Master thesis:

The effect of operational excellence paradigms on organizational resilience building

Katharina Brauel

MSc Business Administration, International Management and Consultancy

University of Twente

Supervisor: Dr. Desirée van Dun & Prof.dr.ir. Erwin W. Hans

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Abstract

Purpose: This paper aims to empirically assess how the micro-foundational capabilities of the operational excellence paradigms agile, lean, and six sigma contribute to building organizational resilience as a dynamic capability.

Design/methodology/approach: This research adopted an exploratory approach in which the operational excellence capabilities and their link to organizational resilience have been researched through a systematic literature review (SLR) and semi-structured interviews. A total of 40 academic articles and eight operational excellence consultant interviews have been included. The interview design has been predominantly guided by Duchek's capability-based conceptualization of organizational resilience (2020).

Findings: Results have shown that each paradigm has specific capabilities that contribute to developing organizational resilience as a dynamic capability. Agile enables high flexibility, quick adaptation in constantly changing environments, and rapid knowledge sharing. Lean enables targeted problem identification and rapid transformation through thorough process comprehension, and six sigma contributes to crisis management with its analytical and statistical approach, facilitated risk assessment, and a data and KPI-guided decision-making process. In consideration of Duchek's (2020) capability framework, research has, however, revealed that these capabilities mostly support the crisis coping and that there is a lack of paradigm support for the anticipation and adaptation skills relevant to resilience. This constitutes a critical weakness of the OE paradigms for the development of organizational resilience and the transformation of the organization on a larger scale. Additionally, a fuzziness in paradigm definitions has been identified resulting in a vague assignment of skills to paradigms and the indefinite differentiation of one paradigm from another. This research was not intended to provide a definite answer to becoming resilient but highlights capabilities contributing to that goal.

Research limitations: Limitations of the research included the too rigorous definition of the research quality criteria for the SLR search string and the strong focus on only one organizational resilience framework. Additional limitations included the lack operational excellence paradigm involved employee perspective, as well as the focus on only external crises.

Practical implications: Especially in perspective of the current disturbances and developments in world politics and economics, organizational resilience has become a requirement to survive. This research provides a clear overview of the micro-foundational capabilities of the various operational excellence paradigms that aid in building organizational resilience.

Keywords: organizational resilience, operational excellence, agile, lean, six sigma, micro-foundational capabilities, dynamic capabilities

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1. Introduction

Over the last two decades, organizational resilience has grown in importance for company survival and received increasing scholarly attention (Annarelli & Nonino, 2016; Duchek, 2020). Still in recovery from the global economic downfalls (McKinsey & Company, 2022; Mishra et al., 2020) and the strongly restricted trade of the Covid-19 pandemic (Mishra et al., 2020; Statista, 2022), organizations additionally faced further economic threats such as a high global inflation (Ozili, 2022), supply chain gaps and an increased investor risk sensitivity (Guénette et al., 2022) as a result of the geopolitical instabilities in the Ukraine (McKinsey & Company, 2022). Yet, despite the recently increased importance and more than two decades of organizational resilience research, the essentially required competencies to build organizational resilience remain unclear and one of the most significant research gaps in this subject. (Annarelli & Nonino, 2016; Duchek, 2020).

Defined and conceptualized in various domains and contexts, academia has acknowledged the importance of dynamic capabilities in the context of organizational resilience (Duchek, 2020). The dynamic capability view (DCV) enables organizations to utilize and bundle a variety of individual supporting capabilities, also referred to a micro-foundational capabilities, to adjust, incorporate, and reconfigure organizational resources and capabilities and build a competitive advantage in dynamic environments (Barreto, 2009; Wang & Ahmed, 2007). Nevertheless, it has been pointed out that, while relevant, the DCV does not provide an exhaustive representation of the building of organizational resilience (Mero & Haapio, 2022). Therefore, the complementation with concepts of different academic domains has been recommended of which some of these recommendations suggested the connection of the DCV with operational excellence and quality management methodologies (e.g., Gutierrez-Gutierrez et al., 2020; Manville et al., 2012; Swink & Jacobs). On this foundation, this research is dedicated to further explore the effect of operational excellence on organizational resilience as a dynamic capability and aims to identify supportive micro-foundational capabilities. Agile, lean and six sigma have been chosen to represent the operational excellence methodology as they have been profoundly studied and practically adopted in a variety of application contexts (Gubinelli et al., 2019). Originating from the software industry, agile enables flexibility and adaptability in dynamic and complex environments (Laanti et al., 2013). Lean has been introduced by Toyota and strives towards process waste reduction and process flow optimization (George, 2003), whereas six sigma describes a process and product optimization-focused analytical total quality management methodology (Ahmed et al., 2020; Truscott, 2003). Whilst research on the combination of these paradigms with resilience is still in its early stages (Habibi Rad et al., 2021; Rad et al., 2022), the first empirical links between operational excellence and resilience, and between the paradigms and the formation of dynamic capabilities, have already emerged. Insights have shown that whilst organizational agility provides more flexibility and faster adaptability in crises (Hussain & Malik, 2022; Küffner et al., 2022; Nold & Michel, 2016; Schmid et al., 2021), lean and six sigma benefit resilience through a transparent and quantifiable process risk assessment, higher efficiency and less resource waste (De Sanctis et al., 2018; Hundal

et al., 2020; Rosso & Saurin, 2018). Additionally, a direct link between the execution of dynamic capabilities and the agile paradigm (Gutierrez-Gutierrez et al., 2020; Mero & Haapio, 2022) and a positive effect of six sigma on dynamic capability formation have been brought forward (Gutierrez-Gutierrez et al., 2020; Manville et al., 2012; Swink & Jacobs, 2012; Yiu et al., 2020). Yet, even though promising, further research is needed to explore the effect of operational excellence on building organizational resilience as a dynamic capability. Thus, this paper is concerned with answering the question: *How can the micro foundational capabilities of agile, lean and six sigma support building organizational resilience as a dynamic capability?*

To address this research question, a qualitative research strategy using a systematic literature review (SLR) and semi-structured interviews among operational excellence paradigm specialized consultants was adopted. The thorough research insights gained by the SLR allow for the identification of relevant hypotheses and are further enhanced by the concepts identified in the primary research findings.

This research provides a unique view on building organizational resilience and contributes to academia by advancing the resilience and operational excellence literature. Especially in the perspective of the current disturbances and developments in world politics and economics, organizational resilience has become even more relevant than ever before. First, insights into the synergies of operational excellence and resilience are provided, whereas, different from most existing publications, the focus is on three different instead of only one operational excellence paradigm. This inclusive perspective creates an understanding of the unique micro-foundational capabilities of the paradigms. Yet, research has also provided a critical view on the qualitative research results and presented limitations of the potential support of the micro-foundational OEP capabilities for organizational resilience building. As this study domain is still immature, this study highly encourages further research in the future.

Regarding practical contributions, this research has worked towards providing comprehensive capabilities of academically and practically mature excellence paradigms that support building organizational resilience as a dynamic capability. The reader is provided with a clear overview of resilience-enhancing operational excellence paradigm capabilities as well as explicit action steps on how to evaluate the own organization and its implemented operational excellence paradigm. Lastly, apparent context factors are provided that describe the required prerequisites for the described resilience benefits of the operational excellence paradigm to take full effect.

The paper is structured as follows: chapter 2 presents the background and related work to introduce the different concepts that are addressed in this paper and serves as a foundation for the following chapters: chapter 3 entails the overview of the research process and the research methodology for the SLR and the semi-structured interviews. Chapter 4 presents the findings of the SLR, and chapter 5 describes the findings of the semi-structured interviews. The paper closes with the discussion and conclusion (chapter 6), the practical implications (chapter 7) and the limitations (chapter 8).

2. Related background

2.1. Organizational resilience

Initially rooted in psychology and physics, resilience has, over time, registered an increasing amount of academic interest (Reghezza-Zitt & Rufat, 2016) and also found use in other domains (Wiig & Fahlbruch, 2019), resulting in a diverse and highly context-dependent understanding of resilience (Walker et al., 2004).

The progression of time and the increase of crises and disturbances have led to a rise in organizational interest in the concept of resilience. While first recognizing the utility of withstanding a destabilizing event, the concept has been broadened over time (Reghezza-Zitt & Rufat, 2016). High academic popularity and various management perspectives (Xiao & Cao, 2017) have led to an extended understanding, including concepts such as recovery capability, times, and costs (Annarelli & Nonino, 2016).

Definitions or conceptualizations of organizational resilience are mostly highly contextualized; thus, a unified definition cannot be presented (Lengnick-Hall et al., 2011). Yet, more than two decades of academic interest and research have shown that the existing definitions can be divided into two (Lengnick-Hall et al., 2011) or even three interpretations (Duchek, 2020). The first group mirrors the aspect of bouncing back from a crisis (Wiig & Fahlbruch, 2019) as the core ability of resilience. Therefore, the interpretations only focus on the "ability to rebound from unexpected, stressful, adverse situations and to pick up where they left off" (Lengnick-Hall et al., 2011, p.244). Yet, different academics did not recognize this classification as sufficient and complemented this view. From the perspective of authors such as Coutu (2002) or Lengnick-Hall & Beck (2016), resilience also implies the crisis instigated acquiring of new skills and the identification of relevant and organization-strengthening opportunities. The most recent understanding, however, suggests a third property which not only refers to resilience as crisis management in the time of actual crisis but also includes elements of anticipation as a crucial element for the success of organizational resilience building (Duchek, 2020; Ortiz-de-Mandojana & Bansal, 2016). Adopting the latter viewpoint and therefore assuming that organizational resilience is to be considered far beyond the temporal limits of the crisis, a self-contained cycle is formed in which crisis anticipation, coping, and adaptation are the key elements (Duchek, 2020; Wiig & Fahlbruch, 2019). The research of Duchek (2020) presents a on past publications relying capability-based conceptualization of organizational resilience that includes a thorough description of the capabilities of each resilience stage as well as their main prerequisites and drivers. Her research describes anticipation as the monitoring and identification of critical developments and the preparation for unanticipated situations (Duchek, 2020). Within such, especially the capability of environmental scanning, as well as the development of adequate resources, relationships, and thorough process overviews, have been highlighted as particularly valuable (Crichton et al., 2009; Duchek, 2020). Helpful practices are for example scenario planning, market research or simulation trainings. Coping comprises crisis and change acceptance and adequate strategy development and implementation. Therefore, a profound environmental understanding, the continual sensemaking of actions and context, the ability to improvise, and a balance of planning, coordination, knowledge-sharing, and

creativity are required (Catalan & Robert, 2011; Duchek, 2020). The reflection of and learning from the crisis, as well as the capability of sustainably changing the organization based on the crisis learnings and opportunities, is described as adaptation. Reflection must occur on an organizational level and is considered to be a continuous learning process in which action and reflection continuously generate new knowledge. The generated insights then lead to organizational change entailing not only the change of current weaknesses but a development of new norms, values and practices enabling a higher resilience and better crisis preparation in the future (Duchek, 2020).

Prerequisites and drivers for building resilience-fostering capabilities and organizational resilience are, according to Duchek (2020), a well-developed knowledge base, sufficient knowledge sharing, the availability of resources, and a shared and experience-based power to implement change. Lastly, as each resilience stage imposes influence on the others, all three stages cannot be distinctly detached from one another and thus must be passed by the organization to become resilient. (Duchek, 2020). A visualization of Duchek's capability-based conceptualization can be found in figure 1.

Figure 1

A capability-based conceptualisation of organisational resilience (Duchek, 2020)
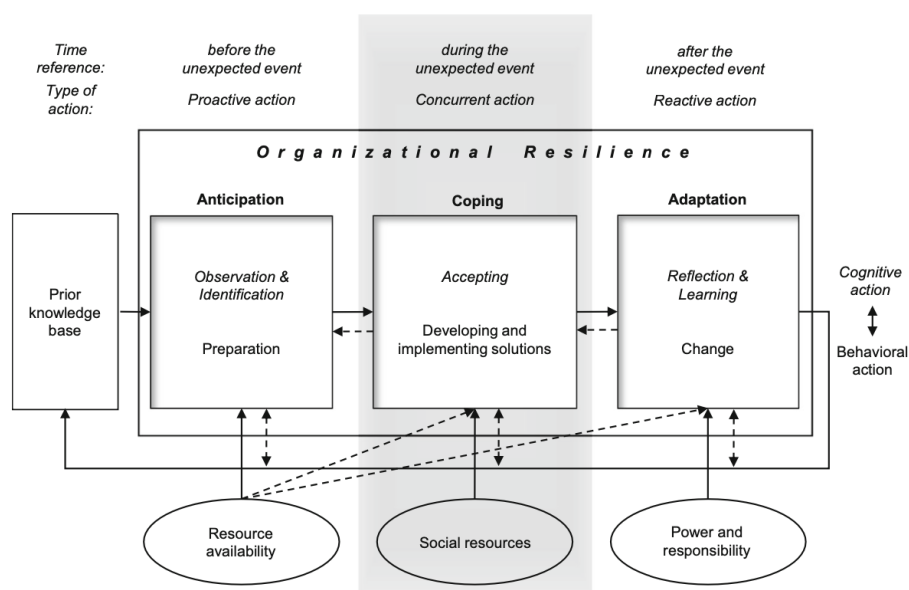
Yet, despite a multitude of research papers and conceptualizations of organizational resilience such as the one of Duchek (2020), a clear identification and empirical testing of the required capabilities of a firm to be organizationally resilient remains one of the leading research gaps in this domain (Annarelli & Nonino, 2016; Duchek, 2020).

2.2. Dynamic capabilities

Specifically for applications in highly volatile, fast-changing, and competitive environments (Barreto, 2009; Wang & Ahmed, 2007), the dynamic capabilities describe "the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments." (Teece et al., 1997, p. 156).

Although Teece et al.'s (1997) interpretation has been challenged several times since its publication (Barreto, 2009), most business management studies still refer to the foundation created by Teece today. The as high-level capabilities considered DCs are composed of sensing, seizing, and transformation capabilities, allowing for environment observation and opportunity identification (sensing), information interpretation and strategy development (seizing), and process, resource, and capability reconfiguration (transformation) in times of market change (Zahoor et al., 2022). Together, they enable organizational adaptation and learning and create and maintain a competitive advantage in dynamic environments (Helfat & Winter, 2011; Teece et al., 1997).

However, the DCV does not describe a complete and resilience-forming uncertainty response (Mero & Haapio, 2022). Therefore, the supplementation with other concepts, such as the operational excellence paradigms, has been suggested and empirically researched (e.g., Gutierrez-Gutierrez et al., 2020; Manville et al., 2012; Swink & Jacobs, 2012; Yiu et al., 2020; Mero & Haapio, 2022; Zahoor et al., 2022). Agile, lean and six sigma have been chosen to represent the operational excellence methodology as they have been profoundly studied and practically adopted in a variety of application contexts (Gubinelli et al., 2019).

The for this research purpose chosen operational excellence paradigms are introduced in the following chapter before further investigating the connection of these paradigms with dynamic capabilities and organizational resilience.

2.3. Agile

Simultaneous yet independent, "agile" software development and manufacturing have been developed as a response to the highly dynamic and volatile industry environments occurring in the 1990s (Kettunen, 2009; Highsmith & Cockburn, 2001; Sommerville, 1995). Yet, especially the introduction of the "Manifesto for Agile Software Development" has resulted in a rising popularity of the agile paradigm (Laanti et al., 2013). Its core values and principles aim to facilitate a more effective and sustainable operation with customer satisfaction, adaptability, competitiveness, collaboration, efficiency, improvement, and human resources at the core (Laanti et al., 2013).

Further evolvement of the paradigm also brought many definitions with altering emphasizes (Laanti et al., 2013; Sharma et al., 2021; Abbas et al., 2008) and altering interpretations forward (Abbas et al., 2008). However, commonalities can be seen in the interpretation of agile as an umbrella definition of tools and techniques (Abbas et al., 2008; Hoda et al., 2011), resulting in a strategically higher interaction, iteration, project planning, and business environment flexibility and a high customer orientation (Gren et al., 2020; Hassan et al., 2020) (Serrador & Pinto, 2015).

Collaboration, dedication, and efficiency in agile teams are ensured through the constitution of smaller teams (Project Management Institute, 2017; Uludağ et al., 2021). Yet, despite the scaling issues of agile frameworks for larger organizations and projects, academic interest is growing as agile practices present highly relevant benefits for such (Sunner, 2017) (Uludağ et al., 2021).

2.4. Lean

Introduced by the Japanese car company Toyota in the 1940s and globally popularized by the book "The Machine That Changed the World" (Womack et al.,1990), lean initially described an efficiency and quality improving method fixating on continuous process and productivity optimization and the waste elimination in manufacturing processes (Ballard & Howell, 2010; Gupta et al., 2016; Holweg, 2007).

The academic interest in the lean paradigm persisted to be high, resulting in a continuous evolvement of the method (Åhlström et al., 2021; Gupta et al., 2016). While the emphasis on waste removal and process flow assessment continues to prevail (George, 2003), the application scope and method understanding have changed throughout the past. The initially by Womack et al. (1990) claimed cross-industrially applicability has been invalidated by several authors (Bortolotti, Boscari, et al., 2015a; Cooney, 2002) and definitions have shifted to include a more client-focused interpretation (Alsmadi et al., 2012; Salentijn et al., 2021). The understanding of lean a collection of tools has been extended to the interpretation of the paradigm as a holistic philosophy (Gupta et al., 2016; Bhasin & Burcher, 2006; Bortolotti et al., 2015; Åhlström et al., 2021) including soft (fundamentals, management models, people, and relationships) and hard (technological and analytical methods) practices that contribute to the success of the lean adoption (Bortolotti et al., 2015).

Nevertheless, a holistic and comprehensible framework (Anand & Kodali, 2009), a clear effect statement of the soft factors on the effectiveness of a lean implementation, and a complete understanding of the effects of lean on the workforce, their working circumstances, and their performance are still lacking in the lean research domain (Salentijn et al., 2021).

2.5. Six Sigma

Introduced by Motorola in 1986, six sigma served as a method for variance and defect minimization (Ahmed et al., 2020; Chen et al., 2021; Qayyum et al., 2021) and has, with time, been further expanded to include aspects of corporate product and cost optimization and stakeholder value creation (Antony, 2007; Montgomery & Woodall, 2008).

Despite the lack of a unified definition, descriptions across industries and application fields mainly adopt the common understanding of six sigma as a process and product optimization-focused analytical total quality management methodology (Ahmed et al., 2020; Qayyum et al., 2021; Truscott, 2003).

The methodology is separated into a statistical and continuous improvement process aspect, enabling a statistical process performance and quality assessment (Truscott, 2003; Vincent et al., 2021) as well as a process resource and customer assignment and review (Truscott, 2003).

All six sigma processes are executed through problem-solving or process-optimizing projects with clearly identifiable yet purpose-depending project phases. The adequate composition of skills and competencies within the project teams is ensured through a to martial arts comparable belt system (Truscott, 2003). Such a system establishes an efficiency and collaboration-enhancing competency-based hierarchy and enables a clear development and training program (Truscott, 2003; Goh, 2010; Antony et al., 2019).

Six sigma has gained increasing popularity in the operational excellence domain (Qayyum et al., 2021) as a variance and expenditure diminution and a customer satisfaction increase are achieved simultaneously (Vijaya Sunder, 2015). Nevertheless, due to its similarities with the waste elimination (Patel & Patel, 2020) and customer focus of lean (Vijaya Sunder, 2015), a combination of both methods into lean six sigma has been proposed (Qayyum et al., 2021; Vijaya Sunder, 2015) resulting in quality, efficiency and stakeholder value synergies (Setijono et al., 2012). However, both cases require a substantial implementation investment (Antony et al., 2019) and the avoidance of a certification accomplishment fixation, a narrow-minded reliance on the statistical data, or the disregard for soft skills (Goh, 2010) to produce the benefits and synergies.

In retrospect, all three operational excellence paradigms are initially designed to enhance operational effectiveness and efficiency yet also bear limitations. While agile offers high flexibility in dynamic environments, scaling to larger teams and companies is particularly difficult. Lean reduces unnecessary waste or costs and strives for continuous improvement, but it has also been critiqued for its effect on existing production models and human resources. Last, six sigma enables a data-based reduction of product and process variation, which, however, is also associated with a high investment of potential soft skills negligence. A detailed overview of all discussed operational excellence paradigms can be found in Table 1.

Table 1

Overview of operational excellence paradigms

	Agile	Lean	Six Sigma
Definition	"The agile paradigm seeks to sense and respond rapidly and in timely manner to highly volatile and unpredictable demand or customer uncertainty" (Sharma et al., 2021, p. 1193)	"integrated multidimensional approach encompassing wide variety of management practices based on philosophy of eliminating waste through continuous improvement." (Gupta et al., 2016, p. 1026)	"a comprehensive and flexible system for achieving, sustaining and maximizing business success. Six Sigma is uniquely driven by close understanding of customer needs, disciplined use of facts, data and statistical analysis, and diligent attention to managing, improving, and reinventing business processes" (Pande et al., 2000 as cited in Braunscheidel et al., 2011, p. 425)
Purpose	Rapid responsiveness and opportunity identification in changing and dynamic business environments (Christopher, 2000; Piotrowicz et al., 2022) and the enhancement of customer satisfaction through cooperation (Van Hoek et al., 2001) and order configuration (Gligor & Holcomb, 2012)	The detection, minimization, and elimination of non-value adding waste (Piotrowicz et al., 2022; Qayyum et al., 2021), as well as cost reduction and continuous product and process improvement and a high customer focus (Moyano-Fuentes & Sacristán-Díaz, 2012; Vijaya Sunder, 2015)	Emphasis on lowering variance, expenditure diminution, and maximizing customer satisfaction (Vijaya Sunder, 2015).
Advantages	Flexibility and fast responsiveness to unpredictable and changing market environments (Piotrowicz et al., 2022), and a higher project planning flexibility and customer orientation (Gren et al., 2020; Hassan et al., 2020).	A decrease in set up times allows for a higher operational flexibility and increases the opportunities of cost savings (Sharma et al., 2021)	(1) clear, accurate quality evaluation and enhancement metric (Goh, 2010), (2) competence-based role allocation, (3) coherence of the statistical tools, (4) connectivity of the methodology with the present technology (5) consideration of the temporal consequences on processes, and (6) ability of organic and context adapting method evolvement (Goh, 2010) Certain degree of flexibility within project (Tkáç & Lyócsa, 2010) Clear competency-based hierarchy due to belt system (Antony et al., 2019)

	Agile	Lean	Six Sigma
Limitations	Supply chain may not be the most economical or least expensive due to required reconfiguration time and nonproductive cost (Putnik & Putnik, 2012; Sharma et al., 2021) Scaling of agile frameworks to larger teams and organizations remains difficult (Sunner, 2017) Multiple scaling agile frameworks aggravate the selection of the most suitable framework (Theobald et al., 2019)	Effect of lean adoption on existing production models and the human resources has been critiqued (Lewis, 2000) Influence of market circumstances on implementation success. Starting conditions and contextual factors result in a unique lean trajectory for every company (Lewis, 2000). Limited transferability to the service sector (Gupta et al., 2016)	(1) extensive initial investment (Antony & Sony, 2020; Sony et al., 2020), (2) high long-term adoption failure rate and the only short-lived benefits of the method, (3) insufficient implementation caused detrimental effect on both employee and client satisfaction, (4) the through the structured and narrow problem-solving approach induced decline of innovation and creativity, (5) debated universal applicability of the fundamental long-term variability measures, (6) bigoted data trust and variation decline focus (Antony & Sony, 2020; Sony et al., 2020), and (7) an unstandardized education system and high training costs (Antony & Sony, 2020; Hollingshed, 2022)
Tools and techniques	Scrum: a project management framework with the focus on incremental development. Small teams proceed through a planning phase, execution phase in form of sprints and a review phase (Sunner, 2017) eXtreme Programming (XP): popular agile method based on values of simplicity, communication, feedback, and courage. It is a lightweight, versatile, and effective method for creating software (Lindstrom & Jeffries, 2006)	Tools and techniques are selected purpose dependent and are often used in combination with each other. Most frequently used are techniques such as value stream mapping, Kanban, Pull production, Just in Time, 5S, cellular manufacturing or Kaizen (Bhamu & Sangwan, 2014). Authors have also distinguished between procedural and analytical tools (hard) and practices related to values, management and humans (soft) (Bortolotti, Boscari, et al., 2015b)	Environmental analysis: e.g., process mapping, statistical process protocols or control charts (Ahmed et al., 2020) System review: e.g., Analysis of Variance outputs, Fishbone Diagrams or Failure Mode and Effect Analysis (Ahmed et al., 2020) Critical indicators: e.g., Defects per Unit or per Million Opportunities, Cycle Time (Ahmed et al., 2020) DMAIC and DMADV: composition of the project phases depending on process purpose (Franken et al., 2021; Tkáç & Lyócsa, 2010) Belt classification of employees: master black, black, green, yellow (Antony et al., 2019).

3. Research Methodology

3.1. Research Design

The determination of organizational resilience-building capabilities as well as the influence of the OE paradigms on organizational resilience lack sufficient academic theorization and sufficient empirical evidence (Habibi Rad et al., 2021; Rad et al., 2022; Annarelli & Nonino, 2016; Duchek, 2020). Hence, an exploratory study approach was chosen and executed through a systematic literature review (SLR) and semi-structured interviews. The findings of the rigorous, replicable, and transparent SLR served as a foundation for the discussion of the interview findings. The semi-structured interviews allowed for exploratory open questions (Veal, 2006) and the inductive analysis of the primary data that was based on the Gioia method resulted in a creative and insightful, yet systematic, generation of new concepts and formulation of a grounded theory (Gioia et al., 2012). Both research methods contributed to the knowledge advancement on the micro-foundational capabilities of the operational excellence paradigms that enable building organizational resilience as a dynamic capability.

3.2. Systematic Literature Review

The SLR served to synthesize prior research, recognize research gaps, and provided context for novel research initiatives to be positioned correctly (Kitchenham, 2004). It enabled a rigorous, replicable and transparent process that minimized biases enhancing the robustness and reliability of the research (O'Brien & Mc Guckin, 2015; Petticrew & Roberts, 2006). The SLR was conducted on the basis of the guidelines provided by Wolfswinkel et al. (2011) as the incorporation of Grounded Theory method of Glaser & Strauss (1967) allowed for a complete and theoretically meaningful coding process and examination of a topic. Table 2 provides an overview of the SLR methodology outline that is further discussed in the following chapter.

Table 2.

Systematic literature review methodology outline

Preparation	Phase 1 – Definition of research objectives and research questions	
	Phase 2 – Selection and evaluation of relevant publications	1. Database selection 2. Inclusion and exclusion criteria definition 3. Creation and implementation of search string
Processing	Phase 1 – Analysis and coding of relevant literature	
	Phase 2 – Synthesis of relevant literature	
Results	Phase 1 – Presentation of findings	

3.2.1. Preparation phase

The purpose of this SLR is the examination of the paradigm characteristics as well as the exploration of the relationship between the OE paradigms and organizational resilience. On the basis of these objectives, the following **search strings** were created:

For agile: (agile AND dynamic capabilit*); for lean: (lean AND dynamic capabilit*); for six sigma: (six sigma AND dynamic capabilit*); and for organizational resilience: (organi? resilience AND lean OR agile OR six sigma).

The asterisk (*) has been included in the search term definition to ensure that articles with singular and plural denominations are displayed and the question mark (?) assures the inclusion of both British and American spelling of the search terms. The defined search string key words are searched within the articles titles, abstracts, and the keywords of the respective databases.

To ensure a high quality and robust SLR, further **inclusion and exclusion criteria** have been established and are presented in table two and three.

Table 3.

Inclusion criteria for the systematic literature review

Selection	Inclusion criteria	Justification
Database selection	Scopus and Web of Science	Both databases present two of the largest bibliographic databases and entail a diverse spectrum of source origins (Falagas et al., 2008).
Language requirements	English	As the research paper and the search strings are written and defined in English, articles have to be published in English as well.
Choice of time range	2012 - 2022	A time frame of 10 years prior to the review's departure point ensures the inclusion of the most recent research findings. Older yet relevant theory is considered if recent research is based upon or has incorporated said theory.
Choice of subject area	Management; Business; Social Sciences; Economics; Operations Research; Decision Sciences; Hospitality & Tourism; Multidisciplinary Sciences	
Journal and article selection	Article requirements: Empirical, peer reviewed Journal requirements: Journal Impact Factor (JIF) and Journal Citation Factor (JCI) in the Clarivate Journal Citation Reports™.: ≥ 1.5 JCI (agile, lean characteristics) ≥4 JIF (six sigma characteristics) or ≥ JIF 2 (organizational resilience and OE paradigms)	The criteria for the selection of journals and articles have led to a higher credibility of the sources and therefore positively contributed to the robustness of the SLR. Due to the high number of agile and lean publications, the journal citation indicator was used to research the paradigm characteristics. For six sigma characteristics as well as all other search strings, the JIF has been used as quality threshold. As the connection of resilience with the OE paradigms presents a low publication count, a lower quality threshold has been chosen to include a higher amount of papers discovering that relationship.

Table 4.

Exclusion criteria for the SLR

Exclusion criteria	Justification
Grey literature (i.e., reports, interviews, dissertations, conference papers, government documents or blogs)	Even though grey literature can benefit a SLR, the detection of false, misleading, or irrelevant assertions and the assessment of the overall quality is challenging and highly time consuming (Adams et al., 2017). This type of literature does not adhere the same the same standards of scrutiny as white literature resulting in a reduction of integrity and quality of the review.
Agile / lean / six sigma / organisational resilience without any specification	These keywords provide an excessively broad output of unrelated articles when used as stand-alone search terms.
agile manifest*	The "Manifesto for Agile Software Development" that has been published in 2001 and represents the foundation of a multitude of agile research papers (Laanti et al., 2013). Until today, many recent studies' definitions and conceptualizations of the agile paradigm are founded on the Manifesto. Consequently, while acknowledging this foundation, the key word angile manifest* in the title is due to its maturity and dated publication disregarded in favor of a more recent research outlook on the agile paradigm.

3.2.2. Processing phase. The analysis of the selected relevant literature has been executed through the application of grounded theory (Wolfswinkel et al., 2011). The assigned codes are separated into main categories relevant to the research and subcategories that have emerged through the coding process. Open codes allowed for a keyword-based data ladling whereas selective codes categorized emerging links between these primary categories. Axial coding then focused on the connection between the subcategories and the main categories. All selective and axial codes are displayed in Appendix 3. The comparative analysis used in the identification of a new category allows the researcher to incorporate the new categorizations into the existing construct and to look for further connections or sources and statements supporting the category and its connections. This constant comparing and matching allows for the continuous modification of concepts and connections. Consequently, the proceeding coding procedure of arbitrarily selected articles guide the analysis of further articles, also known as theoretical sampling. The analysis is performed until no new codes, categories or relations can be identified and the analysis can be considered complete and saturated (Wolfswinkel et al., 2011).

3.3. Semi-Structured Interviews

3.3.1. Sampling and Data Collection. To provide a multi-faceted insight into the relationship between OE paradigms and organizational resilience, business consultants specializing in at least one of the OE paradigms have been chosen as the sample. The consultants' vast expertise and experience in advising numerous organizations in their agile, lean, and six sigma strategies and their ability to compare the effect of such in different business contexts justify the sample's relevance to the thesis topic. Criterion sampling was

chosen as the appropriate sampling strategy for this research work because individuals are chosen based on their experience and their consultancy focus. Consultants and their firms were required to have at least five years of consulting experience in one of the respective continuous improvement paradigms, consult in multiple industries and organizational sizes, and present a clear strategy dedicated to at least one of the three OE paradigms. The 2022 consultancy rankings of https://www.consultancy.nl provided selection guidance for potential interview candidates. First contact with highly ranked consultancies from this list has been established through the professional network of the supervisor. These first contacts have further promoted the participation in the research within their company and professional network which has led to additional interview prospects. At least two interviews addressed each OE paradigm to obtain a multi-faceted spectrum of viewpoints and a better insight into the researched connection. The selection requirements were investigated through an intake interview with the corresponding key contact person. The answers to the intake interviews are presented in the table below.

Table 5

Results of intake questions

Participant	Experience Company	Experience Consultant	Consulting in industries like…	Client size
A	15 years	17 years	high tech industries, banking, insurance, the government, education	> 1.000 employees
B	13 years	1.5 years in consulting; multiple years of work experience in agile	H.R.; construction; innovative technology, publishing & elderly care	> 1.000 employees
C	30 years	30 years (15 years in the area of continuous improvement)	Process industry (liquids, oil, chemical production) & construction industry	> 200 people; some clients > 1.000 employees
D	13 years	7 - 8 years in consultancy	Care organizations, governmental organizations, production, FMCG	100 – 1.000 employees
E	8 years	3 - 5 years external consulting, 20 years internal consulting	Energy industry and construction	main customers: >10,000 employees
F	Decades of six sigma and lean experience	10 years of consulting. Six Sigma 3 - 4 years Lean roughly 10 years	Governmental organizations; I.T., telephone; oil and gas; insurance companies; pharma	usually mid-sized to big size
G	15 years	25 years	clients in various industries	mid-size and above
H	n.a.	9 years	financial services; public services; corporate services	at least >200 and mostly >1000

The respective consultants were contacted via email and the interview was conducted in English. It was clearly communicated that the interview participant is not receiving any reward or payment. Before the conduction of the interviews, each participant recdeived an information sheet introducing the researcher and the research topic and a consent form to sign indicating the use and processing of the collected data.

Prior to the interview, all interview questions and additional documents such as the research introduction were pilot tested by five individuals with different educational backgrounds to ensure understandability and answerability.

3.3.2. Interview design. The interview was designed to allow for a creative, multifaceted, and unforced response approach. Therefore, the interview questions have been formulated open-ended and purposely avoided focusing on specific aspects of the resilience and dynamic capability characteristics to allow the interviewees to freely express all elements associated with the question. This interview design further allowed for a closer elaboration on details as the interviewer was able to pose organically evolving follow-up questions throughout the interview process. To ensure that all topics previously identified as relevant were covered, the interview guide also included a range of possible follow-up questions.

The interview design was informed by the phases of dynamic capabilities, the resilience capability framework of Duchek (2020), and the resilience characteristics of Ambulkar et al. (2015). Thus, questions were formed according to sensing, seizing, and transformation attributes, as well as anticipation, coping, and adaptation phases (Duchek, 2020). The interview introduction and the final interview guide can be found in Appendices three and four.

3.3.3. Analysis of the Primary Data. Assisted by the Gioia methodology as well as the thematic analysis of Braun & Clarke (2006), the data analysis intended to identify the underlying information concepts and theory connections (Gioia et al., 2012) of the interview responses. The analysis was executed through the application of first-order concepts, second-order themes, and aggregated dimensions. While the first-order concepts served the sole purpose of filtering out relevant statements and keywords of the informants, the second-order concepts enabled the categorization of related first-order codes. Even though the literature had been reviewed prior to the primary data collection, the by the Gioia method intended partial ignorance of research-related literature was maintained. Thus, the primary data was reviewed and inductively coded with an open and unbiased mind to allow for newly emerging ideas and concepts to be explored. As Braun and Clarke (2006) advised, the researcher first familiarized herself with the transcribed data set through the recurrent reading of the given answers before continuing with the coding process. First-order concepts were generated based on the data set and remained very close to the original wording of the interview participants. The grouping of first-order codes into meaningful themes was informed by the continuous revision of the entire data set (Braun & Clarke, 2006) and was finalized by allocating an overarching and descriptive second-order code to the themes (Gioia et al., 2012). The second-order themes were further distilled through the composition of aggregated dimensions.

All three levels built the foundation for the composition of the data-informed grounded theory presented in the discussion chapter. The data analysis aimed to construct an evidence-based theory in a nascent research domain and connect such to previous research efforts identified in the SLR. Due to such nascence, this research does not intend to exhaustively and extensively explain a phenomenon but instead serves as a contribution to the evolving research field and a foundation for further investigation.

3.4. Validity and Reliability

Even though still highly associated with quantitative research, validity and reliability have also become essential concepts in qualitative research (Golafshani, 2015). Franklin et al. (2010) suggest various methods to maximize reliability and validity in qualitative studies. Internal reliability was increased through data triangulation, whereas external reliability was achieved through research decisions and evolvement documentation. Validity issues such as respondent bias and researcher bias were countered by a written and spoken introduction of the researcher and the research purpose to promote a trusting environment (Franklin et al., 2010). Peer debriefing implies a regular discussion of analysis results with one or more peers and the detachment of oneself from the analysis process through discussions and critical questions of the peer (Franklin et al., 2010). The peers in this research were the corresponding supervisors as well as fellow students unfamiliar with the topic. Through member checking and the semi-structured interview design, the researcher was able to ask for clarification throughout the interviews and thus avoided biased conclusions (Franklin et al., 2010). The resulting interpretation changes or identified interview weak spots were incorporated in the revisited interview design and the posed follow-up questions (Appendix 2). Noteworthy adaptations have, for example, been the inclusion of a crisis definition or the adaptation of SLR quality criteria to slightly lower journal impact factors.

3.5. Ethical Considerations

The use of semi-structured interviews required the participants to be informed about the research, the purposes for which the answers given will be used, and their consent. Thus, each participant received an informed consent sheet prior to the interview, which was signed and returned to the researcher. These contained a brief introduction to the topic and the background of the research and the researcher (Appendix 1), a clear list of the uses of the statements given, and a data protection and data use statement. Each participant was granted the right to withdraw their participation in the research at any time and thus have all data irrevocably deleted by the researcher.

All individuals involved in this research were treated with respect, and neither they nor any corresponding company was harmed by their participation in this research. To preserve the anonymity of the participants, all interview responses, as well as the transcripts, were allocated a letter. To enforce ethical data collection, the ethics committee of the BMS faculty of the University of Twente has approved this research (Nr. 230024).

4. SLR Results

4.1. Description of the corpus

The initial run of the search string resulted in 447 articles. After filtering for duplicates, JCI, and JIF, 110 articles were further screened for eligibility. The screening of the title, keywords, and abstract revealed 78 potentially research relevant articles that were further assessed for eligibility. Finally, 42 articles were included in the qualitative synthesis of which two contained information for more than one method (see Figure 2).

Figure 2

Overview of data selection
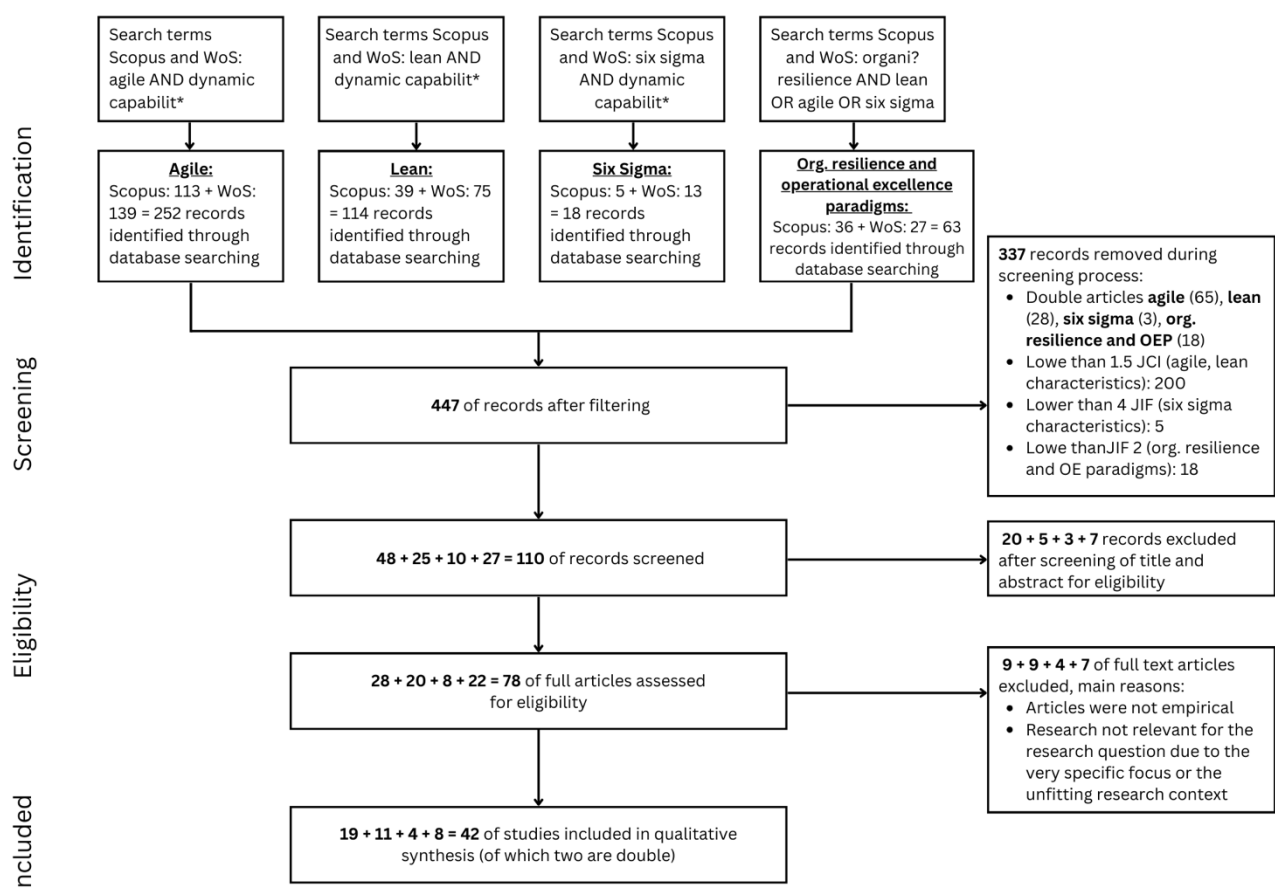
Table six provides insight into the used research methodology and research approach. The table entails the most common research methodologies (interview, questionnaire, or case study) and research approaches (qualitative and quantitative) as well as display the use of a different methodology and the use of a combined qualitative and quantitative research approach ("Mixed" column). Table seven indicates a high predominance of cross-sectional research (80%) as well as a repeated use of quantitative research (57.5%), including questionnaires (50%) resulting in a low representation of the long-term effects of the paradigms on firm and organizational resilience.

Table 6.

Research methodology, approach, and study in the corpus consisting of 40 articles

Author	Methodology				Research approach			Study	
	Interviews	Case study / studies	Questionnaire	Other	Qualitative	Quantitative	Mixed	Cross-sectional	Longitudinal multiple observations
(Alfalla-Luque et al., 2018)				Use of partial least squares structural equation model on a third party survey		x		x	
(Bortolotti et al., 2015)			x			x		x	
(de Sanctis et al., 2018)		x		Development and testing of resilience calculating model		x		x	
(Demeter et al., 2021)		x			x				x
(Dubey et al., 2022)	x		x				x	x	
(Fayezi et al., 2015)	x	x			x			x	
(Furlan & Vinelli, 2018)			x			x		x	
(Geyi et al., 2020)			x			x		x	
(Ghobakhloo & Fathi, 2020)	x	x		Observations	x				Long term case study
(Giacosa et al., 2022)	x	x			x				x
(Glover et al., 2015)				Field study with questionnaires		x		x	
(Gutierrez-Gutierrez et al., 2020)			x			x		x	
(Hundal et al., 2020)	x			content analysis	x			x	
(Hussain & Malik, 2022)			x	CB-SEM approach		x		x	
(Inman & Green, 2022)			x			x		x	
(Iyer et al., 2019)			x			x		x	
(Jafari-Sadeghi et al., 2022)			x			x		x	
(Kaufmann et al., 2020)			x			x		x	
(Küffner et al., 2022)				Delphi study	x			x	
(Lee et al., 2020)			x			x		x	
(Manville et al., 2012)	x		x				x	x	
(Mero & Haapio, 2022)	x				x				x
(Moi & Cabiddu, 2021)	x	x			x			x	
(Nath & Agrawal, 2020)			x			x		x	
(Nold & Michel, 2016)		x	x				x		x
(Qamar et al., 2018)			x			x		x	
(Rathore et al., 2020)			x	Review of sustainability reports			x	x	
(Ravichandran, 2018)			x			x		x	
(Roberts & Grover, 2012)			x			x		x	
(Rosso & Saurin, 2018)	x			participant observation, document analysis	x			x	
(Schmid et al., 2021)	x	x			x			x	
(Stålberg & Fundin, 2018)	x	x		Observations	x				x
(Swink & Jacobs, 2012)				Event study		x		x	
(Tekez & Taşdeviren, 2020)				Fuzzy analytic network analysis		x		x	
(Troise et al., 2022)			x			x		x	
(Vaia et al., 2022)		x			x			x	
(Yang & Yee, 2022)				Event study		x		x	x
(Yiu et al., 2020)				SFA; dynamic panel data model		x			Long term study
(Zahoor et al., 2022)	x	x			x			x	
(Zimmermann et al., 2020)			x			x		x	

Table 7.

Summary of research methodology, approach, and study in the corpus consisting of 40 articles

Methodology				Research approach			Study	
Interviews	Case study / studies	Questionnaire	Other	Qualitative	Quantitative	Mixed	Cross-sectional	Longitudinal
12 (30%)	11 (27.5%)	20 (50%)	14 (35%)	13 (32.5%)	23 (57.5%)	4 (10%)	32 (80%)	8 (20%)

Note. Other than in the research approach and study column summaries, the sums of the method column are not adding up to 100 as each publication may contribute to one or more method categories

Table 8 exhibits the journal distribution of agile, lean, six sigma and OE paradigm & organizational resilience articles in descending order. Most articles have been published in the 'International Journal of Production Economics' (8) followed by the 'Journal of Manufacturing Technology Management' (5) and the 'Technological Forecasting and Social Change' (4). The remaining journals comprise three or fewer articles.

Table 8.

Journal distribution of the articles

Journal	Agile	Lean	Six Sigma	OEP & org. resilience	Total
International Journal of Production Economics	3	4		1	8
Journal of Manufacturing Technology Management	1	4			5
Technological Forecasting and Social Change	3	1			4
International Journal of Lean Six Sigma	1		1	1	3
International Journal of Production Research	1	1		1	3
Industrial Marketing Management	2				2
International Journal of Operations and Production Management	1	1			2
The Journal of Strategic Information Systems	2				2
Applied Ergonomics				1	1
European Journal of Information Systems	1				1
International Journal of Hospitality Management				1	1
International Journal of Physical Distribution and Logistics Management				1	1
International Journal of Project Management	1				1
International Journal of Quality & Reliability Management			1		1
Journal of Business Research	1				1
Journal of Operations Management			1		1
Leadership and Organization Development Journal				1	1
Production and Operations Management			1		1
Progress in Disaster Science				1	1
Supply Chain Management	1				1
Tourism Management	1				1
Total	**19**	**11**	**4**	**8**	**42**

Note: two publications have contributed to more than one method category

A distribution of the publication years of all included articles can be found in Figure 3. Within the selected research boundaries, there were essentially no pertinent publications in 2013, 2014, and 2017, yet there was a publication peak in 2020 and 2022 with 24 published articles. Such peaks further emphasizes the rising relevance and academic attention of the thesis topic.

Figure 3.

Distribution of the selected articles (corpus) by year
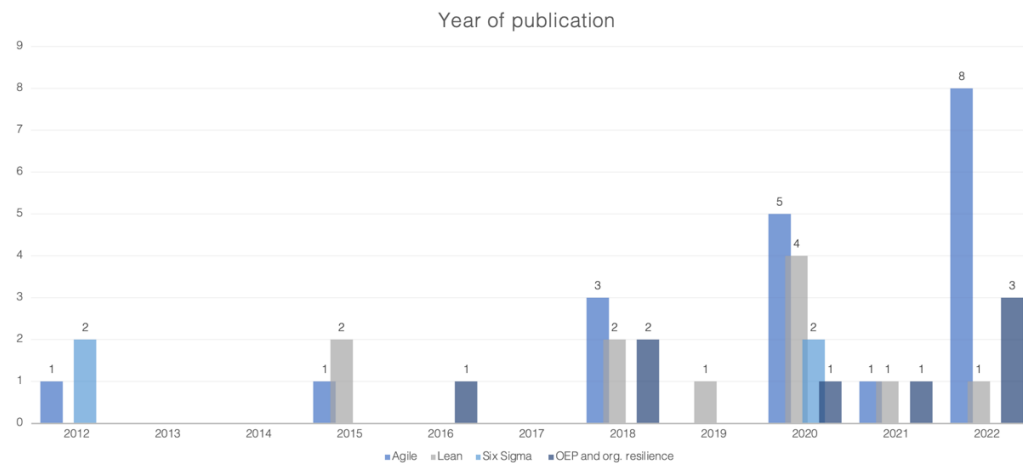
Note: two publications have contributed to more than one method category

4.2. Operational excellence capabilities

The following chapters provide an overview of the capabilities of all three operational excellence paradigms and show how these are linked to dynamic capabilities and organizational resilience to provide a first insight into which micro-foundational capabilities aid building organizational resilience as a dynamic capability.

4.2.1. Agile capabilities

Mostly adopted in the context of highly complex and dynamic environments (Geyi et al., 2020; Inman & Green, 2022; Zimmermann et al., 2020), agility comprises of a collection of capabilities and is a fluid conception that frequently emerges from strategy before influencing and guiding organizational activities and operations (Fayezi et al., 2015; Troise et al., 2022).

While commonly characterized as highly flexible and adaptable firms that are driven by customer orientation, continuous improvement, and collaboration (Fayezi et al., 2015; Lee et al., 2020; Moi & Cabiddu, 2021; Qamar et al., 2018; et al.), academia has also brought forward a variety of agility fostering factors (Jafari-Sadeghi et al., 2022). Thus, agility is particularly driven and leveraged by technological, innovation, and managerial capabilities (Jafari-Sadeghi et al., 2022; Ravichandran, 2018; Troise et al., 2022; Zimmermann et al., 2020) of which especially the strong interconnection of agility and IT competency and integration has been highlighted in recent research (Dubey et al., 2022; Giacosa et al., 2022; Jafari-Sadeghi et al., 2022; Lee et al., 2020; Ravichandran, 2018; Vaia et al., 2022). Additional agility-fostering capabilities constitute a well-established knowledge management and high relational capabilities (Jafari-Sadeghi et al., 2022; Moi & Cabiddu, 2021; Troise et al., 2022).

Further agility-fostering cause factors were identified by Kaufmann et al. (2020) and Geyi et al. (2020). While the former discovered a promoting effect of entrepreneurial orientation on agile capabilities and emerging strategy recognition, the latter found a reciprocal positive effect of agile characteristics and sustainable supply chain practices.

If sufficiently implemented and adopted, agile has positive effects on organizational, economic, and innovation performance (Alfalla-Luque et al., 2018; Geyi et al., 2020; Inman & Green, 2022; Ravichandran, 2018; Roberts & Grover, 2012; Troise et al., 2022; Zimmermann et al., 2020). However, that implies constant sensing and seizing of cliental and environmental changes and possibilities is required to attain this positive effect and a competitive advantage (Geyi et al., 2020; Mero & Haapio, 2022; Roberts & Grover, 2012).

4.2.2. Lean capabilities

Lean has been studied and applied in various contexts. Yet, when described, lean capabilities can mainly be allocated to the quality, cost, and delivery performance dimensions (Tekez & Taşdeviren, 2020). Amongst such, research indicated that the lean criteria Inventory Management, Process Quality Improvement, and Cost competency allocated to the cost dimension enhance the organizational leanness the most. However, according to Bortolotti, Danese et al. (2015), competitive performance capabilities are achieved through the strategic bundling of lean practices. This bundling, however, only proves effective with a dynamic and reinforcing fundament that supports the building of specific lean practices. The building of lean capabilities and the enhancement of performance is further supported by relational partnership resources in the form of collaboration abilities, which have been found to be essential for organizational growth and competitive advantage (Iyer et al., 2019; Bortolotti, Danese, et al., 2015).

In addition, authors identified the importance of innovation. Studies have, for example, shown a positive association of the innovation meta routines that are initiated by the lean practice "Just-in-time" (Furlan & Vinelli, 2018) as well as highlighted a positive association of exploitive and explorative innovation with environmental sustainability (Rathore et al., 2020).

Whether examined individually or collectively, lean practices have shown to positively impact organizational performance (Glover et al., 2015; Iyer et al., 2019; Nath & Agrawal, 2020). The identified synergetic effect of technological resources on organizational performance, as seen in the agile publications, was not reciprocated in the lean literature. Digitalization seems to only partially benefit lean management (Demeter et al., 2021), (Yang & Yee, 2022), (Ghobakhloo & Fathi, 2020) and is, as many other limitations, highly dependent on the research context, operating environment, and paradigm implementation maturity (Stålberg & Fundin, 2018) (Furlan & Vinelli, 2018).

4.2.3. Six sigma capabilities

In the past, six sigma has gained increasing popularity as a quality management methodology (Swink & Jacobs, 2012). Yet, despite the commonly shared characterization of cost, variation, and defect-reducing methodology, recent research has brought forward a more holistic characterization of the paradigm.

While researching the operating performance impacts of Six Sigma adoption, Swink and Jacobs (2012) found, aside from the commonly agreed upon positive effect on the reduction of direct costs, also a significant positive impact on the reduction of indirect costs. Such effects may be explained by the process variance reductions in labor-intensive and

repetitive processes; however, they only prove effective if the repetitive nature of the work does not result in high HR turnover (Manville et al., 2012). The positive association of Six sigma with an organization's capacity for information integration, organizational learning, and knowledge absorption capabilities noted by Gutierrez-Gutierrez et al. (2020) enhances the exploratory and exploitive knowledge and learning structures that ultimately lead to an improved organizational adaptability. Similar ambidexterity-increasing effects of six sigma were also observed by Swink & Jacobs (2012) and Yiu (2020). While Swink & Jacobs (2012) found a potential compatibility and even supportive effect of six sigma on growth-oriented innovation, Yiu et al. (2020) discovered an enhancing effect of Six sigma on the financial R&D investment returns. In both cases, the paradigm adoption enables a more effective handling of uncertainties and high operational complexity as businesses engage in innovation or R&D activities (Swink & Jacobs, 2012; Yiu et al., 2020).

However, such positive effects of Six sigma presuppose a high degree of senior management support and a strong integration into the company-wide business strategy.

4.2.4. Operational excellence and the role of dynamic capabilities

A strong link between the operational excellence paradigms and the dynamic capabilities has been repeatedly pointed out by the six sigma and agile literature (REFS). Six sigma research has shown a positive impact of the learning structures initiated by the methodology on dynamic capability building and highlighted the mediating effect of these structures on the link between Six Sigma methods and adaptability (Gutierrez-Gutierrez et al., 2020; Manville et al., 2012; Swink & Jacobs, 2012; Yiu et al., 2020). The introduction of Six Sigma and the development of dynamic capabilities, therefore, has a positive effect on the company's ability to flexibly and successfully assert itself in a dynamic business environment and to achieve a competitive advantage. (Manville et al., 2012).

However, agile research has shown a direct link between agile and building dynamic capabilities. Dynamic capabilities are successfully formed through the organic and agile transformation of systems and procedures, resulting in a high degree of organizational agility and flexibility (Gutierrez-Gutierrez et al., 2020; Mero & Haapio, 2022). The sensing, seizing, and reconfiguration capabilities implied in the dynamic capability methodology support strategic agility and are reinforced by agile practices (Zahoor et al., 2022). Thus, a strong sensing capability promotes better resource and competence recognition, whereas several agile practices and characteristics reinforce the seizing and transformation activities of the dynamic capabilities (Mero & Haapio, 2022; Zahoor et al., 2022). As a result, a mutually beneficial influence of both concepts, agile and dynamic capabilities, on each other is discernible. In conclusion, the learning structures of six sigma positively impact the building of dynamic capabilities and organizational adaptability, whereas organizational agility and agile practices benefit DCs and vice versa.

4.3. The relationship of operational excellence paradigms and organizational resilience

Some studies in our corpus revealed the first noteworthy links between the operational excellence paradigms and organizational resilience. Thus, organizational agility has shown

to mediate the relationship between seizing, transformation, and resilience as an agile mindset is required to fully seize an opportunity in adverse and disturbing events as well as aids in the transformation of resources for a higher firm resilience (Hussain & Malik, 2022). Furthermore, organizational agility has shown to promote a rapid crisis response as it brings a high level of speed and flexibility (Nold & Michel, 2016; Schmid et al., 2021). In a crisis, organizations are highly dependent on the strategic use of the stakeholder's tacit knowledge collection for the generation of new knowledge as well as on the effective interaction of culture, leadership, and systems to foster a fast and agile crisis response and adaptation (Nold & Michel, 2016). Research has further shown an agility and resilience enhancing effect of a high emphasis on the use of digital technologies (Hussain & Malik, 2022) and technological big data processing means as it allows for data-driven decisions and predictions of relevant operations (Dubey et al., 2022; Küffner et al., 2022).

Resilience-benefitting capabilities have also been identified in the lean and six sigma paradigm. The in the lean paradigm originated value stream and process mapping allow for a constant process review, the identification of bottlenecks, and the adaptation of processes to more resilient versions (Rosso & Saurin, 2018). The strong waste elimination focus additionally prevents the unnecessary use of resources that are otherwise needed for resiliency formation (Hundal et al., 2020; Rosso & Saurin, 2018). Six Sigma, in contrast, helps the organization build resilience through its statistical-analytical nature, as the data-based process analyses reduce output variation, increase effectiveness, and make the implementation and risks of innovations more predictable (Hundal et al., 2020). Such data reliance further enhances a more strategic decision making, which can be especially beneficial in crisis situations.

Higher resilience, reliability, and effectiveness, however, result from the combination of both paradigms. In combination, lean six sigma synergizes process mapping and data analytics and allows for a fact-based KPI monitoring and process risk assessment, ideal resource use and capacity prediction (Hundal et al., 2020).

Thus, whilst organizational agility provides more flexibility and faster adaptability in crises(Hussain & Malik, 2022; Küffner et al., 2022; Nold & Michel, 2016; Schmid et al., 2021), lean and six sigma benefit resilience through a transparent and quantifiable process risk assessment, higher efficiency and less waste of resources (De Sanctis et al., 2018; Hundal et al., 2020; Rosso & Saurin, 2018).

5. Qualitative Study Results

The analysis of the semi-structured interviews revealed that each of the operational excellence paradigms offers several micro-foundational capabilities and context requirements that support crisis coping and resilience building. The following section presents the data structure that emerged from the interviews and substantiates it with quotes from the original transcripts. Based on the previous secondary data research, it was again decided to clearly distinguish between the individual paradigms in terms of content in order to provide a coherent overview and to enable a linkage of the findings of both types of research. Furthermore, the term crisis has been explained prior to the interview as the pilot interviews revealed a potential for misunderstandings. The following figure presents 1st order concepts, 2nd order themes, and the aggregated dimensions of the primary research findings that have been identified through the application of the Gioia et al. (2013) method. Each aggregated dimension either represents a micro-foundational capability aiding building of resilience as a dynamic capability or introduces contextual requirements of the operational excellence paradigm to allow the micro-foundational capabilities to take full effect.

In light of the research question about how the micro-foundational capabilities of agile, lean, and six sigma support the building of organizational resilience as a dynamic capability, following findings have resulted from the analysis:

Figure 4.1.

Agile codes

1st order concepts	2nd order themes	Aggregated dimensions
Lower hierarchies due to autonomy at team level; quick reaction due to autonomy at team level; high individual autonomy enhances confidence and creativity; resource and process transformation benefits from the autonomy resulting expressional safety and creativity	Autonomy at team level	Fast adaptability and capability-enhancement through highly collaborative and autonomous cross-functional teams
higher flexibility through cross-functional teams; high frequency of interactions in cross-functional teams allows for better adaptation; faster risk identification through cross-functional teams; diversity of knowledge, skills and perspectives through cross-functional teams; cross-functional teams increases communication; high focus on context-relevant team formation	Benefits of cross-functional teams	
cross-functional teams promote personal capability development; capability formation benefits from experts of other departments; lacking capabilities in cross-functional teams can be compensated through the introduction of external experts; new capability formation requires openness to change and trial and error usage; agile allows for working with skill matrix; new capability formation benefits form clear skill overview of employees; capability formation through transparent communication of missing skills; capability formation through trainings, new employees or new team members; agile promotes constant evaluation of skills	Capability enhancement under the agile paradigm	
team-based work increases open discussion and innovation; team-based work increases open discussion and innovation; creativity is enhanced through open discussion ad feedback; safe team environment enhances innovation and creativity; agile promotes focused and team based work	Teamwork as innovation and creativity promoter	
iterational work places focus on the present without excessive future focus; constant review of environment, processes and risks through iterative work approach; iterations end with reflections; iterative and incremental work requires flexibility; agile sprints focus on the functionality rather than on perfection	Iterative working	Iterative work with a strong team focus
Teams reflect in the retrospective after the sprint; resource and process transformation benefits from retrospective; team reflection should be extended to company-wide reflection as sole team reflection is too narrow; company-wide reflection requires a more scaled up agile framework; complexity increases need for evaluation	Team-based reflection	

Figure 4.2.

Agile codes

1st order concepts	2nd order themes	Aggregated dimensions
interactions with stakeholders and environment enhances flexibility; agile sprints enhance stakeholder interaction; crisis coping promoted through interaction between the different teams with the stakeholders and the environment	Crisis coping benefits from stakeholder interaction	Inclusion of environmental requirements through regular customer interaction and high customer focus
good product owner combines internal and external stakeholders and context factors product owner monitors the environment	Environmental observation through product owner	
Customer focus is high in reflection activities; reflective moments with stakeholders; stakeholder discussions benefit the operational focus	Customer focused reflection	
agile promotes openness to change; high ownership in teams increases change and adaptation urge; direct crisis reaction due to closeness to the work floor; the urge for crisis coping is felt within the whole company	Promotion of change openness	Fast acceptance of crisis and change through the agile mindset
the continuous improvement mindset aids a quick response to crisis and fast implementation of solutions; continuous delivery allows for early feedback and improvements; continuous improvement culture implies constant optimization efforts	Positive effect of continuous improvement mindset on crisis acceptance and response	
agile reduces predefined job positions / descriptions; processes and task experimentation until success enhances resilience; the in the agile mindset included flexibility aids resilience and crisis coping	Resilience promotion through flexibility	
constant reflection improves decision making, faster adaption and thus faster learning; changing cross-functional teams increase faster adaption capability; quick adaptation due to customer value focus; agile mindset improves product development in complex situations; fast product and process adaptation required to ensure value delivery; monthly process evaluation; agile promotes focus on necessities; agile promotes goal-oriented work; resource and process transformation benefits agile-enhanced creativity	Facilitation of product and process adaptation through agile	Fast transformation and adaptation of resources and processes in crises
suitable for complex & unknown environments; resource and process transformation requires management support; flexible and experimental process design not applicable for already efficient and well-working processes	Contextual requirements	Contextual requirements

Figure 5.1.

Lean codes

1st order concepts	2nd order themes	Aggregated dimensions
The insights into the processes matter, not the methodology; lean promotes process waste elimination; process-oriented work approach aids in crisis coping; process-oriented organization promotes agility; clarity on processes and people; lean offers a good toolbox for working according to the flow principles and gaining an insight into the processes; good overview on gap between your goals and the current status; better understanding of the process gained through the root cause analysis	Achievement of process clarity	
Better identification and improvement of used production and machine capacity and operational equipment effectiveness by reducing waste through measuring facts	Measurement of process effectiveness	
Anticipation is included in lean paradigm; anticipation and coping of a crisis is supported through the direct and constant link to the shop floor; anticipation and coping require structural thinking about improvement; the pan, do, check, act cycle promotes crisis anticipation by considering the outside view; lean promotes problem identification and structured problem solving; a lean, organized process helps with crisis anticipation; anticipation requires well-organized processes	Crisis anticipation through process orientation	
Transformation or new design of processes are supported to assure adequate resources and adequate processes; lean promotes the efficiency and effectiveness improvement of processes and the right skill allocation to the tasks; lean aids crisis coping due to a better flow in processes; lean principles facilitate process change; lean mindset helps with the transformation of processes and resources; lean allows for a quick adaptation to a new situation caused by the crisis; adaptability is only achieved through a combination of lean and flexible mindset	Support of process transformation through lean	Better crisis anticipation and coping through high process-orientation and clear insights into the processes
Clear overview and understanding of work processes helps in better changing and adapting in crisis situations; clear processes and task allocations allow for better steering in crisis situations; one piece flow concept aids in process thinking and organization; change and adaptation is facilitated through the ability to think in processes in a flexible, lean organization; thinking in processes helps with decision-making and implementation speed if flexible mindset is given; deep, shared understanding of processes and tasks enables quick change without many needed instructions; process change is facilitated through clear overview of existing processes	Adaptation through clear process understanding	
Lean promotes standardization of processes and structures; standardization creates flexibility as the high standard can be easily adopted; lean standardization allows for a fast system adaptation; standardization of quality and working methods is critical to sustain improvement; standardization facilitates the transformation of resources and processes	Adaptation through standardization of processes	
Visual management, clear task allocations and descriptions and the process-orientation allow for a quick reaction and adaptation of the production volume in case of change; workplace visualization and organization allow for the fast identification of abnormalities without intensive training in the process; workplace visualization and organization allow for a quick understanding and operation of a process	Better adaptation through work place visualization	
Value stream mapping and simulations aid in transforming a process; value stream mapping can be repeatedly applied for continuously improving a process; lean highly aids in cooperating along the value chain in a more effective manner; value stream thinking influences process orientation of people; anticipation of a crisis requires a value stream management to maintain the quality and customer satisfaction focus	Process orientation through value stream approach	
Kaizen and value stream mapping help with the transformation of processes and resources; value stream mapping and scenario simulation aid in the testing of the new or transformed resources and processes; process flow, standardization, employee training and mindset allow for the transformation of resources and processes; tools such as the daily management board or the Kanban board can help organize the work around short term issues; policy deployment helps with setting a mission and a vision and translating them into shared company wide goals; a well-implemented policy deployment promotes decision and implementation speed; policy deployment is considering the outside environment of the organization; policy deployment allows for a clear ability and situation overview	Lean tools aiding in process and resource transformation	
Environmental observation through high customer focus; high customer focus allows for anticipation of customer demand changes, the end to end customer view does not help with proactively anticipating risks in terms of process breakdown; high focus on the voice of the customer implies constant market review; extension of lean alignment with suppliers improves crisis preparation; scan of customer insights for demand shift anticipation; communication along the customer value chain allows for changes and crisis identification; promotion of crisis anticipation through clear and understandable processes, role allocation and customer-focus	Customer focused work approach	Customer-driven anticipation of demand shift
lean aids in shortening the lead time of innovation development; lean is used for the process quality in innovation; highlighting of inefficient components in innovation process through simulation learnings; lean stabilizes a company; lean innovation requires agile paradigm; lean is not made for product innovation; conscious process planning (lean start-up) facilitates a holistic planning of innovation processes; innovation is starting with value proposition and the voice of the customer; lean includes the voice of the customer and map out the potential value streams when innovating; simulations facilitate an efficiency promoting process improvement freeing up time and people for innovation	Support of lean innovation meta-routines	Faster crisis acceptance and effective innovation process design through continuous improvement mindset
high openness to change due to quality and continuous improvement mindset; pure lean mindset already implies a constant change and adaptation state and mindset; quick process change is capable though the lean mindset, lean organizational structure and the general organization of the company; shared lean mindset results in shared waste reduction and continuous improvement effort; lean is more suitable than six sigma for responding to a crisis	Improved crisis acceptance due to lean mindset	

Figure 5.2.

Lean codes

1st order concepts	2nd order themes	Aggregated dimensions

Reflection through the daily stand up; reflection and anticipation moments in the week start; reflection moments within the whole organization are to some extent supported; promotion of reflection and adaptation in lean; reflection and learning is implicitly build into every lean practice; reflection as part of the root cause analysis; reflection is part of the lean methodology; separate section on reflection of both the result and the process; reflection depends on leader skills and usage of available tools and techniques; reflection helps in reacting and responding to change

Reflection as deeply rooted practice in lean → Strong reflection ability

Lean is people focused; employees should feel ownership and responsibility for their task and their work space; the ambition for high quality should become a natural behaviour for everybody; lean promotes honesty of employees to openly share identified issues; lean is about having an honest discussion on how things really are; to manage a crisis means real teamwork, humble behaviour, no ego are needed; resilience is achieved through better communication and cooperation; allowing to make mistakes, learning from them and correcting them is essential for everything; learning is part of the normal routine of people

The promotion of honesty, teamwork and continuous improvement in lean

Training within industry helps to quickly and efficiently train staff for certain types of jobs; different types of capability trainings can be offered by the company; the offered trainings by the company could lead to the uncovering of shortcomings or missing skills that need to be addressed through other trainings; lean helps with identifying lacking capabilities; the capacity management tool aids in identifying employees' capabilities; you can only develop if you are continuously improving your skills on the ways you are working; training within industry approach allows for the formation of new capabilities; interchanging employees in team rather belongs to the agile paradigm; the formation of new capabilities is highly dependent on the behaviour and characteristics of each individual organization and it people

Capability formation through training within the industry and the drive of constant skill development

Leaders can motivate employees to form new capabilities by leading by good example; learning a capability is something needs an eagerness to learn that needs to be encouraged and demonstrated by the leader and the manager; coaches can help in learning new capabilities; the formation of new capabilities requires feeling the safety to learn; the formation of capabilities is only possible if employees feel ownership of their tasks and responsibilities

The supportive and encouraging role of leaders and managers in the capability formation

Formation and support of improvement-oriented, industry trained employees

Human behaviour is more important the tools and methods when it comes to resilience; the key task of the manager is to install management systems to ensure that lean principles are working; leaders should define the principles of the behaviour to establish customer focus; managers should check on the employees on a daily basis; leaders should coach managers on getting the management system in place; leaders should coach the maintenance of quality, the instalment of a one piece flow system and the adaptation of processes according to the demand; leaders should live the lean principles; leadership is a key component in human behaviour; employees should be rewarded by simple quality improving ideas; the root cause of managing crisis lies on the shop floor; management behaviour is the basis of success; to manage a crisis, you have to be coaching on the shop floor; the management that makes lean effective, not vice versa; continuous improvement requires a safe and candid work culture

The role of the leader and the created work environment for effective lean principles

Lean is about working smarter not harder; lean is a holistic business improvement approach; lean is about the journey of the collective or the individual to apply the available improvement methodologies; lean is a tool to translate your goals throughout the entire organization; lean is about quality and not accepting waste in your production processes

Interpretation of lean

In a crisis, inventory requires a buffer to fight insecurities; Min. three people need to know one process to ensure flexibility and sufficient task coverage; companies benefit from an experienced lean practitioner when implementing lean; lean supports crisis coping if a proper structure is set up, help for the usage of the principles is provided and an honest and quality improving atmosphere is established; lean should be about flexible stock and inventory instead of pure inventory reduction; high maturity of lean implementation is needed for the quick change and adaptation benefits in a crisis; tools and methods only lead to long-term advantages if the entire company commits to a process-oriented work behaviour, all departments of the organization should be involved in resolving the identified bottlenecks to ensure operational flow; to benefit from lean in a crisis, lean needs to be embraced as a part of you and a part of your company; lean itself is never the solution but needs to be paired with the right change and adaptability mindset to cope with a crisis

requirements

Context factors determining the beneficial attributes of lean in crisis and resiliency

Lean often is integrated only partially throughout the organization and lacks mindset supportive personnel; larger organizations mostly only focus on the short-term financial gains; silo working structures with limited communication hinder resilience building; many organizations struggle with a short term focus; it is counterproductive if different departments have different KPIs that contradict each other; a fully lean implementation is difficult in complex organizations and is best achieved by starting as a lean company from the beginning on

Reasons for unrealised benefits of lean

Figure 6.

Six sigma codes

1st order concepts	2nd order themes	Aggregated dimensions

on a lower level lean and six sigma can help stabilizing processes; the Lean Six Sigma training aids in market change	Process stabilization in market change	
analytical view on a process and a better understanding of the customer aids in crisis coping; detailed insights into the processes and their optimization potential in a crisis; six sigma aids in judging the effectiveness and value of processes and increases the speed of analysis in case of abnormalities; various tools to analyse data at any maturity level; data focus allows for better understanding of the correlations of actions and outcomes; six sigma enables a correlation of root causes to measure the effectiveness of the taken actions, no particular reflective moments but a guiding constant	Analytical process insight and optimization	
Six Sigma includes process validation and the reflection of the out of control action plan that sets underperformance signals and determines actions and responsible people in case of such; constant evaluation of the effectiveness of the out of control action plan, its signals and its measures to regain control; the out of control action plan aids in identifying and controlling underperforming processes in a crisis; the out of control action plan helps in the quick evaluation of the usefulness of a process in a crisis; the out of control action plan is made for every KPI	Definition of clear abnormality indicators and crisis strategies in the out of control action plan	Highly structured, databased and predefined crisis coping
KPIs ensure a data driven optimization; six sigma supports data driven choices; the policy deployment ensures a strategic link of all projects to work towards the same organizational goals; reflection of process results and the KPI performance; policy deployment enables a clear understanding of the vision and the corresponding actions that need to be activated to steer through the change in a goal-oriented manner; the X matrix combines individual projects with the strategy KPIs; KPIs help to direct the business into the same direction in the event of change, align all projects and create a measurable goal and outcome	Crisis strategy alignment through KPIs and policy deployment	
Six sigma fosters a sustainable change mentality and a holistic view on possible performance failures; the failure mode effect analysis is a Six Sigma tool to define risk; proficiency of risk judgement through experience	Holistic view on possible performance failures	
Six sigma can measure the outcome analyse the process of innovations Lean Start-up combines lean and six sigma methods and enable a fast innovation Lean Start-up can help in a business stop to quickly start a new idea or business Crisis provide threats and opportunities for which either Six Sigma or design for Six Sigma is relevant Design for Six Sigma supports the set up of new processes as KPIs and processes are already designed Six Sigma conform	Support of six sigma innovation meta-routines	
Skill development should happen regardless of the situation; capability development automatically results in organizational development; the belt system results in a constant development of relevant capabilities and an improved drive of change	Constant personal development through the belt system	
Six sigma is only focusing on the own processes and not on the business environment; a slight shift in pure individual focus on business environment is noticeable; six sigma only aids performance monitoring not environmental monitoring; six sigma only solves quality problems; six sigma aids in performance monitoring and root causes identification	Process and performance monitoring of own processes only	
Six sigma is only able to influence the context factors directly related to your products and processes; resource transformation for quality improvement but not for market change; six sigma tools for data and fact driven statistical analysis to reduce variations; methods help in performance related crisis or change; six sigma aids with quality improvement and variance reduction in a crisis; six sigma is highly product focused and thus does not support a quick acceptance of a crisis; six sigma focus on operational excellence for existing products rather than on product leadership and customer intimacy; six sigma is not helpful with the survival ensuring profitability margin of a company in a crisis	Pure quality and performance focus	High emphasis on statistics and the operational excellence of the existing products
Crisis coping requires flexible processes; a need to take advantage of arising opportunities in a crisis; a mix of methods should be applied	Requirements for crisis coping	
Building continuous improvement maturity requires time; six sigma requires a stable foundation and dataset; resilience requires high maturity; the higher the implementation maturity, the more difficult the processes improvement as all improvements have already been implemented; a solid and well working managerial foundation is required before a continuous improvement culture and process waste reduction can be created; a stable and predictable outcome of that process is required for six sigma; the development of a higher continuous improvement maturity leads to an improvement guided mindset and company DNA encouraging employees to think process and quality orientated; the mindset and DNA remain intact during a crisis however also require years of prior fostering	Six sigma requires stability and a high implementation maturity	

5.1. Agile

Through its working methods and structures, flexibility, and shared mindset, agile has been described as a highly beneficial paradigm to manage crises and build resilience.

5.1.1. Fast adaptability and capability-enhancement through highly collaborative and autonomous cross-functional teams. Especially the work structures in form of cross functional teams have been mentioned as a repeatedly important component of crisis management. The high interaction and communication between team members of various knowledge backgrounds allows for open discussions entailing multiple perspectives which effects in a faster risk and opportunity identification and a higher reactional flexibility and adaptability, as shown by the statements of Participant A and B:

"You put different disciplines into one team and you make them talk a lot more" Participant B

"When you have close contact with each other, and interact a lot (...) then you have more chances to adapt where necessary" - Participant A

"(with a cross-functional team) you're identifying risks and opportunities faster...that will make you more flexible" - Participant A

The close interaction between different disciplines within one agile team and the regular team recompositing due to its project dependency facilitate a regular exchange of knowledge between the individuals as well as enable a more open conversation and feedback culture. This further allows for a speedy development of new capabilities and an increase of creativity and innovativeness. While available skills can be made visible through skill matrixes, transparent communication and an openness to a trial-and-error work approach and personal change are required to fully profit from the knowledge and capability diversity of cross-functional teams. In case of the complete absence of a skill in the different cross-functional teams, external expertise is required to compensate for such.

The high autonomy at team level fosters a feeling of ownership and an environment of safety in which employees feel free and encouraged to make self-directed judgements and decisions as well as act creatively and innovatively. Taken together, the interdisciplinary constitution of cross-functional teams, the autonomy and the high interaction between the team members thus enable a high environmental responsiveness and adaptability and a rapid transformation of resources and processes.

„If you work with other teams, you or other people start to develop the knowledge yourself a bit" - Participant B

"You're working with cross-functional teams (…) which brings different knowledge, different skills, different perspectives together" - Participant A

5.1.2. Iterative work with a strong team focus. Other beneficial crisis management and resilience characteristics also arise, among others, from iterative work design and team-based reflection. Working in iterations and sprints, in the for agile typical fast-paced and complex work environments, allows for an increased focus on the present and the functionality of the product or process which avoids spending too much time on detailing and perfecting the project when working in uncertain work environments. This short-term focus and experimental attitude thus leads to fast development of new ideas, products and

processes that remain adequate and relevant for the respective uncertain business environment.

"Making sure you work on things that work and that are needed in the moment, not on a plan far ahead." - Participant B

"In the sprints you keep away from making something perfect, you move on to a next subject" - Participant B

Whether within or after the sprint, team-based reflection is an integrated component that provides a regular review of the project-related risks and the created value.

"Every time you're looking, if you really make value or not, you consider risk again" - Participant A

"With an iterative approach (...) you are continuously busy with rescheduling, rethinking about things" - Participant A

Especially in the retrospective after each iteration and sprint the completed work is reflected which allows the teams to learn regularly from its experiences and to consider these learnings and any received feedback on the developed processes or products in the next iteration.

"Iteration ends always with a reflection moment, a reevaluation, a retrospective" – Participant A

Nevertheless, critiques on the retrospective include the requirement of a good scrum master to provide the described benefits as well as the narrow focus of the reflections. Especially in a crisis, a company-wide reflection through a more scaled-up agile framework would be required to accurately discuss organizational learnings.

"The retrospective is, of course, the moment to reflect but it requires a good scrum master of a group or good product owner to pinpoint that" – Participant B

"You need a more scaled up, agile framework to discuss that together" – Participant B

5.1.3. Inclusion of environmental requirements through regular customer interaction and high customer focus. The interview analysis further uncovered an advancement of crisis coping through the interaction between agile teams and external stakeholders from the business environment. Reflective moments with the stakeholders directly or with stakeholder in mind maintain a high customer focus and allow according to one interviewee even for a better focus and adaptation of resources and processes:

"in discussion with the stakeholders in the review, they keep changing where they should focus on" – Participant B

"you become more flexible because you are in interaction with your stakeholders and with your environment" – Participant B

Yet, while the interaction with the stakeholders does not seem to be restricted to a specific role, the same interviewee also explained that the monitoring of the environment however is the task of the product owner:

"a good product owner really listens carefully to the stakeholders and is really busy managing the internal world in the company, but also looking outside together with the developers" – Participant B

"(The product owners) keep their view on the outside" - Participant B

5.1.4. Fast acceptance of crisis and change through the agile mindset. Alongside agile practices and structures, interviewees also emphasized characteristics particularly conducive to crisis and change acceptance as well as adaptation to crisis-driven environmental change. Thus, interviews reveal that the openness and willingness to change is an embedded value in the agile mindset. Thus, the through the continuous improvement mentality constant optimization identification and implementation efforts have also been described to positively effect the respondence speed and efficiency when facing market changes or to crisis.

"the most important mindset is always being open to change" – Participant B

"(the continuous improvement mindset) can really help in identifying areas of improvement and implementing changes that enable the people to respond more quickly and effectively to market changes or to crisis" – Participant A

Additionally, the perceived urge and need to change in a crisis is reinforced by the teams' direct connection to operational activities and the high level of ownership within the teams. Thus, agile teams directly experience shifts in the business environment and are required to respond adequately. The in agile executed constant delivery also offers the same benefits, as the early feedback allows changes in the business environment and optimization opportunities to be identified quickly.

"there's more ownership in the teams, which makes it that the teams better feel the urge about changing and they change because you need the urge in order to make a change happen" – Participant B

"the force is really on the work floor (…), they can change what they are doing, so directly you react on a crisis" – Participant B

"Continuous delivery (…. allows the team to) get early feedback from the market and make adjustments where necessary" - Participant A

Lastly, interviewees especially highlighted the reduction of pre-defined job descriptions, processes or tasks, the exploratory and experimental work approach as well as the flexibility anchored in the agile mind set result in better crisis coping and higher resiliency.

"It is not predefined what your job is and what exactly you do and how exactly it works" – Participant B

"we try and experiment again and again until we find the right way and we're getting stronger every moment that we fall down and get up" – Participant A

5.1.5. Fast transformation and adaptation of resources and processes in crises. Aside from the promotion of change acceptance, agile has also been described to support the adaptation of resources and processes in crisis-driven environmental change. Interviewees reported that the agile paradigm's focus on value-based delivery and functionality requires a constant need to reevaluate and adapt operations which is thus leading to a facilitated resource and process adaptation in crisis situations. As the regular process optimization, evaluations and reflections implied in the continuous improvement approach and the regularly changing constellations of the agile cross-functional teams require constant adaptation regardless of the presence of a crisis, agile thus further enhances the resource and process adaptation capability of the individual as well as the team in a crisis.

"you reflect every day on how things are going and how things have went (...) you're able to make better decisions for how to improve in the future" – Participant A

"because you always, depending on your situation, meet in different team constellations, you are more likely to adapt quicker" – Participant A

5.1.6. Context factors for agile. While agile presents a multitude of crisis and resilience aiding capabilities, interviewees also emphasize the consideration of context factors in which agile performs best. Agile is, if properly supported by the management, especially beneficial in complex and uncertain environments. Thus, while praised for its flexibility and experimentation in uncertainty and environmental dynamisms, processes that are already effective and well working require a more efficiency focused and stable process design.

"(Agile) is especially created for the complex work where there's more unknown than known" – Participant A

"So if things are effective already, then stop with being flexible or experimental. So if you're effective already, then try to be efficient." – Participant A

5.2. Lean

Lean aids crisis management and resilience building especially through its process orientation. Clear, effective and well-understood processes support crisis anticipation, process transformation and adaptation. Additionally, lean has shown to have a positive influence on crisis acceptance and a promotion of honesty, environmental and processual attentiveness, communication and resilience. Yet, similar to agile, lean also required sufficient managerial support and contextual requirements to provide the described beneficial capabilities.

5.2.1. Better crisis anticipation and coping through high process-orientation and clear insights into the processes. The most frequently mentioned resilience and crisis relevant attribute of the lean paradigm is the high process orientation of the operational excellence methodology. Lean highly aids in cooperating along the value chain in a more effective manner and the detailed insight and understanding of processes, tasks and people allows for a better waste elimination, adaptation agility and objective tracking. In consequence, the in lean embedded value stream thinking and process orientation have been especially associated with a comparably superior crisis anticipation, process transformation and process adaptation.

"In a process-oriented organization, you are always agile" – Participant C

"(Lean helps to) see the gap between what you need to achieve and what there is now" – Participant D

Additional benefits of said process orientated work approach are the identification and improvement of ineffectively used production and machine capacity as illustrated by Participant C:

"Lean can help with identifying how much production capacity they actually use and how they actually could improve the amount of production capacity they have by reducing waste but then they have to measure facts" – Participant C

The in lean enforced process orientation further supports the crisis anticipation. Clear and well-organized processes, pan, do, check, act cycles as well as the direct and constant link to the shop floor promote problem anticipation, identification and structured problem solving. Especially the two latter allow for the inclusion of an external environment monitoring to some extend and allow for an immediate response.

"We day by day on the shop floor know what's going on which allows us to act immediately"
– Participant C

"a lean, organized process helps with crisis anticipation" – Participant D

"if your processes and your organization is a mess, then anticipation is not possible" –
Participant D

Yet, lean seems to support process adaptation and transformation most significantly. Thus, lean promotes the improvement of efficiency and effectiveness of existing processes, aids in the allocation of the proper skills to the corresponding tasks and supports adequate resource planning in the design of new processes. The consequential clear process flow and task overview allows for a quick situational adaptation and process transformation in times of crisis. Further, the deep and shared understanding of all processes allows for a high decision-making and implementation speed, a high openness to change and a speedy process transformation without many needed instructions.

Nonetheless, adaptability is only achieved through a combination of lean and flexible mindset, as Participant E highlights.

"I do think that lean is kind of the methodology we have in our back in our minds when we redesign processes to make sure that we have adequate resources and adequate process"
– Participant F

"lean is more used for how can we make the processes efficient, effective, how many people with the right skills and capabilities are in the process?" – Participant F

"if there is a crisis going on, the company would be able to adapt really fast to that new situation (as inventory levels and lead times are very low)" – Participant E

"you can change (your processes) with the lean principles very easily" – Participant D

"people have a deep experience and knowledge about the processes that they are working in, people do not need a lot of instruction to change things" – Participant E

"if you have a lean organization, you have your processes all clear, sorted out, then it's easier to change them" – Participant D

Aside from the clear and shared understanding of all processes, lean further promotes transformation and adaptation through the standardization of processes and the visualization of the workspace. Standardization is crucial for the sustainment of improvement, facilitates process change and allows for a fast adoption of high-quality standards. Consequently, interviewees expressed a gained flexibility and a faster system adaptation as the standardization allows for faster adoption of high standards. The workplace visualization further contributes to the crisis management and resilience building as it allows for a quick understanding and operation of a process and a faster identification of abnormalities without intensive training in the process.

"Standardization of the working method and standardization in general is critical because without standardization you cannot improve. If you do not have a standard, how do you actually sustain any improvement?" – Participant C

"Standardization creates flexibility because if you have a very good standard, then it's also easy to adopt the standard" – Participant E

"There are also some elements in Lean, like visualization. Workplace organization helps me to see even if I'm not trained in the process, I can see abnormalities very fast because it's visualized in some kind of a way" – Participant E

Lastly, lean offers a set of tools and practices that a of great value in crises. Tools such as scenario simulations or value stream mapping further support testing and evaluation of transformation processes and resources while strategic planning practices such as policy deployment aid in the design of a mission, the corresponding alignment of the organization and a consequential achievement of a faster decision and implementation speed .

"Use of value stream mapping and scenario simulation to test different scenarios and processes" – Participant F

"If you have the whole policy deployment part implemented in your organization, then it's really easy because they know exactly, how do goals translate through your organization from top to the to bottom" – Participant D

5.2.2. Customer-driven anticipation of demand shift. Aside from the considerably influential process orientation, interviewees also increasingly drew attention to the customer focus within the paradigm. While all participants saw a strong correlation between customer attention and anticipatory and environmental monitoring actions, there was a recurring reference to anticipating the demand shift. Accordingly, the statements show clear signs of anticipatory benefits in relation to customer interests, but similar benefits for anticipating risks and crises seem to be absent.

"You use the perspective of the end consumer, so you're always aware of the end consumer and what he wants and how it changes" – Participant D

"So I do think that especially lean with the end to end view could help to proactively look at process breakdowns" – Participant F

5.2.3. Faster crisis acceptance and effective innovation process design through continuous improvement mindset. While the benefits of lean in regard to adaptation and transformation have been extensively covered in prior paragraphs, the lean mindset likewise promotes the overall crisis acceptance. The constant changes and adaptations inherent to the continuous improvement methodology consequent a high level of acceptance and openness to crisis related changes which according to the interviewees sets the lean paradigm in regard to change acceptance apart from other paradigms such as six sigma.

"Because people are working according to the lean principle, just the general mindset helps with accepting a crisis because you're always striving to be better and to improve your quality" – Participant F

"If you need to change a process because it's lacking in speed or quality, people are more open to changing it because that's their mindset anyway" – Participant E

The lean mindset also supports the in a crisis required innovation of products and processes. The organization stabilizing ascendents of the paradigm as well as the tools and practices aid in the identification of process inefficiencies, allow for a holistic and customer orientated innovation process planning and shorten the lead time of the innovation. Yet, while the waste elimination, process orientation or process evaluation through simulation are of great significance when innovating, the actual development of new ideas has not been described as a characteristic supported by the lean and requires other operational excellence paradigms such as agile.

"The first step in innovation is the VPC (value proposition) and that details out the voice of the customer. And that is kind of lean thinking embedded in that process" –
Participant F

"The idea of this lean startup can also help a little bit with innovation because if you plan out beforehand the new process that you want to innovate, that's also very nice then" –
Participant E

"(to) make a stable organization (we use) lean and agile is more about new products and innovation" – Participant D

5.2.4. Strong reflection ability. Relevant for the resilience building are reflective activities as crisis learnings form valuable input for future crisis management or required organizational change. Nearly all interviewees implied a promotion of reflection under the lean paradigm. While some saw reflective practices mostly implied in lean practices such as the daily stand up, the week start or the root cause analysis, others described it as a separate practice to evaluate processes and outcomes. Regardless, review and reflection seem to be deeply rooted in the methodology, if leadership make proper use of the available tools and techniques.

"A lean thinker looks at learning and reflection. That's all implicitly built in every lean practice I would say" – Participant E

"There are tools and methods, but leaders should really understand that they are the ones who are actually driving the use of it" – Participant C

5.2.5. Formation and support of improvement-oriented, industry trained employees. Aside from the beneficial attributes for process adaptation and transformation, lean has been described to be a highly people focused methodology. The adaptation of lean as a holistic philosophy, the managerial understanding of the methodology and their role of as a leader as well as their provided support for their employees are crucial factors to properly benefit from lean in a crisis and in the process of building resilience. When properly implemented, lean principles build an empowered workforce that is committed to attaining excellence as well as demonstrate ownership and responsibility for their respective task and workspace. Honesty and expressional safety to openly share and discuss identified issues build together with high cooperation and a positive error culture the core of continuous improvement and resilience.

"Lean is also a lot about behavior and what you want in the crisis as well that people are honest and share all the issues they face and all the problems are on the table" –
Participant F

"You become more resilient through better communication, better cooperation" – Participant C

Employees are further supported in their capability formation through trainings within the industry leading to an efficient and practice dominated skill acquisition. Lean allows for the identification of paradigm-specific skillsets and shortcomings yet is deficient in supporting the formation of paradigm-atypical, crisis relevant and ad-hoc required capabilities. This results from the task and process-specific training, the lack of task rotation and the high dependence of capability formation on organization and behavior.

"With this TWI methodology, it is a very fast and efficient way to teach and train people to do certain types of jobs" – Participant E

"Lean will help to see where you lack and to know what new capabilities you will need" – Participant D

"(The switching around of people is more) moving towards agile already" – Participant D

Yet, success, resiliency and capability formation depend greatly on leadership and management behavior even more than on the principles in use. Ideally, leaders are defining principles of customer focused behavior and provide explicit managerial guidelines on the implementation and maintenance of a system of quality, process flow and demand dependency. The actual implementation of said system falls under the responsibility of the managers who should provide next to proper guidance and expertise on the lean principles also a hands-on, encouraging, and motivating management style that serves as an exemplary lean behavior for all personnel. The constant connection to the shop floor is required for all managers to gain an understanding of the adequate management systems and actions that need to be implemented. This is especially relevant in crisis situations. Additionally, manager's and leader's remit should include the reward of quality improving ideas, the motivation of employees to learn new skills as well as the demonstration of the eagerness to learn.

"Human behavior is the core of resilience and not so much the tools and the methods"– Participant C

"Lean itself is a fantastic concept. It's got great tools and methods. But behind it all is operational excellence, a way of living, a management style which is based on respect which is based on living the principles that you want to see quality, wanting to know the facts. That you want to continuously improve every day and that you show as a leader that you really take the lead in this" – Participant C

"Leaders should coach on principles like How do we maintain quality? How do we install a flow system which ensures that based on one piece flow that we can always see where is the waste? How can we ramp up? How can we slow down?" – Participant C

5.2.6. Context factors determining the beneficial attributes of lean in crisis and resiliency. Apart from the managerial behavior that is required to benefit from the lean paradigm to a full extent, further contextual factors have been mentioned as relevant.

To be crisis and resilience beneficial, the lean paradigm must be interpretated as a holistic business improvement approach that needs to be embedded and properly supported

throughout the organization. It should be implemented and communicated as a long-term solution and have a higher level of implementation maturity. While waste elimination remains an essential focus of the lean paradigm, flexibility adaptability have to be introduced in the mindset as well as into the inventory management as a slight surplus can highly benefit the organizational resilience in case of insecurities or crisis. Additionally, skill availability and facilitated personnel allocations can be ensured through the training of processes to multiple employees.

"We also use something like a skill matrix - we always say if you have one person who can do the task, you have no one to do the task. So, if you have three people who can do the same task, then you are way more flexible in moving around and shifting people and making sure you're still able to do everything you need to do" – Participant E

The failure of the paradigm or the lack of the described benefits is thus, according to the interviewees, mostly due to only partial or department specific lean implementation, silo working structures, the focus on short-term financial gains or the high complexity of large and well-established company.

"The larger organizations, they have very often financial KPIs which are shareholder driven and the big boards, again, they do not understand the lean principles and they only look for short term gains" – Participant C

"It is incredibly complex and difficult to create this lean culture in large complex organizations" – Participant E

5.3. Six sigma

Contrary to the in the agile and lean interviews mostly agreed upon influence of the respective paradigm on crisis management and resilience building, Six Sigma has brought a great difference in perspectives forward. While Participant H revealed several crisis and resilience aiding capabilities, Participant G described the paradigm as mostly unsuitable for non-quality related crises.

5.3.1. Highly structured, databased and predefined crisis coping. Known for its high analytical and statistical practices, six sigma provides a detailed and data-based insight into its processes allowing for a speedy identification and analysis of operational abnormalities and a targeted process optimization in a crisis. Further, an understanding of actions and their correlated outcomes is fostered which allows for a clear effectiveness judgement of crisis responding and resilience building actions.

"The tools of lean and six sigma provide you with a good insight into your own processes and optimizing them in a crisis" – Participant G

"When I think about six sigma then I think about figures and KPIs and focus on the KPIs and also deviations or root causes and their correlations. Because that's also a six sigma part. (With measuring) your correlations that you really are sure that the change or the outcome you see is really the result of the actions you have taken. So, it's an important capability in a crisis because there is the need to take the right actions, at the right time, in the right place." – Participant H

The strategic alignment and the vison and goal orientation of the crisis management action plan and the process optimizations are thereby ensured through policy deployment and a clear definition of key performance indicators (KPIs). KPIs further allow for the definition of measurable outcomes as well as require the design of an out-of-control action plan stating exact thresholds, actions, and responsible individuals in case of performance deviation or underperformance. Both, the KPIs and the corresponding out of control action plans are reviewed and validated on a regular basis to assure the quick regaining of control in case of abnormalities such as a crisis. Tools such as the failure mode effect analysis further aid in the definition of risks and further add to the holistic view on possible performance failures and out of control scenarios. The advancement of relevant capabilities and the change drive are fostered through the belt system. Yet, while helpful for crisis significant skills, such skill development should be a situation independent undertaking.

"I really think in KPIs. If you like to change your business, then you need to change your behavior or you need to change the focus. And when you change your KPIs and give focus on what you like to achieve, and as you are fully focused on your action plans, all your innovations, all your focus, your operational organization is focused on all the KPIs, and then then you make your change." - Participant H

"You can say your policy deployment is a very important tool as a capability. Let's say, we have a vision and we are striving to go into one direction and we need to activate that direction. Not all the people might understand what the next steps are. Six sigma and the policy deployment are helping us to activate projects to change. I think that this is really helping in a crisis situation because then you say, my direction is changing, what kind of projects we need to realize to make the change happen" - Participant H

"In six sigma, you need to validate after some time, three months or a year or two years. And then you look back and evaluate if the out-of-control action plan really working or not. And all the black belts are able to perform that." - Participant H

"The structure of six sigma is that those who have a master black belt understand what kind of projects we need to define and it is important that you have black belts and green belts in the organization that are really driving the change." - Participant H

The high analytical and fact-focused attributes of six sigma can further support innovation to some extent. Similar to lean, six sigma proves ineffective in the design of new ideas or products yet provides tools to evaluate the innovation processes and outcomes. In combination with lean, six sigma is further capable of speed up the innovation lead time as well as the setup of new processes.

"For innovating, you can use six sigma to measure the outcome and your processes." - Participant H

"The lean startup method is, I believe, proof that some of the pieces of lean and six sigma are helping to innovate. And when there is a crisis, you need to innovate very fast" - Participant H

5.3.2. High emphasis on statistics and the operational excellence of the existing products. Six Sigma has been described by both parties as highly quality fixated with a nearly

exclusive focus on the organization specific processes. The paradigm predominantly aims at statistical performance and quality monitoring and variance reduction and consequently enables process and resource transformation dedicated to quality improvement. Yet, the high product attention, the emphasis on operational excellence of the existing products and the reliance on statistical analyses neither support environmental observation nor a quick crisis acceptance and greatly disregard the in a crisis required flexibility and innovation.

"The focus only on your own processes is shifting towards also considering data from your environment" - Participant H

"Six sigma is to make the best products or the best service without any mistakes. So very stable. Very predictable. No mistakes, but that is all product oriented (and thus is not helping with a quick acceptance and response to a crisis)" – Participant G

"You can only transform your resources in order to improve quality, but not transform resources and processes to deal with market change" - Participant G

Furthermore, the statistical process performance and quality assessment tools and methods described in Six Sigma require a predictable process outcome and a stable dataset that can only be achieved through a high implementation maturity level of the continuous improvement methodology. Such maturity however is only gained with time as a solid managerial foundation, a continuous improvement culture and waste free processes need to be established before applying statistical analyses for variance reduction. Consequently, mentioned benefits only apply if the high level of implementation maturity has been fulfilled. Once fully matured, there is barely any ability to further improve as all improvements have already been implemented.

"If your process is not stable and the basics are not there, it does not make sense to use six sigma because you start to use the statistical tools on an unstable dataset, which is not allowed." – Participant G

" (If you have a high maturity of six sigma implementation) and there's a crisis coming, they cannot make it more perfect. They are already on a very high level. So maybe the better you become the more difficult it is to improve" – Participant G

"If the company started to work on operational excellence they start, of course, on the lowest level and they work their way up. Creating a solid foundation has not that much to do with lean and six sigma. It's just making sure that the basics of the management system work. The second level is about creating continuous improvement culture, when you apply simple tools to solve problems. On the third level, you start reducing the waste inside the process. So level three is lean. Only if you have a stable and predictable outcome of that process you can use the data from that process to reduce variation on level four. That is six sigma." – Participant G

6. Discussion and conclusion

The findings of the semi-structured interviews have provided a first insight into the connection of the micro foundational capabilities of each paradigm and the connection to crisis management and resilience building. The interview structure allowed for precise targeting of the resilience relevant crisis anticipation, coping and adaptation capabilities (Duchek, 2020; Wiig & Fahlbruch, 2019) as well as the sensing, seizing and transformation capabilities (Zahoor et al., 2022) of dynamic capabilities. The following paragraphs shortly summarize the in the conceptual model (figure 6) visualized research findings and draw the link to the previously conducted SLR and the extension of the organizational resilience and dynamic capability theory.

Figure 7.

Visualization of micro-foundational capabilities supporting the organizational resilience capabilities and DC stages

Anticipation
Sensing

Not supported capabilities and practices
- Environmental scanning practices
- Scenario planning
- Simulation trainings

Coping
Seizing & Transformation

Fast adaptability and capability-enhancement through highly collaborative and autonomous cross-functional teams
- knowledge and capability diverse teams
- transparent communication and the constant recomposition of teams promotes regular exchange of knowledge and capability formation
- high ownership and autonomy at team level encourages self-directed decision-making and innovation
- Flexibility, high environmental responsiveness and the speedy development of new capabilities

AGILE

Iterative work with a strong team focus
- high focus on the present and the functionality of the product or process
- fast development of new and context relevant ideas, products and processes

AGILE

Fast acceptance of crisis and change through the agile mindset
- constant search for optimizing modifications through continuous improvement mentality
- flexibility and adaptability in complex and dynamic environments
- closeness to shop floor increase crisis acceptance and perceived need for change

AGILE

Inclusion of environmental requirements through regular customer interaction and high customer focus
- customer guided product development and regular product reviews

AGILE

Fast transformation and adaptation of resources and processes in crises
- constant need to reevaluate and adapt operations of value-based delivery leads to a facilitated resource and process adaptation
- regular reflection and evaluation of project-related risk within cross-functional teams

AGILE

Better crisis anticipation and coping through high process-orientation and clear insights into the processes
- enables detailed insight and understanding of processes, tasks and people
- value stream thinking and process orientation especially promote crisis anticipation, process transformation and process adaptation
- identification and improvement of ineffectively used production capacity
- clear process overview allows for efficiency and effectiveness improvements, waste reduction and the allocation of skills to corresponding tasks for adequate resource planning
- process clarity throughout the organization increases decision and implementation speed
- process orientation fosters high openness to change and a speedy process transformation
- standardization are crucial for sustaining improvement and allow for flexibility and a faster system adaptation

LEAN

Customer-driven anticipation of demand shift
- anticipatory benefits in relation to customer interests
- *lack of anticipatory benefits in relation to risks and crises*

LEAN

Formation and support of improvement-oriented, industry trained employees
- with sufficient management support, lean principles build an empowered workforce that is committed to attaining excellence
- Honesty and expressional safety, high cooperation and a positive error culture are the foundation of continuous improvement and resilience
- capability formation through trainings within the industry
- resiliency and capability formation depend greatly on leadership and management behavior

LEAN

Highly structured, databased and predefined crisis coping
- speedy identification and analysis of operational abnormalities and a targeted process optimization through statistics and data focus
- understanding of actions and their correlated outcomes is gained
- policy deployment and KPIs allow for strategic alignment and the vison and goal orientation of the crisis management
- KPIS create measurable outcomes and define the out-of-control action plan

SIX SIGMA

Adaptation
Transformation

Not supported capabilities and practices
- Radical innovation
- Continuous reflection on an organizational level
- Development of new norms, values and practices (shift of current business model)

Strong reflection ability

LEAN

The agile paradigm has been shown to provide several micro-foundational capabilities to promote a rapid crisis response and high reactional speed and flexibility, leading to further empirical support for the findings of Nold & Michel (2016) and Schmid et al. (2021). The highly customer, continuous improvement, and collaboration-driven agile paradigm is particularly distinguished from other paradigms by its high degree of flexibility and adaptability (Fayezi et al., 2015; Lee et al., 2020; Moi & Cabiddu, 2021; Qamar et al., 2018; et al.) in complex and dynamic environments (Geyi et al., 2020; Inman & Green, 2022; Zimmermann et al., 2020). Research results highlighted that the crisis-coping capabilities of organizational resilience (Duchek, 2020), as well as the seizing and transformation activities of the dynamic capabilities (Mero & Haapio, 2022; Zahoor et al., 2022), are promoted and reinforced through agile. Crisis acceptance and the recognition of a necessary change are similar to lean, fostered through the continuous improvement mentality, the high customer focus, and the work on the shop floor. The work distribution in sprints and iterations allows for an increased focus on developing functional and business environment-adequate products. Capabilities such as flexibility, high environmental responsiveness, and the speedy development of new capabilities are particularly endorsed through the interdisciplinary constitution of cross-functional teams. Similar to the research of Alfalla-Luque et al. (2018) and Geyi et al. (2020), the findings also suggest high innovativeness under the agile paradigm as the high autonomy at the team level fosters ownership, creativity, and proactive decision-making. Lastly, crisis adaptation and reflection are supported by regular reflections, process evaluations, and project-related risk assessments within the cross-functional teams at the end of each sprint.

While lean, like agile, has been shown to support crisis coping and adaptation, the paradigm has demonstrated a range of seizing and transforming capabilities that arise from the strong value stream and process orientation. Similar to the findings of Hundal et al. (2020) and Rosso & Saurin (2018), the research revealed a promoting effect of the detailed and shared process understanding and standardization on continuous improvement, rapid and facilitated process transformation, the faster adoption of high standards and the efficient design of innovation processes (c.f . Furlan & Vinelli, 2018). The sensitivity to change resulting from the closeness to the shop floor further adds an anticipatory capability to the in lean-embedded process orientation. If implemented holistically and with sufficient management support, the lean paradigm has the power to build an empowered, excellence-striving, and responsible workforce. Driven by the continuous improvement mentality, honesty, and the by Iyer et al. (2019) & Bortolotti, Danese et al. (2015) stated high level of cooperation lean trained workforce further strengthens the company's resilience.

Six sigma is considered to be highly inflexible and dependent on predictable, stable environments. While crisis acceptance and anticipatory capabilities are not fostered in the paradigm, research has found micro-foundational capabilities that are considered favorable for crisis management and resilience building. The statistical-analytical nature fosters, as indicated by Hundal et al. (2020), data-driven and KPI-guided decision-making, a clear action effectiveness judgment, and promotes risk and process predictability. The alignment of the company's crisis and resilience strategy is enforced through policy deployment, and

KPIs define measurable goals for the crisis strategy and the out-of-control action plan. The by Manville et al. (2012) described positive effect of six sigma on enhanced flexibility and competitive advantage in dynamic environments, and the by Furlan &Vinelli (2018) identified supportive effect of on growth-oriented innovation could, however, not be supported through these findings.

Lastly, contextual requirements must be considered to allow the micro-foundational capabilities to take full effect. Those include a high paradigm commitment, sufficient implementation maturity, and a high dedication to continuous improvement. Additionally, leadership and structural support need to be provided. Finally, the overall organizational goal, the business context, and paradigm purpose are of necessary consideration to provide a holistic picture of the potential benefits and its respective application possibilities in building resilience as a dynamic capability.

In light of these results, it can be concluded that each of the paradigms has specific capabilities that contribute to the development of organizational resilience if the contextual requirements are considered. Agile enables high flexibility, quick adaptation in constantly changing environments, and rapid knowledge sharing. Lean enables targeted problem identification and rapid transformation through thorough process comprehension, and six sigma contributes to crisis management with its analytical and statistical approach. All these capabilities support the organizational resilience capabilities mentioned in Duchek (2020) and extend them with new aspects such as the usefulness of statistical data, the relevance of in-depth process knowledge, and the advantage of cross-functional teams and iterative planning.

However, not all resilience capabilities from Duchek's (2020) capability-based conceptualization are equally supported by the micro-foundational capabilities of the OE paradigms. It becomes apparent that the coping capability is particularly strengthened and expanded through agile, lean and six sigma as most identified micro-foundational capabilities support the crisis and change acceptance and adequate strategy development and implementation. The anticipation and adaptation capabilities, however, are hardly considered in any of the paradigms. While the exchange with customers and stakeholders or the regular reflections are helpful, they are insufficient to master these relevant resilience capabilities to the extent described (c.f. figure 7 for not supported capabilities) (Duchek, 2020). Such inadequate support for anticipation and adaptation reveals, apart from the need for capability complementation, a critical weakness of the OE paradigms for organizational resilience. Although all three paradigms offer various capabilities for incremental and situation-depended change, they do not support the radical change or innovation required for resilience building and organizational advancement.

Further relevance should be attributed to the fuzziness of the paradigm definition that has emerged from the analysis. Even though the referenced publications in the SLR and the structure of the findings of this research make a clear distinction between agile, lean, and six sigma, such a clear demarcation proves to be difficult. It can be seen that each paradigm has various specific skills and practices that recur in the interviews but overlaps with other paradigms are also recognizable. Although this definitional fuzziness did not directly

influence the effectiveness of the identified micro-foundational capabilities per se, it does indicate that within the scope of this research it is not possible to uniquely assign the capabilities to clearly discernible paradigms.

Despite the identified deficiencies, the study has revealed various OE paradigm-related, resilience-supporting micro-fundamental capabilities that, due to the strong focus on coping, still require supplementation by additional capabilities to cover all the resilience capabilities described by Duchek (2020). This research was not intended to provide a definite answer to becoming resilient but highlights capabilities that contribute to that goal.

7. Practical Implications

Whether comprehending the own organization and applied paradigm in the context of crisis and resilience, the evaluation and extension of resilience building capabilities or the crisis and resilience strategy design, this research finds applicability in all of these areas. The findings provide a basis for a thorough evaluation of the own micro-foundational capabilities and implementation maturity, offer a prospect to potential gaps threatening the capability of organizational resilience in the face of crisis as well as encourage to expand the capability pool with methods and tools that fit the business context and strategical aim. A clear strategic and operational understanding and an organizationally coherent, mature and management-supported implementation of the applied paradigm are a prerequisite for enabling the described resilience-enhancing capabilities to show full effect, Yet, tools and methods to achieve such capability enhancement should however not strictly be searched for within the boundaries of the own adopted paradigm. The research showed the clear absence of the existence of only one true paradigm for building resilience and highlights, parallel to the various resilience-benefitting micro-foundational capabilities, also the overarching goal of continuous improvement and operational excellence that shared by all three paradigms. Therefore, it is suggested to refrain from limiting oneself to the boundaries of one's own implemented paradigm but to opt for cross-paradigm tools and methods most suitable and beneficial for one's business. This ensures an optimal capability supplementation and development as well as aids in the reduction of general or business context specific shortcomings of one's own paradigm. The combination of both, a clear understanding of one's implemented paradigm as well as the holistic understanding of the potentially beneficial capabilities and capability-building tools of the other paradigms, allows for a better evaluation of the current capabilities and a efficient strategizing of resilience as a dynamic capability.

In concrete action steps that would imply the answering of the following questions:
1. What paradigm have I implemented and why (what are the goals I want to achieve with that)
2. Have I implemented the paradigm long enough to reach enough experience and maturity for the micro-foundational capabilities to have developed?
3. Have I aligned my entire company to work towards the same mission and vision or do I have bottlenecks that may hinder the building of resilience?

4. Do my employees have access to support and help when working with the paradigm?

5. What of the in this research described capabilities does my company already have and which still need to be worked on?

6. Does my company implement practices that tackle all three of the resilience phases or are aspects left out?

7. What shortcomings do I have with my paradigm that may hinder my resilience and what capabilities of other paradigms may help me with that?

8. What are the learnings from past crises that can help us understand what we still need to work on?

9. Can we identify or think of other capabilities that fit the cluster of the presented capabilities that have supported the organizational resilience?

10. (Bonus: Is it advisable to hire a temporary expert like a consultant to support the path towards organizational resilience?)

Lastly, while still remaining a nascent academic research field, this research has worked towards providing comprehensive capabilities of academically and operationally well-known operational excellence concepts that enable a facilitated building and improvement of the yet very vague matter of resilience as a dynamic capability. Especially in perspective of the current disturbances and developments in world politics and economics, organizational resilience has become a requirement to survive.

8. Limitations and recommendations for future research

The here stated research findings provide a first empirical insight into the still very nascent connection of resilience and the continuous improvement paradigms agile, lean and Six Sigma. While presenting a strong theoretical foundation enhanced through multi-facetted insights of operational excellence specialized consultants, clear limitations have surfaced throughout the research process resulting in recommendations for further research.

The rigorous quality-assurance criteria of the systematic literature review ensured the high integrity and robustness of the results, but also excluded potentially relevant and impactful findings in a scientific field that is still emerging and not yet fully established. Thus, despite existing literature, the link between lean, dynamic capabilities, and organizational resilience was an unrepresented part of the SLR that limited the comparison between primary and secondary data and the evaluation of impact. Furthermore, the interview design and evaluation mainly referred to the resilience capability framework of Duchek (2020) and the resilience characteristics of Ambulkar et al. (2015) which, although of high quality, limited the perspective of the underlying concepts. Therefore, future research should consider the criteria of SLR in the context of scientific progress and research maturity, as well as consider the inclusion of other resilience and dynamic capability frameworks and conceptualizations.

Furthermore, limitations and opportunities for future research in regard of the research scope have revealed. First, this research exclusively referred to the experience of high-quality

management consultants. While the inclusion of a detached, objective viewpoint was intended, this sample selection has also shown to susceptible to opinion bias as consultants tended to promote their paradigm of choice. Furthermore, the sample has disregarded perspectives from employees and other direct organizational associates. Thus, future research studies should consider the extension of empirical viewpoints and include the viewpoints and experiences of employees from a wide range of organizational positions and hierarchical levels working with the operational excellence paradigms as it could reduce bias and highlight further capabilities and limitations of the operational excellence paradigms that aid with building resilience as a dynamic capability. Herefore, it is advisable to opt for organizations that have maturely implemented lean, agile and six sigma as the inclusion of such experience reports allows for more detailed and concrete examples and a more accurate representation of the paradigms' effect on the staff, the organizational processes and the resilience learnings. Second, future studies should conduct research on a multitude of crises. This research has exclusively focused on organizationally uninfluenceable and sudden crises while ignoring other crisis origins that require organizational resilience. The consideration of multiple crisis origins would thus enable a comparison of the different results and an extension of the conceptualization of connection between operational excellence and organizational resilience.

In consideration of the current academic maturity regarding the conceptualization of organizational resilience in general, and the exploration of the connection between operational excellence paradigms and organizational resilience in particular it should be of highest priority to gather further and more extensive empirical data to validate the concluded assumptions and enhance the academic literature with multiple real-life cases. As the operational excellence paradigms mostly support one of the three organizational resilience capabilities, future research should further investigate the required supplementation by additional capabilities to cover not only the coping capability but anticipation and adaptation as well.

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Appendices

Appendix 1 – Interview introduction

THE EFFECT OF OPERATIONAL EXCELLENCE PARADIGMS ON ORGANIZATIONAL RESILIENCE BUILDING

MASTER THESIS

My interview invitation

For my research, I would like to invite you to an interview to get a comprehensive insight into your experiences and knowledge in consulting and supporting a company that has adopted agile, lean or six sigma. I am especially interested in the capabilities or processes that you perceived to be especially relevant for crisis survival and resilience during the Covid-19 pandemic.

Participation benefit

In case of interest, the full research paper or, if wanted, a research summary is shared after the completion of the thesis providing a systematic literature review as well as detailed and academically founded analysis of the connection of lean, agile and six sigma with organisational resilience.
These results represent a first empirical insight into the increasingly important but still early research on the link between resilience and the operational excellence paradigms.

Practical relevance of the study

My interest in organisational resilience
- organisational resilience has grown in importance, especially since the Covid-19 pandemic and a firm has to know how to sense, seize and transform its resources to become resilient
- Research gap: the essentially required competencies to build organisational resilience remain unclear

The connection to agile, lean and six sigma
- Agile, Lean and Six Sigma are highly popular yet the connection to resilience is rather new in the business and management domain. Nevertheless, first results show promising relationships motivating me to further explore this connection

My thesis question

How can the micro foundational capabilities of agile, lean and six sigma support the building of organisational resilience as a dynamic capability?

The interview

The interview process
The interview will be held in English and lasts between 30 to 45 minutes.
The interview guide including a research description and a consent form are sent to all participants at least three days prior to the interview.

The participation
The participation in the interview is fully voluntary.
You can refuse to answer any question.
You can withdraw from the study at any time, without having to give a reason.
The are no anticipated physical or psychological risks associated with the participation in this research.

The interview

Data management
All research data be anonymised though the use of pseudonymisation
before they are stored and analysed.
All interviews will be audio recorded and transcribed. The audio data will be backed up and stored on a secured, encrypted UT P-drive and the format will be anonymised. Transcripts are made with the help of a transcription software. All potential personal identifiable information (e.g. names, company names, company-specific or unique references etc.) will be deleted or replaced by non-identifiable information.

About the researcher

MY NAME IS KATHARINA

- 23 years old
- Current study: Master of Science in Business Administration- International Management and Consulting
- Future career ambition: HR Consultant at a large Human Resources Consulting Firm

Appendix 2 – Interview guide

Intake questions

1. How many years of experience does your company have in consulting companies on how to adopt agile / lean / six sigma?
2. How many years of experience do you have as a consultant in this company? And how much consultancy and work experience altogether?
3. In which industry / industries are your clients operating?
4. What organizational size do your clients have?
5. How would you personally define agile/lean/six sigma?

Interview questions

Definition for clarification if needed:

"organizational resilience as an organization's ability to anticipate potential threats, to cope effectively with adverse events, and to adapt to changing conditions" (Duchek, 2020, p. 220)

Anticipation (Sensing)

Duchek (2020): Anticipation - Observation of business environment and identification of potential threats; Preparation for unforeseen events

> *How does agile contribute to the anticipation of crisis?*

Possible follow up questions:

1. What agile practices are directed towards the systematic review of the market situation?
2. What agile capabilities specifically contribute to the anticipation of threats?
3. What agile capabilities specifically contribute to business?? opportunity identification?
4. What agile capabilities contribute to the crisis preparation of an organization?
5. Through which agile practices are these sensing actions supported?
6. How does the adoption of agile contribute to the building stakeholder relationships that support the company in a crisis?

Coping (seizing)

Duchek (2020): Acceptance and response to crisis; Ambulkar et al. (2015): Measurement of firm resilience

> *How does agile contribute to a quick acceptance and response to the crisis?*

Possible follow up questions:

1. Which agile capabilities allow for a quick relation and utilization of outside knowledge?
2. Which capabilities acquired through the paradigm are essential for successful crisis management and the quick response to business disruptions?
3. What agile capabilities facilitate new product and process innovation?
4. What agile practices support the strategic crisis response?
5. How does the adoption of agile facilitate the acceptance of change?
6. How is creativity supported by the paradigm?

Coping (transformation)

How does agile contribute to an effective transformation of resources and processes in response to market changes?

How is the formation of new capabilities in response to the market change promoted under the agile paradigm?

Possible follow up questions

1. How is an open error culture promoted under the paradigm when adopting processes to the disrupting event?
2. How are process and time waste reduced during the transformation phase?
3. How does the agile organizational structure influence the implementation speed of decisions?
4. What capabilities acquired through the paradigm aid in the transformation process?

Adaptation (transformation)

Duchek (2020): Learning and reflection from crisis

How is organizational learning and crisis reflection supported through the agile paradigm?

Follow up

1. How is reflection on implemented actions strategies supported through the agile paradigm?
2. How is organizational learning supported through the agile paradigm?
3. What agile capabilities support a long-term change within the company?

Appendix 3 – Systematic literature review codes

Principle	Selective codes	Axial codes
Agile capabilities	- Flexibility - Adaptability - High customer orientation - Focus on continuous improvement - High collaboration - The role of technological, innovation, and managerial capabilities - knowledge management and relational capabilities	Agile capabilities
	- promoting effect of entrepreneurial orientation on agile capabilities - reciprocal positive effect of agile characteristics and sustainable supply chain practices - agile effects on organizational, economic, and innovation performance	Effect of agility
	- The role of technological, innovation, and managerial capabilities - strong interconnection of agility and IT competency	Agile and technology
Lean capabilities	- quality, cost, and delivery performance - relational partnership resources	Lean characteristics
	- positive impact of lean practices on organizational performance - cumulative performance construct	Lean practices
	- importance of innovation - innovation meta routines and the lean practice "Just-in-time" - The ambivalent effect of digitalization on lean management	Innovation and digitalization
Six Sigma capabilities	- variation, and defect reduction - reduction of direct and indirect costs - improved organizational ambidexterity - high management support and implementation maturity required	Six Sigma capabilities
	- supportive effect of six sigma on growth-oriented innovation - positive effect of Six Sigma on the financial R&D investment returns	Six Sigma, innovation & R&D
Operational excellence and the role of dynamic capabilities	- Positive impact of six sigma learning structures on dynamic capabilities - Introduction of six sigma and development of DCs positively affects organizational flexibility - direct link between agile and the building of dynamic capabilities	Connection of agile to dynamic capabilities
The relationship of operational excellence	- organizational agility has shown to mediate the relationship between seizing, transformation, and resilience - agile crisis response requires strategic use of the stakeholder's knowledge	Effect of agility on resilience

paradigms and organizational resilience	collection and supportive culture and leadership	
	- agility enhanced through digital orientation	Technology effect on agility and resilience
	- value stream and process mapping help resilience through clear process understanding - waste elimination helps reduce unnecessary resource use	Resilience and lean
	- statistical-analytical nature of six sigma reduces variation and enhances effectiveness - data helps in situation evaluation and strategic decision making	Resilience and six sigma
	- combination of lean and six sigma aids resilience more due to the synergizing tools	Synergies between six sigma and lean aiding organizational resilience