.000
4 4 3 Andere agile Methode
Klassisch (Wasserfall... 4
6 2025-09-22 09:13:08 3PL (klassische Speditio... ≥ 5.000
4 4 3 Andere agile Methode
Klassisch (Wasserfall... 4
# i abbreviated names: `welche Art von Logistikdienstleister beschreibt
Ihr Unternehmen am besten?`, `Unternehmensgröße (Mitarbeiter gesamt):`
,
# `3`In meinem Unternehmen gilt [Fehler werden als Lernchance verstand
en.]`, `4`In meinem Unternehmen gilt [Offene Kommunikation in Krisenzeite
n wird gefördert.]`,
# `5`In meinem Unternehmen gilt [Innovation und Experimentieren wird ak
tiv unterstützt.]`, `6`welche agilen Methoden setzen Sie in Ihrem Unterne
hmen ein? (Mehrfachwahl möglich)`,
# `7`welche Organisationsform herrscht in Ihrem Unternehmen?`, `8`wie be
werten Sie die Krisenbewältigung Ihres Unternehmens in den letzten 3 Ja
hren? [Servicelevel gehalten]`
# i 23 more variables: `Wie bewerten Sie die Krisenbewältigung Ihres Unt
ernehmens in den letzten 3 Jahren? [Umsatz-/Volumen-Rückgang kompensier
t]` <dbl>,
# `Wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den l
etzten 3 Jahren? [Lieferzeiten stabilisiert]` <dbl>,
# `Wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den l
etzten 3 Jahren? [Kundenzufriedenheit gesichert]` <dbl>, ...
> table(Red$`welche Redundanzen haben Sie implementiert? (Mehrfachwahl)`)

```

```

                                Keine Multi-Carr
ier-Strategien (mehrere Paketdienste/Frachtführer)
Notfall-/Krisenpläne
                                75
203                                197
                                Pufferbestände / Safety Stocks
Zwei-Lieferanten-Strategien (oder mehr)
                                135
110
>
> #####
> # 5. DESCRIPTIVE STATISTICS BY BLOCK
> #####
>
> #####
> # Block A - Company profile
> #####
>
> table(df$`welche Art von Logistikdienstleister beschreibt Ihr Unterne
hmen am besten?`)

3PL (klassische Spedition/Transport/Distribution)
4PL / Lead Logistics Provider Carrier (z. B. Luftfracht, Seefracht, Bah
n, LKW-Flotte)
                                42
21                                16
                                Industrie
Integrator                        KEP-Dienstleister (Kurier/Express/Paket)
                                11
5                                151
                                Kontraktlogistik / Warehousing
Lager, WE, WA, Intra (Industriebetrieb)      Outbound im Unterne
hmen (National & Export)
                                23
9                                41
                                Reseller
nehmens interne Logistik (Intralogistik)      Unter
                                10
71
> table(df$`Unternehmensgröße (Mitarbeiter gesamt):`)

      < 50      ≥ 5.000 1.000-4.999      250-999      50-249
        68         204         12         48         68
>
> #####
> # Block B - Organizational culture
> #####
>
> describe(df[, c(
+ "In meinem Unternehmen gilt [Fehler werden als Lernchance verstan
den.]",

```

```

+ "In meinem Unternehmen gilt [Offene Kommunikation in Krisenzeiten
wird gefördert.]",
+ "In meinem Unternehmen gilt [Innovation und Experimentieren wird
aktiv unterstützt.]"
+ )])

```

```

vars  n mean  sd median trimmed  mad min max range  skew kurtosis  s
e
In meinem Unternehmen gilt [Fehler werden als Lernchance verstanden.]
1 400 3.94 1.04      4    4.06 1.48   1   5    4 -0.71   -0.45 0.05
In meinem Unternehmen gilt [Offene Kommunikation in Krisenzeiten wird g
efördert.]      2 400 3.48 1.18      4    3.51 1.48   1   5    4 -0.22
-1.17 0.06
In meinem Unternehmen gilt [Innovation und Experimentieren wird aktiv u
nterstützt.]    3 400 3.36 1.21      3    3.39 1.48   1   5    4 -0.16
-1.07 0.06

```

```

>
> #####
> # Block C - Crisis performance
> #####
>
> describe(df[, c(
+ "Wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den
letzten 3 Jahren? [Servicelevel gehalten]",
+ "Wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den
letzten 3 Jahren? [Umsatz-/Volumen-Rückgang kompensiert]",
+ "Wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den
letzten 3 Jahren? [Lieferzeiten stabilisiert]",
+ "Wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den
letzten 3 Jahren? [Kundenzufriedenheit gesichert]",
+ "Wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den
letzten 3 Jahren? [Individuelle KPI's gehalten]"
+ )])

```

```

vars  n mean  sd median trimmed  mad min max range  skew kurtosis  s
e
Wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den letzte
n 3 Jahren? [Servicelevel gehalten]      1 400 3.40 1.21
4.0    3.48 1.48   1   5    4 -0.49   -0.76 0.06
Wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den letzte
n 3 Jahren? [Umsatz-/Volumen-Rückgang kompensiert]  2 400 3.12 1.18
3.0    3.15 1.48   1   5    4 -0.24   -0.77 0.06
Wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den letzte
n 3 Jahren? [Lieferzeiten stabilisiert]      3 400 3.16 1.17
3.0    3.20 1.48   1   5    4 -0.20   -0.86 0.06
Wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den letzte
n 3 Jahren? [Kundenzufriedenheit gesichert]  4 400 3.15 1.17
3.0    3.22 1.48   1   5    4 -0.48   -0.82 0.06
Wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den letzte
n 3 Jahren? [Individuelle KPI's gehalten]    5 400 3.38 1.05
3.5    3.42 0.74   1   5    4 -0.43   -0.34 0.05

```

```

>
> #####
> # Block D - Antifragility indicator
> #####
>
> describe(df$`wie bewerten Sie die Aussage „Krisen haben unser Unterne
hmen langfristig gestärkt (z. B. durch neue Prozesse, Innovationen).“`)
  vars   n mean   sd median trimmed  mad min max range  skew kurtosis
se
X1    1 400  3.5 0.93     3    3.53 1.48   1   5    4 -0.14   -0.2
0.05
>
> #####
> # Block E - Organizational structure
> #####
>
> table(df$`wie ist die Struktur Ihres Unternehmens?`)

Eher dezentral (regionale Einheiten mit hoher Autonomie)
Eher zentralisiert                               Hybrid (zentral + dezent
ral)
                                         40
121                                         122
                                         Stark dezentral   Stark zentr
alisiert (zentrale Steuerung, Standard-IT)
                                         14
103
>
> #####
> # Block F - Asset-light & redundancies
> #####
>
> describe(df$`wie stark setzt Ihr Unternehmen auf „Asset-Light“-Strate
gien (z. B. Outsourcing, flexible Netzwerke statt eigener Flotten/Lager
)?`)
  vars   n mean   sd median trimmed  mad min max range  skew kurtosis
se
X1    1 400  3.36 1.29     3    3.41 1.48   1   5    4 -0.11  -1.23
0.06
> table(Red$`welche Redundanzen haben Sie implementiert? (Mehrfachwahl)
`)

                                         Keine Multi-Carr
ier-Strategien (mehrere Paketdienste/Frachtführer)
Notfall-/Krisenpläne
                                         75
1203                                         197
                                         Pufferbestände / Safety Stocks
Zwei-Lieferanten-Strategien (oder mehr)
                                         135
110

```

```

>
> #####
> # Block G – Budget mechanisms
> #####
>
> table(df$`Gibt es in Ihrem Unternehmen spezielle Budgetmechanismen für
Digitalisierung / Resilienzmaßnahmen?`)

      Nein      Ja, feste Budgetlinie Ja, projektbezogen (Case-by-Case)
60      113      227
>
> #####
> # Block H – Macroeconomic pressure
> #####
>
> describe(df$`wie stark haben Sie in den letzten 3 Jahren makroökonomi
schen Druck wahrgenommen (Pandemie, Krieg, Inflation, Engpässe)?`)
vars  n mean  sd median trimmed  mad min max range  skew kurtosis
se
x1    1 400 4.12 0.96      4    4.24 1.48   2   5    3 -0.72   -0.63
0.05
>
> # Frequency of actions (H2-Makrodruck)
> H_actions <- df %>%
+   separate_rows(`welche Maßnahmen wurden infolge des Makrodrucks bei
Ihnen verstärkt eingeführt? (Mehrfachwahl)`, sep = ", ") %>%
+   filter(`welche Maßnahmen wurden infolge des Makrodrucks bei Ihnen
verstärkt eingeführt? (Mehrfachwahl)` != "")
>
> table(H_actions$`welche Maßnahmen wurden infolge des Makrodrucks bei
Ihnen verstärkt eingeführt? (Mehrfachwahl)`)

      Agile Methoden (Scrum      Antifragil
itäts-Maßnahmen (Redundanzen      For
casts)
      29      166
166      166
29
      Keine spezifischen Maßnahmen Kostensenkungen / kla
ssische Robustheitsmaßnahmen
OKR)      Szenarien
      28      29
342
166
>
> #####
> # Block I – Future scenario
> #####
>

```

```
> table(df$`welches der folgenden Szenarien erscheint Ihnen für Ihr Unternehmen in den nächsten 3-5 Jahren am wahrscheinlichsten? (Bitte nur eine Option wählen)`)
```

Flexibel anpassen – wir möchten uns an neue Markt- oder Krisensituationen flexibel anpassen und neue Lösungen schnell einführen. (entspricht Agilität)

144
Gestärkt aus Krisen hervorgehen – wir möchten Krisen aktiv als Chance nutzen, um unsere Wettbewerbsfähigkeit zu steigern und neue Geschäftsfelder aufzubauen. (entspricht Antifragilität)

188
Schnell wieder aufstehen – wir möchten nach Krisen möglichst rasch wieder zum alten Leistungsniveau zurückkehren. (entspricht Resilienz)

39
Stabilität sichern – wir möchten vor allem bestehende Prozesse und Leistungen absichern, ohne große Veränderungen. (entspricht Robustheit)

```
29
> #####
> # 6. INDUCTIVE STATISTICS - HYPOTHESIS TESTING (H1-H7)
> #####
> #####
> # H1 - Culture → Agile methods
> #####
>
> df$Kultur_Index <- rowMeans(df[, c(
+   "In meinem Unternehmen gilt [Fehler werden als Lernchance verstanden.]",
+   "In meinem Unternehmen gilt [Offene Kommunikation in Krisenzeiten wird gefördert.]",
+   "In meinem Unternehmen gilt [Innovation und Experimentieren wird aktiv unterstützt.]")
+ ), na.rm = TRUE)
>
> df$Agile_JaNein <- ifelse(df$`welche agilen Methoden setzen Sie in Ihrem Unternehmen ein? (Mehrfachwahl möglich)` == "Keine", 0, 1)
>
> t.test(Kultur_Index ~ Agile_JaNein, data=df)
```

Welch Two Sample t-test

data: Kultur_Index by Agile_JaNein
t = -5.5227, df = 227.33, p-value = 9.093e-08

```

alternative hypothesis: true difference in means between group 0 and group 1 is not equal to 0
95 percent confidence interval:
 -0.8264204 -0.3917761
sample estimates:
mean in group 0 mean in group 1
    3.210291      3.819389

```

```

>
> df$Agile_Count <- sapply(strsplit(df$`welche agilen Methoden setzen Sie in Ihrem Unternehmen ein? (Mehrfachwahl möglich)`, ","), function(x)
length(x))
>
> cor.test(df$Kultur_Index, df$Agile_Count)

```

Pearson's product-moment correlation

```

data: df$Kultur_Index and df$Agile_Count
t = 2.9032, df = 398, p-value = 0.003899
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 0.04661481 0.23868967
sample estimates:
cor
0.1440083

```

```

>
> #####
> # H2 - Organizational form → Crisis performance
> #####
>
> df$Krise_Index <- rowMeans(df[, c(
+   "Wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den
letzten 3 Jahren? [Servicelevel gehalten]",
+   "Wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den
letzten 3 Jahren? [Umsatz-/Volumen-Rückgang kompensiert]",
+   "Wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den
letzten 3 Jahren? [Lieferzeiten stabilisiert]",
+   "Wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den
letzten 3 Jahren? [Kundenzufriedenheit gesichert]",
+   "Wie bewerten Sie die Krisenbewältigung Ihres Unternehmens in den
letzten 3 Jahren? [Individuelle KPI's gehalten]"
+ )], na.rm = TRUE)
>
> df$Orgform <- factor(df$`welche Organisationsform herrscht in Ihrem Unternehmen?`)
>
> anova_H2 <- aov(Krise_Index ~ Orgform, data=df)
> summary(anova_H2)

```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Orgform	2	124.5	62.25	95.33	<2e-16 ***

```

Residuals    397    259.2      0.65
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
>
> TukeyHSD(anova_H2)
  Tukey multiple comparisons of means
    95% family-wise confidence level

Fit: aov(formula = Krise_Index ~ Orgform, data = df)

$Orgform

diff          lwr          upr          p adj
Klassisch (Wasserfall, Top-Down)-Hybrid (agil in Innovation/IT, klassisch in Operations) -0.9962482 -1.2183498 -0.7741465 0.0000000
voll agil (auch Operations agil gesteuert)-Hybrid (agil in Innovation/IT, klassisch in Operations) 0.7296923  0.3111977  1.1481869 0.0001469
voll agil (auch Operations agil gesteuert)-Klassisch (Wasserfall, Top-Down) 1.7259405  1.3358279  2.1160530 0.0000000

>
> #####
> # H3 - Digitalisation → Antifragility
> #####
>
> df$Digital_Count <- sapply(strsplit(df$`welche digitalen Tools nutzen Sie?`, ","), function(x) length(x))
>
> cor.test(
+   df$Digital_Count,
+   df$`wie bewerten Sie die Aussage „Krisen haben unser Unternehmen langfristig gestärkt (z. B. durch neue Prozesse, Innovationen).“`
+ )

Pearson's product-moment correlation

data: df$Digital_Count and df$`wie bewerten Sie die Aussage „Krisen haben unser Unternehmen langfristig gestärkt (z. B. durch neue Prozesse, Innovationen).“`
t = 4.5975, df = 398, p-value = 5.751e-06
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 0.1293647 0.3156688
sample estimates:
      cor
0.2245679

>
> #####
> # H4 - Structure → Crisis performance
> #####

```

```

>
> df$Struktur_Group <- factor(df$`wie ist die Struktur Ihres Unternehme
ns?`)
>
> anova_H4 <- aov(Krise_Index ~ Struktur_Group, data=df)
> summary(anova_H4)
              Df Sum Sq Mean Sq F value Pr(>F)
Struktur_Group  4   94.1   23.526   32.08 <2e-16 ***
Residuals      395  289.6    0.733
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
>
> TukeyHSD(anova_H4)
  Tukey multiple comparisons of means
    95% family-wise confidence level

Fit: aov(formula = Krise_Index ~ Struktur_Group, data = df)

$Struktur_Group
diff          lwr          upr      p adj
Eher zentralisiert-Eher dezentral (regionale Einheiten mit hoher Autono
mie)                -1.18599174 -1.61398466 -0.7579
9882 0.0000000
Hybrid (zentral + dezentral)-Eher dezentral (regionale Einheiten mit ho
her Autonomie)      -0.15581967 -0.58337658  0.2717
3723 0.8558728
Stark dezentral-Eher dezentral (regionale Einheiten mit hoher Autonomie
)                   -0.21928571 -0.94798643  0.5094
1500 0.9229291
Stark zentralisiert (zentrale Steuerung, Standard-IT)-Eher dezentral (r
egionale Einheiten mit hoher Autonomie) -0.96325243 -1.40043792 -0.5260
6694 0.0000000
Hybrid (zentral + dezentral)-Eher zentralisiert
1.03017206  0.72909556  1.33124857 0.0000000
Stark dezentral-Eher zentralisiert
0.96670602  0.30425083  1.62916121 0.0007210
Stark zentralisiert (zentrale Steuerung, Standard-IT)-Eher zentralisier
t                  0.22273931 -0.09186092  0.5373
3954 0.2978021
Stark dezentral-Hybrid (zentral + dezentral)
-0.06346604 -0.72563962  0.59870754 0.9989508
Stark zentralisiert (zentrale Steuerung, Standard-IT)-Hybrid (zentral +
dezentral)          -0.80743276 -1.12143956 -0.49342
595 0.0000000
Stark zentralisiert (zentrale Steuerung, Standard-IT)-Stark dezentral
-0.74396671 -1.41239778 -0.07553564 0.0205166

>
> #####
> # H5 - Asset-light + redundancy → Resilience

```

```

> #####
>
> df$Redundanz_Count <- sapply(strsplit(df$`Welche Redundanzen haben Si
e implementiert? (Mehrfachwahl)`, ","), function(x) length(x))
>
> lm_H5 <- lm(
+   `Wie würden Sie die Resilienz (Widerstandsfähigkeit) Ihres Untern
ehmens einschätzen?` ~
+   `Wie stark setzt Ihr Unternehmen auf „Asset-Light“-Strategien
(z. B. Outsourcing, flexible Netzwerke statt eigener Flotten/Lager)?` +
+   Redundanz_Count,
+   data=df
+ )
>
> summary(lm_H5)

```

```

Call:
lm(formula = `Wie würden Sie die Resilienz (Widerstandsfähigkeit) Ihres
Unternehmens einschätzen?` ~
  `Wie stark setzt Ihr Unternehmen auf „Asset-Light“-Strategien (z. B.
. Outsourcing, flexible Netzwerke statt eigener Flotten/Lager)?` +
  Redundanz_Count, data = df)

```

```

Residuals:
    Min       1Q   Median       3Q      Max
-2.03799 -0.74562  0.09423  0.24042  1.29955

```

Coefficients:

```

Estimate Std. Error t value Pr(>|t|)
(Intercept)
4.22935    0.16175   26.148   <2e-16 ***
`Wie stark setzt Ihr Unternehmen auf „Asset-Light“-Strategien (z. B. Ou
tsourcing, flexible Netzwerke statt eigener Flotten/Lager)?` -0.07309
0.03222    -2.269    0.0238 *
Redundanz_Count
-0.05913     0.04618  -1.280    0.2012
---

```

```

Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

Residual standard error: 0.7834 on 397 degrees of freedom
Multiple R-squared:  0.01355, Adjusted R-squared:  0.008582
F-statistic: 2.727 on 2 and 397 DF, p-value: 0.06665

```

```

>
> #####
> # H6 – Budget mechanisms → Implementation rate
> #####
>
> df$Budget <- factor(df$`Gibt es in Ihrem Unternehmen spezielle Budget
mechanismen für Digitalisierung / Resilienzmaßnahmen?`)

```

```

>
> anova_H6 <- aov(`wie hoch ist die Umsetzungsquote von Digital-/Agilitäts-Initiativen?` ~ Budget, data=df)
> summary(anova_H6)
              Df Sum Sq Mean Sq F value    Pr(>F)
Budget           2   14.17    7.086   15.88 2.36e-07 ***
Residuals       386  172.26    0.446
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
11 Beobachtungen als fehlend gelöscht
>
> TukeyHSD(anova_H6)
  Tukey multiple comparisons of means
    95% family-wise confidence level

Fit: aov(formula = `wie hoch ist die Umsetzungsquote von Digital-/Agilitäts-Initiativen?` ~ Budget, data = df)

$Budget
              diff
lwr      upr      p adj
Ja, projektbezogen (Case-by-Case)-Ja, feste Budgetlinie 0.1982811 0.0
1092515 0.38563700 0.0351443
Nein-Ja, feste Budgetlinie -0.3372549 -0.5
9297467 -0.08153513 0.0058204
Nein-Ja, projektbezogen (Case-by-Case) -0.5355360 -0.7
6369356 -0.30737840 0.0000002

>
> #####
> # H7 - Macroeconomic pressure → Antifragility actions
> #####
>
> df$Makro <- df$`wie stark haben Sie in den letzten 3 Jahren makroökonomischen Druck wahrgenommen (Pandemie, Krieg, Inflation, Engpässe)?`
>
> df$Antifragil_Count <- sapply(strsplit(df$`welche Maßnahmen wurden in folge des Makrodrucks bei Ihnen verstärkt eingeführt? (Mehrfachwahl)`,
","), function(x) length(x))
>
> cor.test(df$Makro, df$Antifragil_Count)

Pearson's product-moment correlation

data: df$Makro and df$Antifragil_Count
t = 3.7805, df = 398, p-value = 0.0001805
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 0.08977306 0.27914165
sample estimates:
cor

```

0.1861859

```
>
> lm_H7 <- lm(Antifragil_Count ~ Makro, data=df)
> summary(lm_H7)

Call:
lm(formula = Antifragil_Count ~ Makro, data = df)

Residuals:
    Min       1Q   Median       3Q      Max
-1.686 -1.347 -1.007  1.314  4.653

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.98807    0.38002   2.600  0.00967 **
Makro        0.33967    0.08985   3.781  0.00018 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.719 on 398 degrees of freedom
Multiple R-squared:  0.03467, Adjusted R-squared:  0.03224
F-statistic: 14.29 on 1 and 398 DF, p-value: 0.0001805

>
> #####
> # END OF R DOCUMENTATION
> #####
```