The Evolutionary Nature of Entrepreneurial Ecosystems and its Impact on Resilient Growth

An Empirical Investigation on the Role of Entrepreneurial Ecosystems in Facilitating Productive Entrepreneurship in Regional Economies

Zur Erlangung des akademischen Grades eines

Doktors der Wirtschaftswissenschaften

(Dr. rer. pol.)

von der KIT-Fakultät für Wirtschaftswissenschaften

des Karlsruher Instituts für Technologie (KIT)

genehmigte

DISSERTATION

von

Diplom-Wirtschaftsingenieur

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Tag der mündlichen Prüfung: 17.07.2023

Referent: Prof. Dr. Orestis Terzidis

Korreferent: Prof. Allan O´Connor

Karlsruhe, 2024

“Give a Man a Fish, and You Feed Him for a Day.

Teach a Man to Fish, and You Feed Him for a Lifetime”

Confucius

Acknowledgments

First of all, I would like to thank my supervisor, Prof. Dr. Orestis Terzidis, who encouraged me in my scientific aspirations. Orestis, you have supported my research work from the beginning, not only by sharing your scientific expertise, but also with open discussions, and constructive feedback. I thank you for providing me the opportunity to conduct the Ph.D. thesis and giving me the freedom to set and pursue the research agenda according to my strength and capability.

To all my colleagues. You have always challenged me to think beyond my research area. Many thanks for the coffee breaks, the lively discussions, and the intense feedback, which has been highly valuable for me to rethink and further develop the research project. It was a great time for me to be part of the EnTechnon team. A special thanks to all the persons having reviewed the written parts of my thesis. I am fully aware of the exhausting work and appreciate your effort. Luise, Katharina, Matthew, Christina, Sarah, Rahel, and Mailin you are phenomenal.

Furthermore, I am grateful for the financial and value-based support for this research project provided by the Ph.D. scholarship of the Konrad Adenauer Foundation. In particular, Prof. Rolf Hasse and Elvira Giebel-Felten as well as the members of the Promotionskolleg „Soziale Marktwirtschaft“ have been a great support for years.

A special thanks go to the entrepreneurship research community around the globe. Juan Carlos Leiva, Carolina Madriz Ortiz, and Vivian Arias Gamboa for letting me deep diving into the Costa Rican entrepreneurial landscape. Monica Castro Garcia for introducing the beautiful sides and culture of Peru . Janna Alvedalen for hosting me for a research stay at Lund University and the fruitful discussions about the shortcomings in recent EE literature.

Furthermore, many thanks to the entrepreneurial community in Karlsruhe. It would not have been possible without you!!!

Most of all, I feel deeply grateful to my loved ones, for accompanying me through my life.

Bertold, for believing in me from the beginning and encouraging me no matter what has happened. Through your dedication, you supporting me in building the fundament and confidence to deal with all the challenges and struggles life brings.

Jochen, Christine, and Tobias, for being those siblings you wish to have when experiencing youthful foolishness.

Andy, Anne, and Paul, for cooking excellent dishes with the appropriate wines. Andy, you are an amazing buddy for wave and kite surfing, wakeboarding, and beach volleyball.

Dieter, for accompanying me since kindergarten and sharing a variety of unforgettable experiences thenceforward.

Sonja, for being a comrade-in-arms since our studies, for countless coffee dates, and always having a sympathetic ear in private affairs and professional matters. I am very glad that we both failed the Informatic 2 exam twice.

Alex, for having been a great roommate, for all the travels to entrepreneurial ecosystems around the globe, for broadening my mind with invitations to cultural events, and for always knowing which restaurants are worth going to.

Meike, for empowering me through regular mid-week vacations, for being a wonderful distraction from the daily routine and working pressure, and for your calmness in every situation. You have been a gorgeous co-driver in my life, and this not only but above all on the adventure-filled road trip through Scandinavia.

Luzie, for your sacrificing support in rough times, for always keep reminding me what I can achieve, for exploring Europe by train and bus, and for riding waves together.

Hannah, for your wholehearted support in getting the job done and for providing me with your unreached skills as a layout nerd. I cannot imagine that anyone could be a better match, making all challenges in life easy.

Lina, for all the special moments, for this endless night under the starry sky at the beachfront, and for sharing your dreams with me. You are a great inspiration.

Honestly, and from the bottom of my heart, without you folks, I would never have been able to make this journey a successful one!!!

Abstract

Entrepreneurship research has advanced significantly alongside its crucial role in economic development, the role of a lasting structural change, and its impact on society. However, studies in the field of entrepreneurship have focused strongly on the individual entrepreneur, firms, and their characteristics, neglecting the influence of the surrounding framework conditions. Recently, scholars have provided a more holistic approach, adopting a systemic view of entrepreneurship. Based on this conceptualization, the entrepreneurial ecosystem (EE) approach has emerged across different disciplines in recent years. Although there has been a fast-growing body of EE literature, the concept remains fragmented, and its theoretical foundations are underdeveloped. To address the existing gaps, the concept of economic resilience has been integrated into the EE approach, as economies need to prepare against exogenous shocks and endogenous crises. Thereby, the exploitation of new business opportunities is seen as an entrepreneurial response to absorbing negative effects, securing the survival of economic regions.

Hence, the objective of this dissertation is to create an understanding of how entrepreneurial ecosystems and their framework conditions can impact productive entrepreneurship, fostering resilient growth within a regional context. To support the academic community, policymakers, as well as practitioners around the globe, the findings of this thesis aim to provide guidelines on how to deal with challenges and barriers in developing sustainable and more resilient EEs. In doing so, the insights of this research project support local EE actors to act well-founded and thoughtfully, concerning their local EE characteristics.

Methodologically and empirically, this thesis follows a mixed-method research design applying qualitative and quantitative studies to seek an in-depth understanding of relationships and causal mechanisms affecting entrepreneurial activities in a local context. First, a systematic literature review (SLR) summarizes the existing body of literature, analyzing the linkages between the EE concept and economic resilience. Second, a cross-national qualitative data analysis based on semi-structured expert interviews with local EE actors is conducted to identify profound EE development strategies. Third, the EE of Karlsruhe is presented as a region that has managed structural change successfully, and therefore, case study research is applied to highlight the complex intersections between high-growth firms and the local EE in a real-life scenario. Fourth, using a questionnaire-based survey tool to collect longitudinal data from startups of Karlsruhe, enables the monitoring and evaluation of evolutionary dynamics, providing empirical evidence for recommendations for actions. In addition, the data set is used to test hypotheses about linear relationships of individual EE elements and firm performance indicators through a bivariate correlation analysis.

Overall, the increased understanding of how context, composition, and interactions between individual EE determinants impact productive entrepreneurship as the outcome can be beneficial for future decision-making, supporting researchers, policy-makers, and local EE builders.

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List of Abbreviations

AI	Artificial Intelligence
B2B	Business-to-Business
B2C	Business-to-Customer
BEEP	Babson Entrepreneurship Ecosystem Project
CORFO	Corporación de Fomento de la Producción de Chile
DLR	Deutsches Zentrum für Luft- und Raumfahrt
DSM	Deutscher Startup Monitor
EE	Entrepreneurial Ecosystem
EU	European Union
EUR	Euro
HGF	High-Growth Firm
ICT	Information and Communications Technology
IE	International Entrepreneurship
IT	Information Technology
KA	Karlsruhe
KIT	Karlsruhe Institute of Technology
MCAR	Missing completely at random
NTV	New Technology Venture
NTBF	New Technology-Based Firm
RIS	Regional Innovation System
SME	Small and Medium-Sized Enterprise
VC	Venture Capital

List of Publications

Henn, R., Terzidis, O., Haubeil, T., Schultmann, M. & Kaufmann, L. (2024). The case of heliopas.ai. In: C. Ben-Hafaiedh & T. Cooney, Case Studies on STEM Entrepreneurship (pp. 58-71), Edward Elgar, Cheltenham, UK.

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Martjan, R S., Weimar, S., **Henn, R.** & Terzidis, O. (2023). Business Modelling for Digital Health Startups: A Systematic Literature Review. XXXIV ISPIM Innovation Conference. Ljubljana, Slovenia.

Ungerer, C., Rintsch, H. & **Henn, R.** (2023). An outline of the interplay between female entrepreneurship and entrepreneurial ecosystems. IEEE ICE Conference 2023. Edinburgh, Scotland.

Manthey, S., Herr, H. & **Henn, R.** (2023). How to evaluate applications for technologies – An investigation of evaluation criteria. IEEE ICE Conference 2023. Edinburgh, Scotland.

Henn R. & Ruml, A. (2023). Digital Entrepreneurship and Rural Entrepreneurial Ecosystems. The Impact of Public Policy on the Resilient Growth of AgriTech Businesses. 20th Rural Entrepreneurship Conference. Glasgow, Scotland.

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Henn, R., Kuschel, K., Finner, A., & Terzidis, O. (2022). Resilient Growth of Entrepreneurial Ecosystems - A Questionnaire-Based Evaluation Approach. RADMA Conference 2022. Trentino, Italy.

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1 Introduction

1.1 Research Motivation

Productive entrepreneurship and high-growth firms are the fundamental basis of regional economic development with new value creation at the center (Schumpeter, 1934; Motoyama & Knowlton, 2017; Audretsch et al., 2021). In general, the concept of entrepreneurship is seen as a possible solution to combat poverty, especially in emerging and developing countries (Sutter et al., 2019). In particular, high-growth firms are drivers of economies, generating prosperity and economic wealth (Wong et al., 2005; Munoz et al., 2020). Increasing those entrepreneurial activities is a key factor for sustainable structural change (Wennekers et al., 2005; Stough, 2016). Thereby, local framework conditions have a positive influence on entrepreneurial processes in quantitative and qualitative outcomes (Urbano et al., 2019; Munoz et al., 2020; Xie et al., 2021). Hence, entrepreneurs need an appropriate environment to be successful and scale their businesses (Spigel et al., 2020; Sternberg, 2022). The entrepreneurial ecosystem (EE) approach based on Isenberg (2010; 2011) works as a conceptual umbrella, supporting the creation, growth, and survival of new ventures (Spigel & Harrison, 2018). The importance of regional EEs is emphasized by using the forest metaphor, describing that the birth of trees leads to a continuous renewal of the entire forest, securing its survival (O´Connor & Audretsch, 2022).

Whereas EEs have been utilized at a national level at first (Acs et al., 2014), the conceptualization tends to shift in the direction of a city, local, and regional perspective recently (Malecki, 2018; Audretsch et al., 2019; Bouncken & Kraus, 2022). The role of entrepreneurship on regional development and structural change as an outcome parameter outlines the importance of investigating the effects of place-specific resources (Müller, 2016; Wurth et al., 2022). Multiple studies have been conducted to analyze peripheral post-industrial places and their successful structural change such as Thessaloniki, Greece (Williams et al., 2013), Sheffield, UK (Williams & Vorley, 2014, Gherhes et al., 2018), Dublin, Ireland (Walsh, 2019), and Guildford, UK (Xu & Dobson, 2019). Thereby, the well-functioning of EEs is supportive to secure regional competitiveness after a shock, loss of an anchor company, or de-industrialization (Holm et al., 2017; Spigel & Vinodrai, 2021). In general, this regional capability emergence leads to entrepreneurship-led economic growth, creating resilient EEs (Spigel & Harrison, 2018; Walsh, 2019).

In the wake of the financial crisis in 2008, the former flourishing city of Detroit collapsed economically and now presents a compelling story of the slow death of an urban area and missed economic opportunities (Eisinger, 2014). Hence, the understanding of how to prevent an EE to fall into the stage of decline has gained increasing importance in the scientific community and among political deciders (Belitski et al., 2021; Cantner et al., 2021). Additionally, strategies to reinvigorate those places have become essential to building an evolutionary path based on existing capabilities within the EE, using the power of entrepreneurial recycling (Walsh, 2019; Spigel & Vinodrai, 2021).

In times of crisis, the well-functioning of an EE is a competitive advantage, increasing resilience and long-term competitiveness at a local level (Cho et al., 2022). The Covid-19 pandemic has revealed the challenges and difficulties entrepreneurship faces under high uncertainty and as a consequence of external shocks (Shepherd, 2020; Zahra, 2021). Longitudinal studies highlight the paramount importance of high-growth firms as job generators, even in times of crisis (Birch, 1987; Kane, 2010; Devece et al., 2016). Thereby, the development of an EE combined with quick and appropriate policies reduces the level of unemployment among younger generations (Gănescu, 2014). Regional economies have to prepare upfront to enhance their robustness against exogenous shocks (Williams & Vorley, 2014; Walsh, 2019; Maritz et al., 2020). Thereby, the resilience of an EE impacts the capability to recover from and adapt to external shocks (Roundy et al., 2017, Iacobucci & Perugini, 2021). However, especially smaller EEs and those in peripheral places are confronted with multiple challenges due to their remoteness, and the lack of resources (Xu & Dobson, 2019; Spigel et al., 2020). Overall, it is still a conundrum why some regions overcome crises straightforwardly while other ecosystems collapse (Venkataraman, 2004; Hudson, 2009; Martin & Sunley, 2015).

Over the last few years, the EE concept has emerged as a central topic in fostering economic resilience at a local level (Roundy et al., 2018; Iacobucci & Perugini, 2021). Due to the growing interest of the academic circle, policy-makers, and practitioners, the EE literature has grown tremendously across multiple disciplines in recent years (Cavallo et al., 2019; Cao & Shi, 2021; Fernandes & Ferreira, 2022). However, EE research is still considered quite young (Alvedalen & Boschma, 2017) and in its infancy (Maroufkhani et al., 2018). Although current literature has provided a comprehensive list of relevant EE elements (Stam & van de Ven, 2021), multiple shortcomings are inhibiting the emergence

of a holistic approach (Cho et al., 2022). Due to the absence of a clear analytical framework (Alvedalen & Boschma, 2017), the EE conceptualization remains highly fragmented and the theoretical basis is still underdeveloped (Wurth et al., 2022).

Although enhancing EE resilience needs to build on a long-term evolutionary nature rather than a short-term equilibrium (Christopherson et al., 2010; Spigel & Harrison, 2018), mechanisms that impact the evolutionary dynamics have been widely ignored (Cho et al., 2022). However, supporting the transformation processes is an indispensable prerequisite for the development of a well-functioning and sustainable EE (Walsh, 2019; Theodoraki et al., 2022). Over the last decades, there have been several endeavors to replicate well-functioning EEs at other locations (Cowell et al., 2018). As framework conditions are unique in any regional context, depending on not interchangeable variables that are driven by historical development and cultural circumstances (Mason & Brown, 2014), no 'one-size-fits-it-all' approach exists (Isenberg, 2010; Szerb et al., 2019). Therefore, understanding the regional conditions in a particular place is essential for EE development (Acs et al., 2017; Sleuwaegen & Ramboer, 2020). To improve the impact of EEs on the success of local new ventures, new spatial settings and perspectives have to be adapted to a novel conceptualization (Lange & Schmidt, 2021; Schäfer, 2021). As evolutionary processes are central to the EE dynamics that evolve through growth, adaptation, and resilience (Cho et al., 2022), the systematic nature of entrepreneurship has a key role in the emergence of sustainable regional economies (Iacobucci & Perugini, 2021).

In general, there is a strong relationship between economic resilience and entrepreneurship in city regions (Williams & Vorley, 2014). Therefore, research has to explore and highlight the intersections between both conceptualizations (Korber & McNaughton, 2018). As the emerging concept of economic resilience provides an understanding of how to increase regional competitiveness (Müller, 2016; Sitaridis & Kitsios, 2020), transferring this knowledge base to the EE approach could enhance productive entrepreneurship and the creation of new value-adding ventures (Bala Subrahmanya, 2022; O´Connor & Audretsch, 2022).

1.2 Problem Statement and Research Questions

Recent studies highlighted the strong relationship between the fields of entrepreneurship and geography in the context of regional economic development repeatedly (Audretsch

& Belitski, 2021; Sternberg, 2022). Due to this importance, governments raised their awareness of promoting entrepreneurship (Mason & Brown, 2014). However, national-level policy-makers have not managed the creation of more entrepreneurial and resilient economies so far (Gherhes et al., 2018; Belitski et al., 2021). Although the EE approach has increasingly attracted attention and has become broadly recognized, critical debates about methodological maturity and a clear delimitation from other concepts of regional economic development have been stimulated (Shwetzer et al., 2019; Cantner et al., 2021). Furthermore, the EE concept is often depreciated as just a biological metaphor, ignoring the creation of an implicit tendency in entrepreneurship theory and its potential (Kuckertz, 2019; Roundy & Lyons, 2022). The view on EEs is rather static, analyzing only the current status, instead of providing an evolutionary perspective (Cho et al., 2022).

According to existing shortcomings concerning a holistic EE approach, further research needs to improve theoretical foundations and empirical validation (Alvedalen & Boschma, 2017; Malecki, 2018; Volkmann et al., 2021; Theodoraki et al., 2022). Although EE literature has grown tremendously, it is still unsolved how to evaluate an EE, its well-functioning, and its resilience (Muñoz et al., 2020; Rocha et al., 2021; Leendertse et al., 2022). As the EE approach still lacks a shared analytical basis, the available data is of limited usage (Perugini, 2022). Research on EEs has not found a common agreement on a widely shared definition of spatial scale and boundaries (Malecki, 2018; Cavallo et al., 2019; Schäfer, 2021; Wurth et al., 2022), However, an increasing contextualization of entrepreneurship research could lead to an emerging understanding of local and regional entrepreneurial activities (Welter & Baker, 2021). Enhancing the interplay of context and entrepreneurship addresses the necessity to explain what cause and effect are as well as their interdependence and co-evolution (Alvedalen & Boschma, 2017; Stam & Welter, 2020; Stam & van de Ven, 2021).

Although resilience has been identified as a system-level characteristic, there is still a lack of knowledge about how single determinants impact the growth of EEs into the resilient stage and how these evolutionary dynamics should be conceptualized, measured, and evaluated (Martin & Sunley, 2015; Roundy et al., 2017; Spigel & Harrison, 2018). For the objective to develop a more holistic approach, future research should be based on a multi-level and longitudinal perspective (Korber & McNaughton, 2018).

Addressing these research gaps and contributing to the development of the EE literature, the research question of this dissertation is:

How does the configuration of entrepreneurial ecosystems at the stages of emergence and resilient growth influence entrepreneurs and entrepreneurial activity dynamics in a regional context?

To capture the main research question of this thesis, the following three sub-questions guide the conceptual and empirical chapters.

- RQ1: Which framework conditions impact the transformation and resilience of an entrepreneurial ecosystem and the survival of new ventures?
- RQ2: What challenges and barriers exist to the growth of entrepreneurial ecosystems into the resilient stage and how to overcome these obstacles?
- RQ3: How to measure entrepreneurial ecosystems in a local or regional context?

In addition, the thesis will derive recommendations for actions for EE development.

1.3 Structure of the Thesis

Chapter 1 is an introduction to the importance of EEs for economic development and resilient growth. The challenges entrepreneurship faces to prepare upfront against external shocks are illustrated. In addition, this problem statement and the derived motivation for this thesis are specified. Based on this understanding the research questions of this thesis are developed and presented.

Chapter 2 presents the state-of-the-art in the field of EEs. In the first step, the basic concept of Isenberg (2010), relevant definitions, and terminologies are introduced to underpin the theoretical framework of the research topic. In the second step, the growing interest in EE research is discussed and the lineages of the EE approach are outlined. Moreover, further developments and enhanced versions of the EE conceptualization are presented. By pointing out the critique of the current EE literature, shortcomings and weaknesses are debated, and challenges to address are identified.

Chapter 3 provides an overview of the research design of this thesis. It outlines the applied mixed-method approach of Creswell (2015) and its adaptation to the needs of this study, including research strategy, techniques, and procedures. Furthermore, the main methodological considerations and the particular methods used for addressing the

research questions are presented. This includes the following: Systematic Literature Review (SLR), Qualitative Data Analysis, Case Study Research (CSR), and Quantitative Analysis.

Chapter 4 conducts a Systematic Literature Review to analyze the linkages between the EE concept and resilience. By using the search terms “entrepreneurial ecosystem” AND “resilience” in the main scientific databases, relevant articles are identified. The data extraction and synthesis of the sample of literature in a structured process to create a more specific and deeper review article instead of only summarizing existing literature. The findings of the SLR are divided into the following categories: (1) EE determinants, (2) EE evolution, (3) perspectives on EE resilience, and (4) measurement of EEs.

Chapter 5 performs a qualitative analysis to validate EE development strategies through the international lens. Based on thirty-five semi-structured expert interviews with actors from four EEs in Latin America, this cross-national study applies an evolutionary perspective to identify challenges to achieving resilient growth, and how to overcome these barriers. The findings provide an in-depth understanding of how regional economies can raise their robustness against shocks and crises.

Chapter 6 introduces the EE of Karlsruhe by illustrating its historical development over the last three decades, the current startup landscape, and ongoing activities. Primary case study research offers a perspective to understanding complex interconnections between new ventures and their local environment. Therefore, this section analyzes the impact of the EE framework conditions in Karlsruhe on the evolutionary growth process of two local startups.

Chapter 7 conducts a quantitative analysis of the EE of Karlsruhe. After a critical reflection on the overall data availability and quality in the field of EE measurement, this section develops a startup survey approach to address this shortcoming. Therefore, hypotheses are developed out of the previous findings and transformed into a questionnaire design. Furthermore, the processes of data collection, preparation, and analysis are described precisely. Through a descriptive analysis, the EE of Karlsruhe is evaluated, providing recommendations for actions. Finally, a correlation analysis is conducted to test the hypotheses.

Chapter 8 is the concluding chapter of this thesis. This final section integrates and discusses the findings from all conducted studies. Additionally, the relevance of this study

is highlighted, implications for theory development and practice are drawn, and suggestions for future research are given. Finally, the limitations of this scientific study are presented, ending with the concluding remarks.

2 The Entrepreneurial Ecosystem Approach - The Status Quo

Over the last few years, multiple literature reviews outlined the emergence of the entrepreneurial ecosystem approach (Alvedalen & Boschma, 2017; Malecki, 2018; Maroufkhani et al., 2018; Cavallo et al., 2019; Cao & Shi, 2021; Fernandes & Ferreira, 2022). Although current EE research is mainly based on Isenberg (2010; 2011) and its visualizations, Dubini (1989) introduced the term "entrepreneurial ecosystem" to the scientific community at first. The term "ecosystem" has been transferred from biology to the field of business and social science to outline the entrepreneurial community as a physical environment with complex interactions between living and non-living components (Moore, 1993; Acs et al., 2017). Furthermore, van de Ven (1993) used that idea to develop an infrastructure for entrepreneurship creating a systemic view that facilitates and constrains entrepreneurship. In one of the first scientific articles, Neck et al. (2004) and Cohen (2006) applied the EE conceptualization in Boulder/Colorado, and Victoria/British Columbia to examine the applicability of the entrepreneurial ecosystem literature. Subsequently, multiple studies joined the aspiring research streams by analyzing single EE all around the globe (Williams et al., 2013; Mack & Mayer, 2016; Cowell et al., 2019; Walsh, 2019; Adams, 2021; Belitski & Büyükbalci, 2021; Spigel & Vinodrai, 2021). Overall, the core idea behind the EE approach is "to explain the persistence of high-growth entrepreneurship within regions" (Spigel, 2017). Thereby, entrepreneurship is considered the process in which new products, service opportunities, and innovative technologies are exploited (Shane & Venkataraman, 2000) and the output of an ecosystem (Acs et al., 2017). The following chapter introduces the entrepreneurial ecosystem approach by outlining the basic concept, further developments, definitions, and descriptions. In doing so, a common understanding is ensured to avoid any misinterpretations by the reader. Additionally, the systematic literature review in Chapter 4 is completing the creation of an in-depth knowledge base.

2.1 Definition of an Entrepreneurial Ecosystem

Although the EE approach is referred to as "quite young" (Alvedalen & Boschma, 2017), the lineages are based on a variety of antecedents (Acs et al., 2017). Roots can be found in different economic geography concepts such as industrial districts (Marshall, 1890), regional innovation systems (Cooke, 1992), high-technology districts (Storper, 1993), clusters (Porter, 1994), innovative milieus (Maillat, 1995), and localized learning

(Malmberg & Maskell, 1997; 1999). Despite the high prevalence of the EE concept, no widely shared definition has been established yet (Stam, 2015; Malecki, 2018; De Brito & Leitao, 2021; Wurth et al., 2022). Thus, the concepts have been used "diversely in literature, making it rather chaotic" (Cavallo et al., 2019). Based on the findings of Malecki (2018) and Cavallo et al. (2019), the variety of definitions is listed in Table 1.

To summarize Table 1, the terminus "entrepreneurial ecosystem" is defined in very different ways, using different scales, research designs, and data (Malecki, 2018). Those definitions tend to include diverse connotations on relevant systematic elements, in particular existing actors, connections, and the subject of entrepreneurship (Cavallo et al., 2019). However, the majority of EE definitions agree on a "place-based community of stakeholders and/or elements" as a geographically defined framework, including relevant factors that are necessary for entrepreneurship (Schäfer, 2021). Further definitions highlight "the combination or interaction of elements, often through networks, producing shared cultural values that support entrepreneurial activity" (Malecki, 2018) and the creation of new ventures as the ultimate objective of an EE (Cavallo et al., 2019). This is supplemented by Bruns et al. (2017) describing an EE as "a multidimensional set of interacting factors that moderate the effect of entrepreneurial activity on economic growth". Thereby, the focus on facilitating productive entrepreneurship and reducing unproductive entrepreneurship is of high relevance (Stam & Spigel, 2016; Audretsch et al., 2021).

Table 1. *List of entrepreneurial ecosystem definitions (own compilation)*

Authors (Year)	EE Definition
Van de Ven (1993)	Networks of actors involved in developing each function, and how these functions and networks of actors interacted over time to facilitate and constrain innovation development
Spilling (1996)	The entrepreneurial system consists of a complexity and diversity of actors, roles, and environmental factors that interact to determine the entrepreneurial performance of a region or locality
Neck et al. (2004)	EEs are defined as the interacting components of entrepreneurial systems, which foster new firm creation in a specific regional context
Cohen (2006)	Sustainable entrepreneurial ecosystems are defined as an interconnected group of actors in a local geographic community committed to sustainable development through the support and facilitation of new sustainable ventures
Isenberg (2010)	The entrepreneurship ecosystem consists of a set of individual elements - such as leadership, culture, capital markets, and open-minded customers - that combine in complex ways
Qian et al. (2013)	Those economic, social, institutional and all other important factors that interactively influence the creation, discovery and exploitation of entrepreneurial opportunities
Acs et al. (2014)	A dynamic, institutionally embedded interaction between entrepreneurial attitudes, abilities, and aspirations, by individuals which drives the allocation of resources through the creation and operation of new ventures
Stam (2015)	The entrepreneurial ecosystem as a set of interdependent actors and factors coordinated in such a way that they enable productive entrepreneurship within a particular territory
Mack & Mayer (2016)	Entrepreneurial ecosystems (EE) consist of interacting components, which foster new firm formation and associated regional entrepreneurial activities
Cukier et al. (2016)	We define a start-up ecosystem as a "limited region within 30 miles (or 1-hr travel) range, formed by people, their start-ups, and various types of supporting organizations, interacting as a complex system to create new start-up companies and evolve the existing ones
Audretsch & Belitski (2017)	We define systems of entrepreneurship (further ecosystem) as institutional and organizational as well as other systemic factors that interact and influence identification and commercialization of entrepreneurial opportunities
Bruns et al. (2017)	Entrepreneurial ecosystem as a multidimensional set of interacting factors that moderate the effect of entrepreneurial activity on economic growth
Gauthier et al. (2017)	We defined ecosystems ... around the concept of a shared pool of resources generally located within a 60-mile (100-km) radius around a center point
Roundy et al. (2017)	Communities of agents, social structures, institutions, and cultural values that produce entrepreneurial activity
Spigel (2017)	A combination of social, political, economic, and cultural elements within a region that support the development and growth of innovative start-ups and encourage nascent entrepreneurs and other actors to take the risks of starting, funding, and otherwise assisting high-risk ventures
Maroufkhani et al. (2018)	An entrepreneurial ecosystem is a conceptual model or a strategy that is designed to nurture economic development by promoting entrepreneurship, small business growth and innovation

Other definitions involve a dynamic and systematic nature within a supportive environment for multiple actors, institutions, and processes (Brown & Mason, 2017). Thereby, entrepreneurial processes are defined by geographical boundaries from a city-, local-, regional- or national-level perspective (Acs et al., 2017; Spigel et al., 2020). Whereas EEs have been observed on the national scale at the beginning (Acs et al., 2014), there is a shift in the concept toward a city and local phenomenon (Malecki, 2018; Audretsch et al., 2021). Further studies proposed to define EEs by geographical distance, using a concrete number of kilometers or miles, or the time of traveling (Cukier et al., 2016; Gauthier et al., 2017). However, all these definitions are too rigid, not describing the conditions at any specific place correctly, and therefore, only have limited applicability (Alvedalen, 2021). Hence, the use of "analytical terms of space such as the scale, borders but also the center or periphery" is required to research the spatialities of entrepreneurship (Schäfer, 2021). To improve the definition of nature and the characteristics of any ecosystem, evolutionary dynamics should be included, requiring geographical and technological dimensions additionally (Cho et al., 2022). Overall, Stam (2015) describes an EE "as a set of interdependent actors and factors coordinated in such a way that they enable productive entrepreneurship within a particular territory", putting the relevant features in a nutshell and therefore, is the most applied definition in EE research so far (Acs et al., 2017). Especially, focusing on productive entrepreneurship is a key characteristic of the EEs, differentiating the concept from more traditional studies that are based on self-employment and all kinds of firms (Alvedalen, 2021).

2.2 Development of the EE Approach

As presented before, the EE concept is still in the stage of discovery and development. The original EE approach has been developed by Isenberg (2010; 2011) within the Babson Entrepreneurship Ecosystem Project (BEEP) as an "entrepreneurship strategy for economic development". Thereby, the aim has been to support policymakers and entrepreneurial leaders in successfully developing their local start-up communities. The importance of Isenberg (2010) is illustrated as the study is amongst the most cited works related to EE research (Malecki, 2018).

In a first step, Isenberg (2010) established the following nine instructions as a guideline for all relevant actors involved in the EE: (1) Stop emulating Silicon Valley, (2) Shape the ecosystem around local conditions, (3) Engage the private sector from the start,

(4) Favor the high potentials, (5) Get a big win on the board, (6) Tackle cultural change head-on, (7) Stress the roots, (8) Don't overengineer clusters, and (9) Reform legal, bureaucratic, and regulatory frameworks. Thereby, the conceptualization of how entrepreneurial ecosystems form is following a bottom-up process, confirmed by research evidence recently (Thompson et al., 2018).

Additionally, Isenberg (2011) set up the illustration of the EE framework (see Figure 1), representing all key components of a healthy ecosystem. Overall, the conceptualization consists of six domains (1) policy, (2) financial capital, (3) culture, (4) supports, (5) human capital, and (6) markets, twelve subdomains, and a total of 51 components.

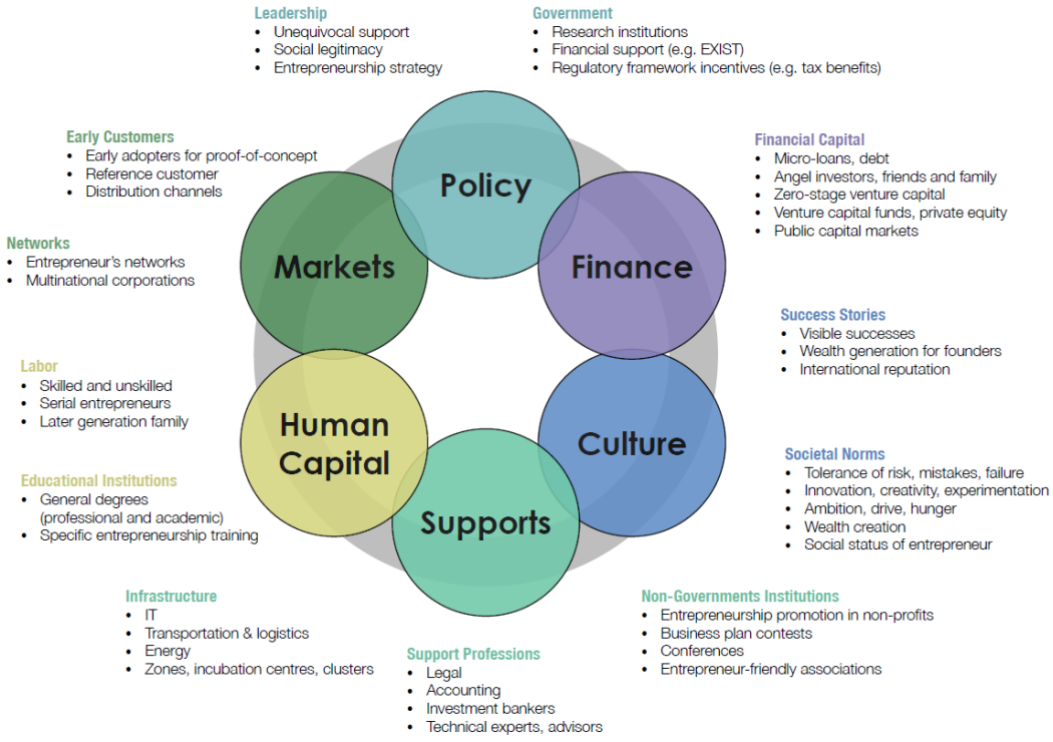

Figure 1. *Domains of the entrepreneurship ecosystem (Isenberg, 2011, own illustration)*

All of these elements are reflecting the perceptions of entrepreneurs and should have an impact on entrepreneurial decisions permanently, increasing the success of new businesses (Suresh & Ramraj, 2012). At a later stage, Isenberg (2016) adapted the graphical overview, including the actors within a start-up community. Even though the EE framework of Isenberg (2011) provides three levels of depth, there is no indication of its completeness, and a lot of effort was done to search for additional elements (Shwetzer et al., 2019). These further developments are essential to building adequate framework conditions to enable entrepreneurs to unfold the whole potential of their firms

(Theodoraki et al., 2018). This stands in line with prior argumentation that the support of new ventures and their scaling require specific policy tools and tailored governmental institutions (Isenberg, 2011, Brown & Mason, 2017). According to Isenberg (2010), policy-makers "pursue some unattainable ideal of an ecosystem and look to economies that are completely unlike theirs for best practices". Due to this lack of knowledge, local, regional, and national policies have failed to create sustainable entrepreneurial ecosystems (Gherhes et al., 2018).

Besides the work of Isenberg (2010; 2011), the book of Feld (2012) was among the first articles to pioneer the EE approach by presenting the practical relevance reader-friendly to a broad mainstream audience (Cowell et al., 2018). Based on an analysis of the EE in Boulder, Colorado, the study identified nine key attributes of successful startup communities. Those elements are named leadership, intermediaries, network density, government, talent, support services, engagement, companies, and capital. Besides the access to resources and the supportive role of governmental institutions, the central point is the interaction of entrepreneurs with the entrepreneurial ecosystem.

Table 2. *Attributes of a successful startup community (Feld, 2012, own compilation)*

Attribute	Description
Leadership	Strong group of entrepreneurs who are visible, accessible and committed to the region being a great place to start and grow a company
Intermediaries	Many well-respected mentors and advisors giving back across all stages, sectors, demographics, and geographies as well as a solid presence of effective, visible, well-integrates accelerators and incubators
Network Density	Deep, well-connected community of start-ups and entrepreneurs along with engaged and visible investors, advisors, mentors and supporters. Optimally, these people and organizations cut across sectors, demographics, and culture engagement. Everyone must be willing to give back to his community
Government	Strong government support for and understanding of start-ups to economic growth. Additionally, supportive policies should be in place covering economic development, tax, and investment vehicles
Talent	Broad, deep talent pool for all level of employees in all sectors and areas of expertise. Universities are an excellent resource for start-up talent and should be well connected to community
Support Services	Professional services (legal, accounting, real estate, insurance, consulting) are integrated, accessible, effective, and appropriately priced
Engagement	Large number of events for entrepreneurs and community to connect, with highly visible and authentic participants (e.g. meet-ups, pitch days, startup weekends, boot camps, hackathons, and competitions)
Companies	Large companies that are the anchor of a city should create specific departments and program to encourage cooperation with high-growth start-ups
Capital	Strong, dense, and supportive community of VCs, angels, seed investors, and other forms of financing should be available, visible, and accessible across sectors, demographics, and geography

Especially practitioners and EE builders should benefit from the list to develop a deeper understanding of their local environment of entrepreneurship (Stam & van de Ven, 2020). Thereby, policy measures should be adapted to the development of the EE to reinforce itself permanently (Feld, 2012; Liguori & Bendickson, 2020). As the majority of policy-makers lack knowledge about entrepreneurial processes, it is more important to "enable things" than to get actively involved (Lerner, 2009).

Following the breakthrough of the EE approach based on the publications of Isenberg (2010; 2011) and Feld (2012), policymakers and EE leaders raised their awareness of the guidelines of how to build an EE. Triggered by the rising popularity multiple studies of researchers and institutions worked on the further development of the conceptualization (Cavallo et al., 2019). Based on a survey with over 1,000 responses from entrepreneurs around the globe, the World Economic Forum studied the components of EEs and defined a conceptualization with eight pillars (WEF, 2014). As Figure 2 illustrates the categories were named as follows: accessible markets, funding, and finance, regulatory framework and infrastructure, major universities as catalysts, human capital/workforce, support system, education and training, and cultural support.

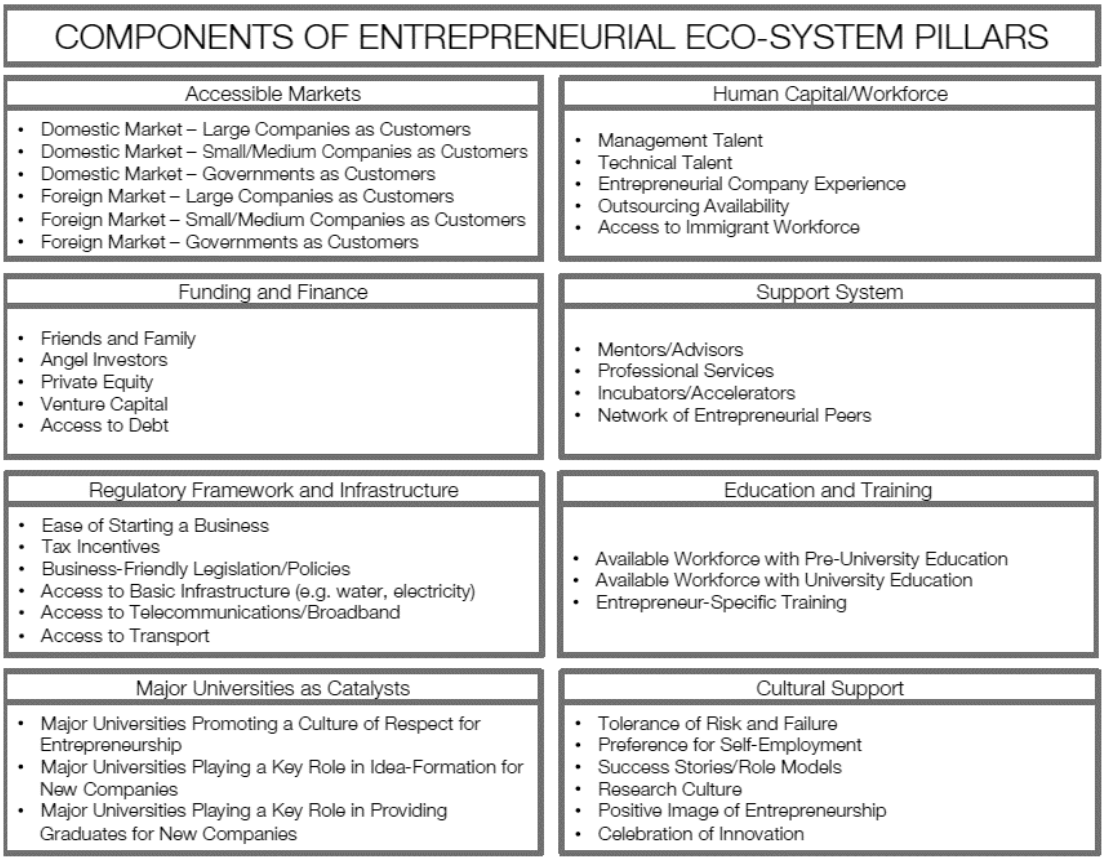

Figure 2. *Components of entrepreneurial ecosystem pillars (WEF, 2014)*

These pillars largely overlap with the elements described by Isenberg (2010) and Feld (2012). However, this report is introducing an entrepreneur´s perspective, highlighting the role of entrepreneurs (mentors, founders, investors, and inspirators) as significant contributors to EEs. Furthermore, the analysis of the survey identified that in particular three of the pillars have a high impact on the development and maintenance of an EE. The finding reveals that there are vast differences across all regions in the availability of each EE pillar (Brown & Mason, 2017). Through this survey, it has been shown that different models of governance can be an accelerator for entrepreneurial growth, or can negatively influence the (WEF, 2014; Spigel, 2017). In general, the outcome of EEs is a combination of social, institutional, and economic factors varying from place to place (Stangler & Bell-Masterson, 2015; Stam & Spigel, 2016; Acs et al., 2017). As the success of young companies and the outcome of entrepreneurial activities are vague and barely predictable, support infrastructure is of high importance (Theodoraki & Catanzaro, 2022).

Stam (2015) devised another EE conceptualization (see Figure 3) that is based on key elements, outputs, and outcomes. Thereby, Stam (2015) addresses the under-theorization of the EE approach. In doing so, this study created a novel, constructive synthesis of innovation systems theory and entrepreneurship-led economic development approaches (Velt et al., 2020, Cao & Shi, 2021).

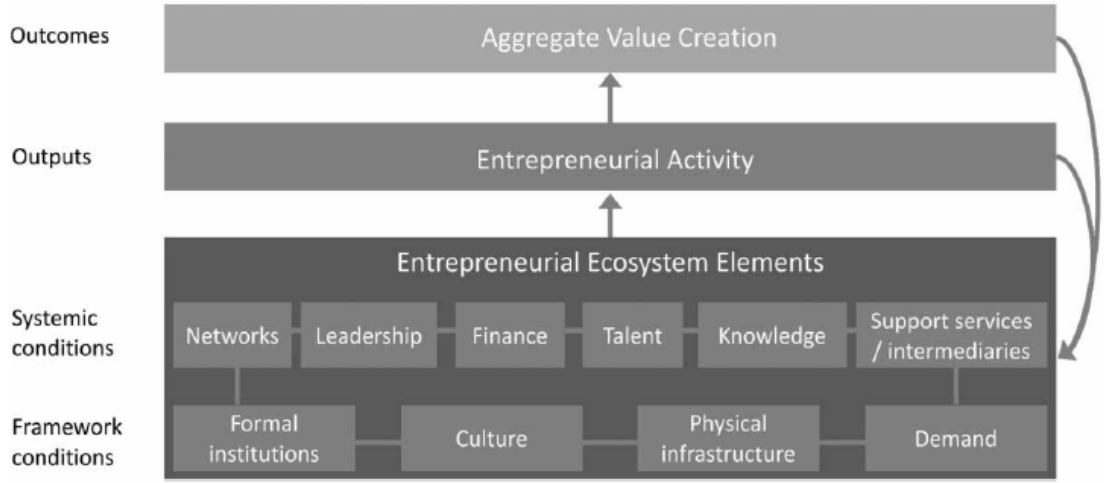

Figure 3. *Key elements, outputs, and outcomes of the entrepreneurial ecosystem (Stam, 2015)*

Thereby, the model combines framework and systemic conditions and points out the impact on entrepreneurial activities as output and aggregate value creation as an outcome (Stam, 2015). Although the approach is valuable to uncover the fundamental

relationships, the model is inherently linear and does not answer what cause is and what effect (Alvedalen & Boschma, 2017; Stam & van de Ven, 2021). Furthermore, the configuration of EE elements became highly relevant to shaping new venture development (Velt et al., 2020). Building on this conceptualization, an index-based EE measurement approach was developed which has been applied in twelve regions in the Netherlands (Stam, 2018; Stam and van de Ven, 2021).

The article by Mack & Mayer (2016) developed a life-cycle-based framework, addressing the evolutionary nature of EEs (Cho et al., 2022). In doing so, this study increased the understanding of interdependencies between EE components and their evolutionary dynamics (Mack & Mayer, 2016). Based on the core domains of Isenberg (2010), the four stages of birth, growth, sustainment, and decline of an EE were integrated into the conceptualization. In a follow-up study, Cantner et al. (2021) added a fifth phase highlighting the necessity of EEs to successfully re-emergence (see Figure 4).

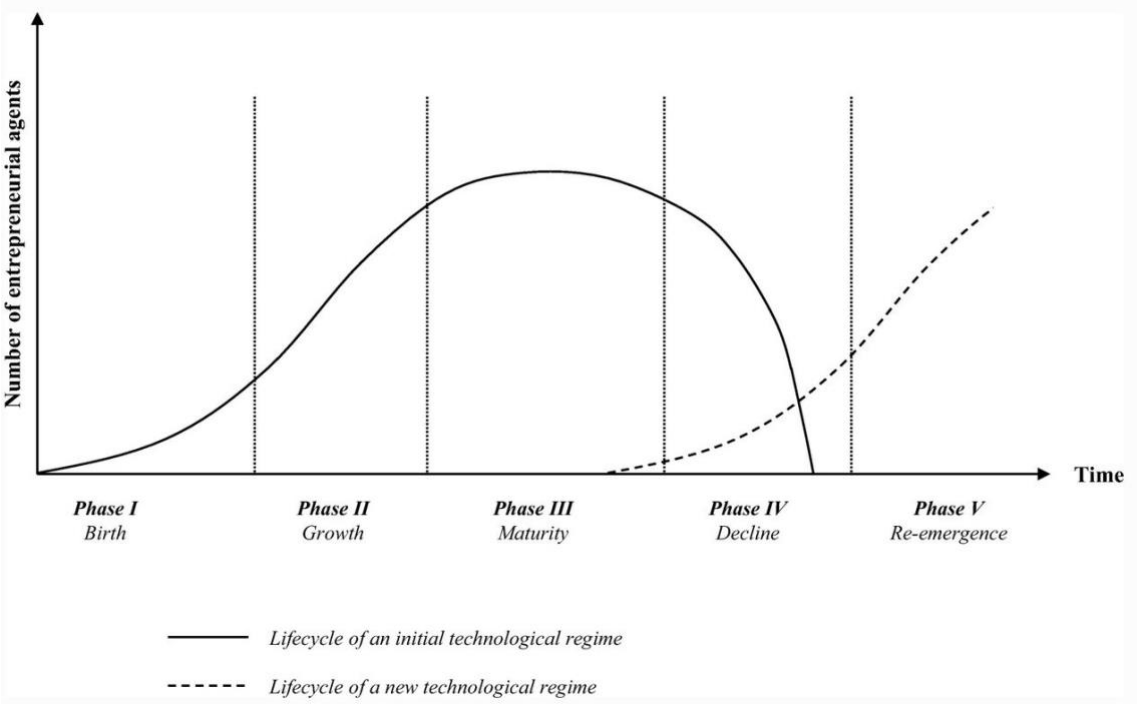

Figure 4. *A dynamic lifecycle model of an entrepreneurial ecosystem (Cantner et al., 2021)*

By conducting a case study of the EE in Phoenix, US, the study illustrates how the elements evolve through the stages and how their particular importance is changing over time (Cho et al., 2022). Policy-makers need to be aware of in which stages an EE is to select suitable measures and instruments, to support the transition of local framework

conditions (Belitski et al., 2021). Building on this contribution, further studies worked on building an evolutionary perspective by further modifying the EE life-cycle approach (Brown & Mason, 2017; Colombelli et al., 2019; Cantner et al., 2021; Cho et al., 2022).

In contrast to that, Spigel & Harrison (2018) proposed a process-based view of the EE concept, including the established theories of clusters and regional innovation systems (RIS). The study focused on the transformation of EEs with the support of new venture creation and high-growth entrepreneurship in the center. Thereby, the levels of connectivity, the recycling of resources, and the attraction of new resources to the ecosystems are used to describe the functioning of an EE. The different stages are defined in Figure 5 as a nascent ecosystem, a strengthened ecosystem, and either a weakened ecosystem or a resilient ecosystem.

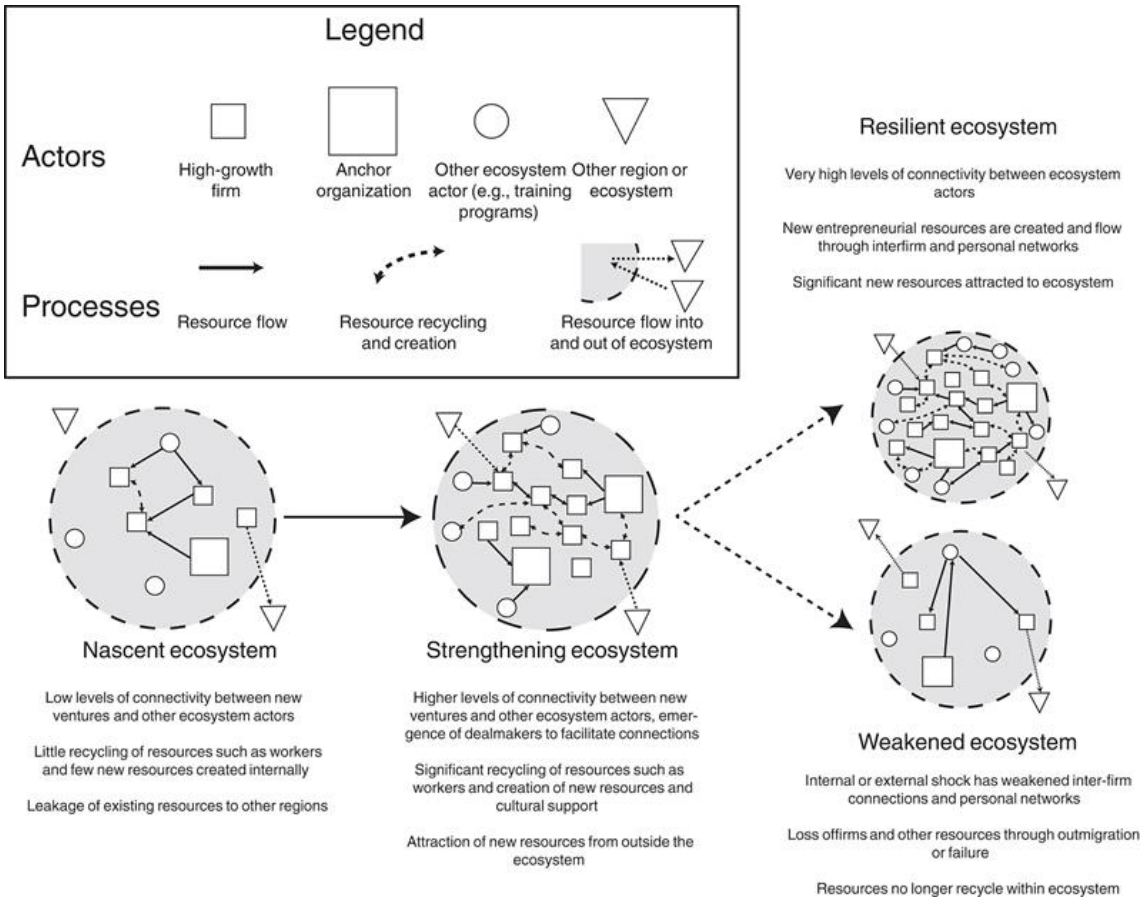

Figure 5. *Transformation of entrepreneurial ecosystem (Spigel & Harrison, 2018)*

This understanding of how to increase the resilience of an EE is important as it allows a continuous adaption to upcoming unexpected events and shocks (Roundy et al., 2017). Especially a high level of entrepreneurial recycling results in increased regional resilience, avoiding falling into a stage of decline (Walsh, 2019; Shi & Shi, 2021; Spigel

& Vinodrai, 2021). Furthermore, the role of actors and institutions, and the functioning of networks are highlighted (Walsh & Winsor, 2019). Independently thereof, networks can either facilitate or hinder access to given resources (Scott et al., 2021). Based on this resource-based view the dynamic capability theory emerged subsequently to explain how EE narratives compete with other regional economic theories in reconfiguring entrepreneurial opportunities and resources (Roundy, 2019).

2.3 Gaps in the EE Literature

Although a large number of articles highlight the emerging importance of the EE approach in creating regional economic development, critiques point out that there are still weaknesses and unsolved issues in the conceptualization (Cavallo et al., 2019; Shwetzer et al., 2019; Perugini, 2022; Wurth et al., 2022). The EE framework does not provide a solid foundation for answering the fundamental conceptual, theoretical, and empirical questions (Stam, 2015). Other controversies raise the question of the concept is only "old wine in new bottles" (Scaringella & Radziwon, 2018). EEs are rather considered a conceptual umbrella summarizing "a variety of different perspectives on the geography of entrepreneurship" than building a coherent theory (Spigel, 2017). In consequence, the EE phenomenon itself remains undertheorized and research in this field is still underdeveloped (Autio et al., 2018; Kansheba & Wald, 2020; Cantner et al., 2021). Therefore, the current debate can be briefly summarized as follows.

The EE concept pursues an interdisciplinary approach, including multiple disciplines such as strategic management and economic geography (Scaringella & Radziwon, 2018). However, due to the high number of antecedents, it remains vague under what conditions entrepreneurial firms grow and how those companies "influence economic, technological, and societal thinking within their ecosystem" (Audretsch et al., 2019). Therefore, a clear demarcation to related concepts has to be made and the boundaries of the EE framework need to be sharpened (Cho et al., 2022; Wurth et al., 2022). In consequence, EE research has often been criticized for not providing any shared EE definition so far (Malecki, 2018). Despite the local nature of entrepreneurship, EEs are often identified at a regional or national level (Acs et al., 2014; Malecki, 2018). Struggling with the spatial scale of EEs (Schäfer, 2021), the unit of analysis has not been standardized, resulting in a lack of regional comparative analyses (Stam, 2015; Brown & Mason, 2017). Therefore, EE

research needs to utilize a multi-scalar approach to compare the evolutionary dynamics of single EEs (Alvedalen & Boschma, 2019; Belitski & Büyükbalci, 2021).

Over the last few years, research has focused on individuals and their characteristics and behavior (Cavallo et al., 2019). Although an EE is considered a dynamic and complex system (Acs et al., 2014; Haarhaus et al., 2020), there is still a lack of a clear analytical framework (Alvedalen & Boschma, 2017; Autio et al., 2018). Due to this shortcoming, the EE approach does not explain the cause-and-effect relationships yet (Alvedalen & Boschma, 2017; Nicotra et al., 2018; Cunningham et al., 2019). Thus, researchers worked on the identification of single elements rather than studying their interaction and connectivity (Roundy et al., 2017; Malecki, 2018). As existing approaches have identified successful components by relying on static frameworks (Cao & Shi, 2021), those studies documented and analyzed the status quo instead of providing an evolutionary perspective (Mack & Mayer, 2016; Spigel & Harrison, 2018; Cantner et al., 2021). However, a longitudinal monitoring mechanism is required to track the implication of single actions (Cunningham et al., 2019; Cho et al., 2022). Furthermore, future trends in EE research need to address the dynamic and systemic nature of entrepreneurship by integrating entrepreneurs' perspectives and experiences (Ratten, 2020).

Further critiques argue that focusing mainly on the analysis of the most successful areas instead of producing a balanced picture may lead to survivorship bias (Mack & Mayer, 2016). In addition, EE research concentrates on advanced economies, widely ignoring the contextualization of EE conditions in emerging and developing countries (Lopez & Alvarez, 2018; Cao & Shi, 2021). As the impact of local framework conditions is relevant to entrepreneurial processes in developed, emerging, and developing markets, all kinds of EEs should be investigated (Guerrero et al., 2021). Therefore, future research needs to include the observation of systemic conditions for entrepreneurship in less developed regions and increase the understanding of how to adapt to those diverse regional challenges (Kantis et al., 2020).

Finally, the missing validity and comparability of existing data are limiting empirical research in the field of EEs (Sternberg, 2022; Wurth et al., 2022). Resulting in a lack of a reliable diagnosis tool (Credit et al., 2018), local ecosystem builders often fail in fostering supportive framework conditions, not being able to reflect on wrong decisions (Leendertse et al., 2022). To conduct a robust study for analyzing the resilient growth of

EEs, the underlying data material is insufficient (Rocha et al., 2021). Therefore, future research needs to address the further development of EE measurement toward higher quality, validity, and reliability of data (Leendertse et al., 2022).

3 Research Design

This research project aims to identify all relevant determinants that impact the resilient growth of EEs in a regional context. Relying on this in-depth understanding a questionnaire-based tool as a final artifact is developed. Applying this approach enables researchers and local decision-makers to analyze and evaluate the current status of an EE and to derive recommendations for actions and suggestions for improvement. As EEs are highly vibrant places, the close interaction between a theoretical and practical perspective is a noteworthy characteristic of this research approach (Wurth et al., 2022).

Since its conceptual formation, EE literature has been dominated so far by theoretical articles and the use of qualitative methodologies (Maroufkhani et al., 2018; Cao & Shi, 2021). Being aware of these issues, the research design of this thesis emphasizes the demand for a more holistic approach (Shwetzer et al., 2019; Schäfer, 2021; Theodoraki et al., 2022). Thereby, a major challenge is to deal with the need of balancing the findings from quantitative and qualitative studies (Spigel et al., 2020). To address the research purpose and answer the guiding research questions, the thesis consists of several studies using different methods, following a multiple-methods design (Morse, 2015). The procedure of the research design is illustrated in Figure 6.

Figure 6. *Research design of the thesis (own illustration)*

In doing so, the topic of EEs and resilient growth can be explored from multiple perspectives, requiring the application of several methods (Cowell et al., 2018). Using a multi- or mixed-methods design is a necessary prerequisite to dealing with the complexity of entrepreneurship in general (Najmaei, 2016). Although both terminologies are widespread in multiple research fields, the basic principles are frequently confused, leading to an 'identity crisis' (Anguera et al., 2018). Whereas a multi-method approach is described as a combination of two or more qualitative methods (Morse, 2003), a mixed-method approach is based on the use of qualitative and quantitative data (Roller & Lavrakas, 2015). A core assumption of a mixed-method research strategy is the collection, analysis, and integration of 'both' quantitative and qualitative data, combining statistical trends (quantitative data) with stories and personal experiences (qualitative data) (Creswell, 2015).

The combination and integration of qualitative and quantitative analysis enable research projects to benefit from the respective advantages of both approaches (Mayring, 2001; Davidsson, 2003; Flyvbjerg, 2006). Relying on this collective strength provides a deeper understanding than either form of data separately (Creswell, 2015). However, linking different kinds of methods is not only advantageous for the research quality but also counteracts the weaknesses of single methodologies (Johnson & Christensen, 2012). Whereas qualitative approaches provide more in-depth knowledge about a socio-economic context (Cunningham et al., 2017), quantitative studies are used to determine causal relations about a concrete phenomenon, increasing the generalizability of the findings (Morse & Mitcham, 2002). Similar to mixed-method approaches, the application of multiple methods is increasing the quality of the research outcomes (Johnson & Gray, 2010). Additionally, applying mixed-method research is beneficial in research projects dealing with primary and secondary data (Hall, 2020).

Overall, EE literature is "possibly encouraging the use of mixed-method designs when seeking a deeper understanding of particular relationships and the causal mechanisms in effect" (Zahra, 2022). Hence, a broad range of qualitative and quantitative methods is applied in this thesis to generate empirical data, aiming to answer the research questions. The research design of this thesis includes the methodologies of systematic literature review (Kraus et al., 2020), qualitative research based on semi-structured expert interviews (Mayring, 2014), case study research (Yin, 2014), and survey-based quantitative research (Rowley, 2014).

3.1 Systematic Literature Review

EE literature has grown tremendously in recent years, becoming a central topic in the field of entrepreneurship and economic development (Fernandes & Ferreira, 2022). However, the concept remains atheoretical, static, and broad (Theodoraki et al., 2022). In addition, the large number of new publications makes it difficult to maintain an overview of trends, fragmentations, and the influence of EE characteristics on resilience and economic growth (Iacobucci & Perugini, 2021; Cho et al., 2022). Addressing these issues, multiple literature reviews have been conducted in recent years (Alvedalen & Boschma, 2017; Malecki, 2018; Maroufkhani et al., 2018; Cavallo et al., 2019; Shwetzer et al., 2019; Kansheba & Wald, 2020; Velt et al., 2020; Cao & Shi, 2021; Guerrero et al., 2021; Kang et al., 2021; Cho et al., 2022; Fernandes & Ferreira, 2022; Theodoraki et al., 2022).

Hereby, various articles applied a broad perspective, summarizing and mapping the status quo and analyzing current development trends (Alvedalen & Boschma, 2017; Malecki, 2018; Maroufkhani et al., 2018; Cavallo et al., 2019; Kansheba & Wald, 2020; Velt et al., 2020; Kang et al., 2021). Based on those findings, subsequent studies tended to focus on single specific aspects such as advanced and emerging economies (Cao & Shi, 2021; Guerrero et al., 2021), networks (Fernandes & Ferreira, 2022), sustainability (Theodoraki et al., 2022), and evolutionary dynamics (Shwetzer et al., 2019; Cho et al., 2022).

During periods of rapid market changes and high uncertainty and to prepare against upcoming crises and exogenous shocks, resilient EEs raise the robustness of regional economies (Iacobucci & Perugini, 2021). Although the intersection between resilience and entrepreneurship is of high relevance (Korber & McNaughton, 2018), EE research has not explicitly emphasized resilience as a key characteristic (Roundy et al., 2017). Despite the emerging body of EE literature, research on resilience and stability and their impact on the performance of regional EEs is limited (O´Connor & Audretsch, 2022). To synthesize the body of literature according to the linkage between the EE approach and resilient growth, a systematic literature review has been conducted in this section of the thesis. By evaluating and interpreting all available and relevant articles, the objective is to perform a rigorous review of current empirical evidence (Kitchenham & Charters, 2007). Therefore, the guidelines of Kraus et al. (2020) were used to follow a standardized process, covering and summarizing the existing scientific literature thoroughly. This research strategy enables the identification of the key scientific contributions to the field of EE resilience as well as improving the quality of the process (Shwetzer et al., 2019). In doing so, the aim is to create a holistic understanding of the pathway toward more resilient EEs (Boschma, 2015; Scott et al., 2021). Furthermore, research gaps were identified to further build a knowledge base related to the specific research questions (Kraus et al., 2020). The overall process and the findings have been published in an article in the Journal of Entrepreneurship & Regional Development (Henn et al., 2023).

3.2 Qualitative Data Analysis

The advantage of qualitative research is the ability to understand the socioeconomic context in a broader and more in-depth context (Creswell, 2009; Mayring, 2014). Especially in research streams that are not yet well-advanced, qualitative data analysis of a few cases is essential to build a theoretical foundation as a knowledge base (Johnson &

Christensen, 2012; Cunningham et al., 2017). These in-depth insights are a prerequisite to generating hypotheses for subsequent quantitative analysis (Flyvbjerg, 2006; Shepherd & Suddaby, 2016).

As the validity and reliability of qualitative research largely depend on the skill and rigor of the researcher, it is required to follow a strategic and structured process (Guba & Lincoln, 1985; Cypress, 2017). Therefore, the approach of a thematic analysis according to Miles & Huberman (1994) has been selected. Following this approach strengthens the coherence of the analysis and creates comparable data, which is especially important when involving multiple sources (Dul & Hak, 2008; Cunningham et al., 2017). In addition, research projects are guided to use eight universal hallmarks to ensure the trustworthiness of qualitative research (Tracy, 2010).

As the aim of this study is to further modify the theory derived from the literature review by analyzing practice-related data, an inductive coding strategy is applied (Gioia et al., 2012). In addition, the use of analytic imagination in the process of interpreting qualitative data is supportive to identify causal mechanisms (Pratt, 2009; Silverman, 2015). Finally, by matching the findings to existing patterns the theoretical foundation can be further developed (Sinkovics, 2018).

Through a cross-national analysis the robustness of the outcomes of the qualitative study is increased (Stake, 2005). As purposeful sampling is highly relevant for theory building, selecting information-rich cases is of paramount importance (Glaser & Strauss, 1967; Piekkari et al., 2009). Furthermore, an interview guideline was used to ensure the coverage of all aspects related to the EE approach and the evolutionary perspective as the focal points of the research (Tsvetkova et al., 2019). Although relying on a standardized protocol, the guidelines need to consist of open, clear, neutral, and unbiased questions (McIntosh & Morse, 2015). This procedure enables the interviewer to pursue follow-up queries flexibly and to adapt to unexpected answers and directions (Williams et al., 2013; Theodoraki & Catanzaro, 2022).

In total, four Latin-American EEs with similarities in the framework conditions have been included in the study, namely San José/Costa Rica, Lima/Peru, Santiago/Chile, and Buenos Aires/Argentina. In doing so, it can be demonstrated that similar factors may lead to different results in different geographical contexts (Griffin & Ragin, 1994; Belitski & Büyükbalci, 2021). Adopting an international lens is addressing the lack of a comparative

and multi-scalar perspective (Stam & van de Ven, 2021: Theodoraki & Catanzaro, 2022). To analyze the challenges and barriers in EEs, semi-structured interviews with relevant stakeholders are appropriate for studying the dynamic processes, aiming at causal explanations (Campbell et al., 2013). Overall, thirty-five interviews have been conducted with local key actors, representing small firms and institutions in their local EEs.

The findings of this chapter have been transformed into an article published in the Journal of Small Enterprise Research (Henn et al., 2022a).

3.3 Case Study Research

Addressing the exploratory nature of this thesis, the case study methodology as an emerging discipline has been included as the next step in the research design. Case studies can be used as an instrument to analyze and understand complex issues in real-life scenarios (Tellis, 1997). To contribute to the current scientific discourse, this investigation is following an exploratory multiple-case approach (Yin, 2014). In doing so, this study is addressing the need for more case study research in entrepreneurship as demanded by the academic community (Duxbury, 2012). Based on the investigation of a contemporary phenomenon within its real-world context, case study research can increase the understanding of multilayered relationships (Flyvbjerg, 2006). By questioning these insights with the knowledge base developed from the literature review and the qualitative analysis, the conceptualization can be verified and if necessary further advanced (Eisenhardt & Graebner, 2007).

Recently, EE research tends to utilize case studies about single ecosystems to illustrate theoretical contributions to a specific place (Walsh, 2019). However, from the ethical and scientific standards, it is problematic to draw generalizations from only single and mostly successful ecosystems (Stam, 2015). Future research is obliged to improve generalizability by using a comparative case approach (Roundy, 2020). Hence, using a multiple-case study design as a comparative approach is increasing the robustness of outcomes (Stake, 2005) and ensuring a higher validity of the implications (Yin, 2014). Conducting primary case study research utilizes several data collection techniques such as semi-structured interviews, observations, and documents (Dul & Hak, 2008; Yin, 2014).

In this thesis, the objective of the case study research is to analyze the impact of the local EE on new ventures and their growth processes. In doing so, our study takes a broad

system perspective to deal with the complex interconnection between single EE actors and the local environment (Belitski & Büyükbalci, 2021). Therefore, the two technology-based companies RESTUBE and heliopas.ai from the EE of Karlsruhe have been selected as case examples. The framework of how to conduct case study research in the EE of Karlsruhe has been successfully developed within a pre-study about the ICT companies Astaro, BrandMaker, Gameforge, Knuddels.de, and Web.de during the diploma thesis in 2014. By analyzing the evolution of RESTUBE and heliopas.ai separately and drawing cross-case conclusions afterward, the well-functioning and effectiveness of the local EE have been evaluated (Cunningham et al., 2017). Having these insights in combination with the findings from the previous chapters is mandatory to define the right hypothesis for the statistical tests in the quantitative analysis.

Both studies have been published as separate cases under Henn & Niermann (2020) and Henn et al. (2024).

3.4 Quantitative Analysis

Although the EE approach has become a popular concept for economic development and strategic management, quantitative modeling and survey-based research are still underrepresented (Maroufkhani et al., 2018; Fernandes & Ferreira, 2022). However, as EE research evolves, quantitative methods are rising as well (Chen et al., 2020). Recently, researchers are focusing on the development of EE metrics and measures to create a framework for comparable data (Liguori et al., 2019; Stam & Van de Ven, 2021; Johnson et al., 2022). The non-existence of an adequate diagnosis approach is a major shortcoming and may be a reason why local decision-makers are not successful in building supportive framework conditions, and not learning from previous mistakes (Leendertse et al., 2022). Hence, through the development of a questionnaire-based survey tool, the quantitative part of this addresses these challenges. Following the assumption that startups are the outcome of an EE and can be used as a proxy to conclude the health and resilience of an ecosystem, this artifact enables the collection of data. For the quantitative analysis, the EE of Karlsruhe has been chosen as the investigation area. This selection was made based on two fundamental decision-making factors. First, the local characteristics are similar to further peripheral post-industrial places such as Thessaloniki, Greece (Williams et al., 2013), Sheffield City Region, UK (Williams & Vorley, 2014; Gherhes et al., 2018), Dublin, Ireland (Walsh, 2019), and Guildford, UK (Xu & Dobson, 2019). Second,

personal contacts with the entrepreneurial community of Karlsruhe enable the researchers to receive a high number of respondents and therefore, ensure access to data. Additionally, previous studies conducted in the EE of Karlsruhe have been integrated into the discussion as well (Rabe, 2005; Deubel, 2012).

The objective of a quantitative approach is to determine certain facts, or correlations between facts (Young, 2007). Although quantitative methods are likely to increase the generalizability of the findings, there is still the need to improve rigor and transparency (Lux et al., 2020; Maula & Stam, 2020). Using a questionnaire design as a standardized instrument is an efficient mechanism for structured data collection (Krosnick, 2018). For the design of the questionnaire and the classifications of the responses, this study follows the methodical framework of Rowley (2014). Through the combination of traditional and modern pre-testing methods, the reliability and quality of data could be increased (Geisen & Murphy, 2020). Overall, the quantitative study consists of two analysis parts. First, descriptive statistics are used to visualize the current status of an EE. Thereby, longitudinal data is further developing the evaluation of EEs from a statical to a dynamical level, facilitating the analysis of trends additionally (Leendertse et al., 2022; Fernandes & Ferreira, 2022). However, as research should lead to a better interpretation of phenomena, it is required to move "beyond a purely descriptive analysis" (Anguera et al., 2018). In the second part, a correlation analysis is applied to test the hypotheses, that have been derived from the findings of the literature review and the qualitative study. In doing so, the hypothesis about the impact of EE conditions on the firm performance of young companies can be either verified or falsified. Finally, based on the insights from both parts, evidence-based implications and recommendations for the further development of the EE of Karlsruhe as a concrete example are given. Thereby, the applicability of the questionnaire as an analysis instrument has been proved, improving the rigor and reproducibility of quantitative entrepreneurship research (Maula & Stam, 2020).

4 Systematic Literature Review

For the sake of scientific merit, it has to be indicated properly that the following chapter is the manuscript of a submission that is in revise in the Journal of Entrepreneurship & Regional Development. In this dissertation the article with the title “A pathway towards the resilient growth of entrepreneurial ecosystems: A review.” is cited under the reference of Henn et al. (2023).

4.1 Introduction

In recent years, the popularity and general appreciation of the entrepreneurial ecosystem (EE) approach have grown tremendously (Fernandes & Ferreira, 2022). The Covid-19 pandemic impressively demonstrates the challenges entrepreneurship faces under high uncertainty (Shepherd, 2020; Zahra, 2021). Especially in times of crisis, the competitiveness of a regional economy becomes crucial, as it leads to competitive advantage and secures survival (Cho et al., 2022; Spigel & Vinodrai, 2021). Enhancing entrepreneurial activities within a local environment is a key factor for structural change and economic development (Wennekers et al., 2005; Stough, 2016). In particular, high-growth firms are indicated as driving forces for regional economies, leading to economic wealth and the generation of prosperity (Wong et al., 2005; Roundy et al., 2017). The importance of entrepreneurial processes can be described by a ‘forest metaphor’ illustrating that the permanent birth of young trees is responsible for the renewal of the whole forest and its survival (Windzio, 2013; Spigel & Vinodrai, 2021).

Over the last decade, the appreciation of establishing new businesses and their contribution to sustainable economic development enhanced significantly (Shwetzer et al., 2019; Theodoraki et al., 2022). Nonetheless, already Schumpeter (1934) argued that ambitious entrepreneurship is the fundamental basis of economic growth and development with new value creation in its centre. The importance of high-growth firms for a successful structural change is outlined by longitudinal data analyses observing that job generation is primarily driven by new technology-based firms, not by established companies (Birch, 1987; Song et al., 2008; Kane, 2010). Even in times of crisis, jobs were created through the formation and growth of new ventures, whereas the majority of the established companies had to substantially reduce their number of employees (Devece et al., 2016). As framework conditions influence significantly local entrepreneurial activities in quantitative and qualitative numbers (Urbano et al., 2019; Sternberg, 2022),

there is a definite need for a conducive environment in which entrepreneurs can be innovative and scale their businesses (Spigel et al., 2020). In conclusion, these relevant surrounding factors impact the success of start-ups within the particular EE (Szerb et al., 2019). Especially, interactions between existing elements are leading to an increased performance of regional economies (Alvedalen & Boschma, 2017).

During periods of rapid market changes and high uncertainty, regional economies have to raise their robustness against upcoming crises and exogenous shocks (Williams & Vorley, 2014; Iacobucci & Perugini, 2021). Resilience and the link to entrepreneurship have raised considerable attention in recent discussions (Roundy et al., 2017; Gherhes et al., 2018; Zahra, 2021). Entrepreneurial processes are critical in restructuring local economies continuously, pursuing sustainable and future-oriented structural change (Williams et al., 2013; Belitski et al., 2021; Wurth et al., 2022). Especially in developing countries, EEs contribute largely to overcoming barriers towards resilience, supporting largely the transitioning, and restructuring of economies (Guerrero et al., 2021). Therefore, the overall concept of entrepreneurship is being considered as one possible fundamental solution against poverty all around the world (Sutter et al., 2019).

The most prominent example of a well-functioning EE is the world-famous area of Silicon Valley in California, US (Adams, 2021). Describing preciously the success story of Tel Aviv and the start-up nation Israel, the myth of being the most start-up-friendly ecosystem in the world is promoted (Senor & Singer, 2011). Apart from these popular places, smaller ecosystems are quite successful such as Boulder, Colorado, United States (Neck et al., 2004; Sprinkle, 2015) or Waterloo, Ontario, Canada (Bramwell & Wolfe, 2008; Ensign & Farlow, 2016; Spigel & Vinodrai, 2021). In contrast, there are former flourishing areas, not succeed in having a continuous structural change and broke down. During the financial crisis in 2008, the city of Detroit collapsed economically, and now stands as an example of a dying city and missed economic opportunities (Eisinger, 2014). The understanding of how to reinvigorate an EE that is in recession or is potentially endangered to develop towards this direction becomes increasingly important in future considerations (Walsh, 2019; Belitski et al., 2021).

All of the above leads to the question of why some regions perform better than others do (Venkataraman, 2004; Agrawal et al., 2014; Martin & Sunley, 2015) or overcome crises relatively straightforward while others fail (Christopherson et al., 2010; Roundy et al.,

2017). Regardless of EE literature lacking in a clear analytical framework (Alvedalen & Boschma, 2017), suggestions and guidelines on how to build a sustainable EE have raised considerable attention (Feld, 2012; Theodoraki et al., 2022). Although there have been several attempts to replicate successful EEs somewhere else, no 'one-size-fits-it-all' approach exists (Szerb et al., 2019). Framework conditions are unique in any regional context, driven by the historical development of a specific place and depending on not changeable variables (Mason & Brown, 2014). Having a strong focus on building resilience is highly relevant for all kinds of ecosystems - in particular for small and medium-sized ecosystems as there is inherently economic vulnerability (Briguglio et al., 2004; Roundy, 2017). Examining the link between the EE approach and the concept of economic resilience, the main objective of this study is to provide a detailed understanding of how to strengthen the framework conditions of a regional economy in the long run by increasing entrepreneurial activities qualitatively and quantitatively.

The structure of this study is as follows. Section 4.2, provides a review of the antecedents of regional entrepreneurship. In Section 4.3, we introduce the theoretical framework of the EE approach and economic resilience in the regional context. Section 4.4 presents the methodology of the applied systematic literature review. Then, Section 4.5 analyses the sample of literature on a descriptive level, and in Section 4.6, we discuss the findings. Finally, the implications and contributions of the study are presented and suggestions are made for future research directions.

4.2 Historical Evolution of Entrepreneurship in a Regional Context

Referring to the historical perspective of economic geography, agglomeration is a necessary happening (Nylund & Cohen, 2017). Due to resource bundling, synergy effects lead to additional value creation, resulting in regional comparative advantages (Pitelis, 2012). Over the past decades, there have been developments towards the EE approach generally established nowadays (Schäfer, 2021). Consequently, the theoretical foundation is based on a variety of antecedents of geographical economics concepts (Acs et al., 2017; Brown & Mason, 2017). Identifying the significance of industrial clusters and economic agglomeration in Victorian England within the 19th century, Marshall (1890) came up with the first theoretical concept already more than one century ago. In contrast, Jabobs (1969) argued that diversification leads to knowledge exchange and the transfer of goods and innovative ideas between unrelated industry fields so that a wider range benefits

directly from technological progress. In the scientific community, no final consensus on whether specialization or diversification is more supportive of regional innovativeness and entrepreneurial processes has been reached yet (van der Panne & van Beers, 2006). Whereas Kirznerian entrepreneurship focuses on the quantity of new business creation, Schumpeterian entrepreneurship points out the importance of quality (Szerb et al., 2019). In the 1980s and 1990s, research dealing with the impact of geographical factors on the performances of firms revived under the term 'new economic geography' (Feldman & Tavassoli, 2015). This movement included concepts such as the cluster theory (Porter, 1994), regional innovation systems (Cooke, 1992), high-technology districts (Storper, 1993), localized learning (Malmberg & Maskell, 1999), and innovative milieus (Maillat, 1995). From today's view, all streams of literature shaped the understanding of regional economic development and the EE approach to a certain degree (Malecki, 2018; Scaringella & Radziwon, 2018). Nevertheless, the historical context and the role of regional entrepreneurship have been underrepresented in economic literature (Stam & Welter, 2020). The overall objective of a systemic framework is to clarify the differential performance of regions concerning socioeconomic aspects with its innovativeness and employment as outcomes (Acs et al., 2017).

The idea behind a systemic view of entrepreneurship has been introduced by van de Ven (1993). The concept is based on interactions between actors and components and the creation of new ventures as an outcome of the entrepreneurship system (Spilling, 1996; Neck et al., 2004**).** In contrast to its antecedents, entrepreneurship is promoted as the central part of the conceptualization (Cavallo et al., 2019). Over time, similar expressions such as 'regional systems of entrepreneurship' (Neck et al., 2004), 'entrepreneurial milieu' (Löfsten & Lindelöf, 2003), 'entrepreneurship environment' (Armington & Acs, 2002), and 'entrepreneurial climate' (Hingtgen et al., 2015) were used to describe entrepreneurial processes in a local context. Moore (1993) transferred the ecosystem metaphor from the field of biology to business and social science. Thereby, an ecosystem is described as "a biotic community, its physical environment, and all the interactions possible in the complex of living and non-living components" (Acs et al., 2017). It is a complex system of interdependent human and natural variables co-evolving over time and geographical space (Stough, 2016; Brown & Mason, 2017). The difference lies in the fact that within an ecosystem a single agent cannot survive without the others and in the end, their success is depending on each other (Audretsch et al., 2019).

Although Dubini (1989) introduced the term ‘entrepreneurial ecosystem’ to the scientific community, Cohen (2006) was one of the leading pioneers with his study about the EE of Victoria, British Columbia. The final breakthrough for the EE concept has been the publications of Isenberg (2010) and Feld (2012) and their practical relevance for the mainstream audience. Both publications presented the topic as reader-friendly and easy to understand for non-academics which raised its popularity significantly (Cowell et al., 2018). In particular, the illustration of Isenberg (2010) became the starting point of a new understanding of regional economic development towards a biology-inspired perspective (Kuckertz, 2019). The EE approach seems to be closely connected in its evolutionary process to related concepts such as innovation, business, and knowledge ecosystems (Scaringella & Radziwon, 2018). Hence, it is important to distinguish between these concepts and in conclusion, to set up clear boundaries (Spigel & Harrison, 2018; Shwetzer et al., 2019).

4.3 Theoretical Framework

4.3.1 Entrepreneurial Ecosystem Approach

Recently, the total number of publications about EEs has risen sharply, increasingly attracting attention in academic and policymaking circles (Fernandes & Ferreira, 2022). Literature reviews have highlighted significant growth in publications since 2014 (Cao & Shi, 2021; Kang et al., 2021). Nevertheless, research on EEs is still ‘quite young’ (Alvedalen & Boschma, 2017), ‘in its infancy’ (Maroufkhani et al., 2018), and also referred to as the ‘latest fad’ (Martin, 2015; Brown & Mason, 2017). Hence, the research domain is considered still fragmented and undertheorized (Wurth et al., 2022). However, the increasing relevance can be made evident by the fact that the wording ‘entrepreneurial ecosystem’ has replaced all other terms for regional entrepreneurship (Malecki, 2018). Indeed, the sample of EE literature contains five times more publications compared to the entrepreneurial system literature (Alvedalen & Boschma, 2017).

After the initial starting point of a new line of research was set up by the work of Isenberg (2010) several subsequent models evolved out of this by adapting additional components to the concept or restructuring them (Shwetzer et al., 2019). Although no common understanding of what an EE exactly is has evolved yet (Malecki, 2018), most definitions are based on interactions between different actors and factors in given geographical boundaries, regulated in such a way that productive entrepreneurship is enabled (Stam,

2015). For a long time, the lion's share of entrepreneurship literature has focused on the characteristics and behavior of individuals or firms (Shane, 2003; Cavallo et al., 2019). Economics and entrepreneurship studies rarely considered the role of framework conditions and their impact on the performance of new ventures (Brown & Mason, 2017; Spigel & Harrison, 2018). In contrast to its antecedents, the EE approach offers a distinctive viewpoint by placing the entrepreneurial activity and socio-territorial entity as a pillar of an adequate conceptualization (Brown & Mason, 2014). Hence, its novelty 'lays in the focus on (productive) entrepreneurship as an output of the ecosystem' (Acs et al., 2017). As a unique characteristic, entrepreneurs and their interactions with the surrounding regional resources are placed at the center of the concept (Walsh, 2019).

Even though the EE approach receives broad acceptance so far, several studies raise critical questioning concerning the methodological maturity and the delimitation from other concepts of regional economic development (Shwetzer et al., 2019; Cantner et al., 2021). Frequently, it is still seen as just a metaphor from biology, not taken seriously enough (Kuckertz, 2019). Skeptical reviews raised concerns about the concept of EE being 'only new bottles from old wines' (Scaringella & Radziwon, 2018). According to these observations, shortcomings concerning the concept of EEs exist, and further development is needed to improve the theory and validate it empirically (Alvedalen & Boschma, 2017). Toward a future agenda, the following underdeveloped topics and weaknesses have been identified. First of all, an explicit boundary to similar concepts such as business or innovation ecosystem has to be tightened (Scaringella & Radziwon, 2018). Secondly, there is still no common understanding of the term 'entrepreneurial ecosystem', resulting from an insufficient amount of empirical studies (Malecki, 2018; Audretsch et al., 2019). Hence, a clear analytical framework concerning cause and effects in EE has not been developed yet (Alvedalen & Boschma, 2017). Even if single determinants were identified in-depth, less effort was set on the connectivity between these elements, especially on how they are influencing each other's performance (Motoyama & Knowlton, 2017; Roundy et al., 2017). Another aspect not sufficiently considered in EE literature yet is which capabilities are needed for market penetration and scaling of new ventures (Walsh, 2019). Although conducting case studies with a focus on one single region is valuable, there is a lack of comparative and multi-scalar analyses (Stam & van de Ven, 2021). Lastly, existing conceptualizations are static, documenting only the status quo, and are not able to illustrate evolutionary dynamics (Cho et al., 2022).

4.3.2 Economic Resilience

Similar to the EE literature, the concept of economic resilience in a regional context has emerged significantly in recent publications and is applied in a wide range of disciplines, including social science and economics (Walsh, 2019; Iacobucci & Perugini, 2021). Illuminating economic change and adaption as well as examining responsiveness to exogenous and endogenous shocks gained increasing popularity (Williams et al., 2013; Roundy et al., 2017). Nevertheless, the concept of resilience stayed underdeveloped and understandably fuzzy (Gherhes et al., 2018). Although resilience is acknowledged as a system-level characteristic of an EE (Martin, 2012; Roundy et al., 2017), there is ambiguity on what regional economic resilience is and how the determinants should be conceptualized and measured (Martin & Sunley, 2015). Furthermore, there is no common understanding of how a region should be transformed and what element combination within an EE is leading to a lasting structural change and economic resilience (Walsh, 2019). The question of why some regions succeed easily in overcoming crises while others fail remains unanswered (Christopherson et al., 2010).

Although examining the notion of resilience is a novel trend in entrepreneurship, it has been used in the fields of ecology and psychology (Martin & Sunley, 2015). Scientific articles have been published in a broad spectrum such as biology (Walker, 1995; Elmqvist et al., 2003), socio-ecological systems (Walker et al., 2004), and business-related environments (Carayannis et al., 2014). Thereby, resilience is described as the capacity of a system to anticipate and react to unpredictable shocks from outside, to absorb them while maintaining its structural conditions as well as to return to the previous state after the incidents are over (Martin, 2012). In addition, economic resilience can be understood as ‘the ability to recover from or adjust to the negative impacts of external economic shocks’ (Briguglio et al., 2004). According to Dawley et al. (2010), it is ‘the ability of regions to be able to ‘bounce-back’ or ‘comeback’ from economic shocks and disruptions’. Whereas ‘robustness’ is closely connected, both should not be confused with the ‘resistance’ of an ecosystem (Martin & Sunley, 2015). To create economic resilience on a local or regional level, the short-term handling of shocks as well as the long-term adaptation to develop new paths have to be considered as important issues (Boschma, 2015). However, resilience is not the same as resistance, and therefore, the long-term evolutionary nature of a system is preferable to be strengthened (Roundy et al., 2017). Thus, one major objective of the conceptualization of resilience is to avoid negative

consequences and economic decline through an external shock and to enable new growth paths afterward (Hassink, 2010). In the context of EEs, resilience is the 'health' of a particular region (Roundy et al., 2017). Similarly, to the EE approach, the importance of regional economic resilience is shown by the fact that political decision-makers are using the concept as a new way for the future planning of local economies (Martin & Sunley, 2015). Although there have been initial approaches to quantify economic resilience (Briguglio et al., 2004), a representative measurement tool has not been established yet (Cantner et al., 2021). Consequently, empirical research on regional economic resilience is rather scarce (Iacobucci & Perugini, 2021).

In the entrepreneurship literature, resilience is additionally used as a personality trait of an entrepreneur and his/her mental strength (Bernard & Barbosa, 2016). For the long-term success of a start-up, this ability is certainly one of the key factors (Song et al., 2008). Although being diverse approaches, the concepts of EEs and economic resilience have considerable synergies which not have to been explored in the scientific literature yet (Williams et al., 2013; Iacobucci & Perugini, 2021). Although research has been done on entrepreneurship at a national level, the dynamics of entrepreneurial processes and resilience on an urban or local scale have been widely ignored (Gherhes et al., 2018). Therefore, it is important to build a bridge between both concepts and identify patterns of regional growth (Martin & Sunley, 2015). This article is intended to complement the emergent literature by examining the link between regional economic resilience and the development of EEs.

4.4 Methodology

In this study, we followed the guidelines of Kraus et al. (2020) to ensure a well-structured review process and to reach a thorough coverage of academic literature. In doing so, replicability and a high validity of the findings and the contributions to theory are ensured. The objective of this study is to provide a holistic view of relevant research articles in the fields of EEs and resilience and consequently, to identify connecting factors for a future research agenda (Kitchenham & Charters, 2007). Therefore, relying on a high-quality selection of studies is more worthwhile than just a large number of articles (Petersen et al., 2015). According to the recent discussion, research gaps have been identified to build up a broader knowledge base related to the specific research question (Kraus et al., 2020). In doing so, we provide a valuable basis for future research projects.

Planning stage

Derived from of the previous insights, the following research questions are formulated:

- RQ 1. What is the link between the concepts of entrepreneurial ecosystems and economic resilience?
- RQ 2. How to set up the framework conditions of an entrepreneurial ecosystem to facilitate the transformation process towards a resilient stage positively?
- RQ 3. How to measure the performance of an entrepreneurial ecosystem and its resilience?

Research protocol

The infancy of the EE research stream is reflected by the low complexity of the applied search strings in recent reviews (Alvedalen & Boschma, 2017; Cavallo et al., 2019; Cao & Shi, 2021; Fernandes & Ferreira, 2022). As a first step, we transformed the research questions into specific keywords. To cover a wide spectrum of relevant studies, synonyms of the terms have been identified and added to the search query. In conclusion, we applied the search string 'entrepreneur* ecosystem*' AND 'resilience*' in common electronic databases for scientific publications known as EBSCO (Academic Search Premier and Business Source Premier), Science Direct, Scopus, Springer Link, and Web of Science. To round things up, a non-structured search was conducted at ResearchGate and Google Scholar. In addition, the forward and backward search procedure of Webster & Watson (2002) has been integrated into the review design to ensure the identification of all relevant sources. Spreading the search process over various databases leads to a high level of coverage of academic literature (Alvedalen & Boschma, 2017). In doing so, it is of high necessity to conduct the review process even more strictly concerning the reliability of publications and their findings (Kitchenham & Charters, 2007).

Criteria for selecting suitable and valuable literature

Ensuring high quality and transparency during the selection process of primary studies is critical for the validity of a systematic literature review. For the credibility of the proceeding, we selected the following criteria for including and excluding publications. Included studies have to be (1) written in English, (2) published as a journal article, (3) peer-reviewed, (4) available in full-text, not requiring paid access, (5) containing at least once the concrete indication 'entrepreneurial ecosystem'. Furthermore, and (6) the reliability of the research methodology and its findings has to be given. Publications that (7) don't have any or less theoretical foundation or (8) bias by only describing a single

case of an EE without any theoretical contribution were excluded. In addition, (9) research articles with no clear distinction to related concepts like innovation or business ecosystem were removed. As the term 'entrepreneurial ecosystem' is a timestamp itself, the year of publishing is not defined as an inclusion or exclusion criterion.

Conducting phase

The search for articles of relevance has been conducted in Q4 of 2021. Using a funnel principle, the procedure has been divided into multiple steps. At first, a title and abstract analysis according to Brereton et al. (2007) has been applied. After the initial query, 578 relevant items could be identified as potentially relevant. Each article has been analyzed based on the relevance concerning the selection criteria. In cases with insufficient information in the title and abstract but with a highly relevant research question, the conclusion chapter was scanned likewise. Subsequently, by following including and excluding criteria thoroughly a sample of 72 suitable studies has been selected. According to the guidelines of Webster & Watson (2002), the following steps were (1) going backward based on the lists of references from the identified literature and then (2) going forward on the most relevant scientific articles by using the functionality of Scopus and Google Scholar. These steps were vital to ensure that all relevant publications were identified transparently (Kraus et al., 2020). Hereby, the same criteria for including and excluding were applied and 33 unique items could be added to the final selection of 105 primary studies (see Appendix A1). The high number of publications excluded within the selection process can be traced to the different understanding of the term 'ecosystem' in the context of entrepreneurship and the blurring with other types of ecosystems (innovation, business, knowledge, technology). In doing so, we kept the scope of the investigation sharpened.

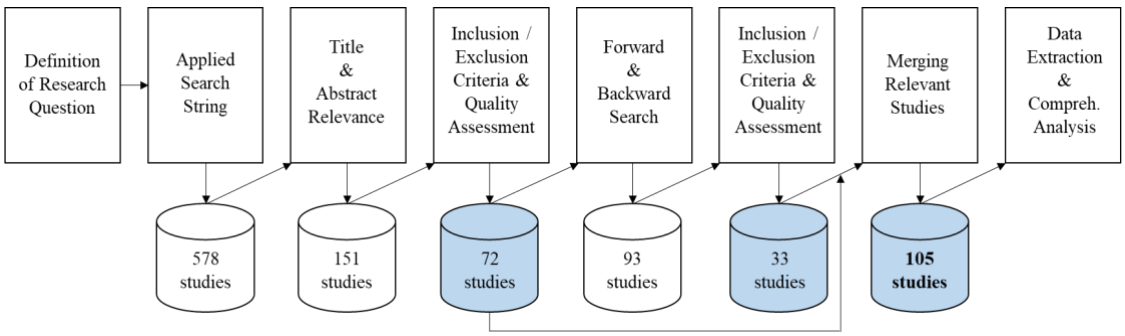

Figure 7. *Literature search and selection process. Adapted from Petersen et al. (2008)*

4.5 Descriptive Analysis

The in-depth search procedure revealed a sample of 105 unique items. The interest in research around the EE concept and resilience has increased significantly (see Figure 8). Hence, it can be considered thoroughly as an emerging research discipline. Furthermore, it is worth mentioning that the lion's share of research articles has been published after 2017. Since then, the annual number of publications has been permanently remaining at a high level. Only in 2020 did the publication activity decrease as a result of the Covid-19 pandemic. Peaking up a total of 25 publications in 2021, the strategic importance in recent scientific debates is emphasized. These figures are confirming the evolutionary path of the EE literature presented in recent systematic reviews (Shwetzer et al., 2019; Cao & Shi, 2021; Fernandes & Ferreira, 2022).

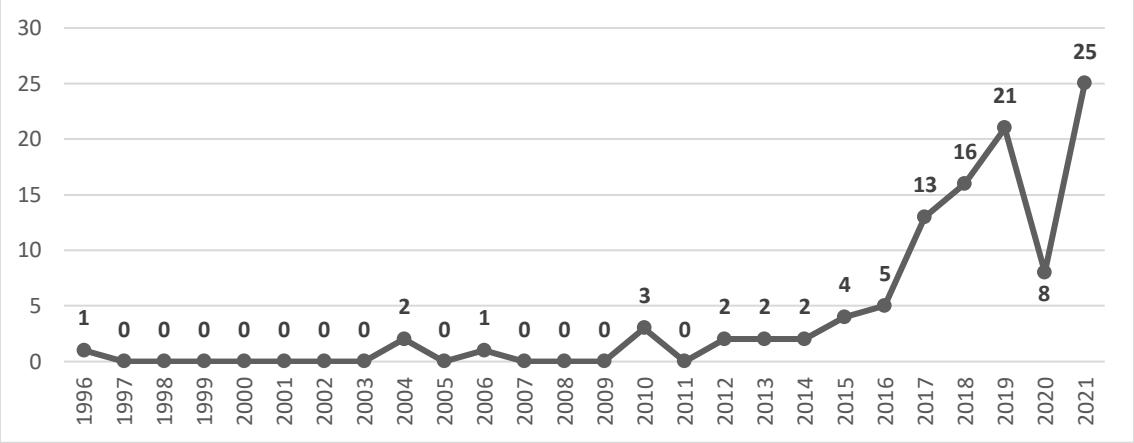

Figure 8. *Publication years of included articles*

Research Fields

As its broad spectrum of antecedents may suggest, the EE approach is driven by a wide range of perspectives. Nonetheless, the majority of publications are related to the research fields of business and management (41), economics (31), and social science (13). However, scientific papers from categories such as geography, planning and development studies, strategic management, urban studies as well as management of technology and innovation are to be found in the sample likewise. Thereby, the journals of Small Business Economics (17), Entrepreneurship and Regional Development (8), Journal of Enterprising Communities (6), Journal of Technology Transfer (5), Local Economy (4), and Strategic Entrepreneurship Journal (3) stand out as the most frequent.

Country and Geography

Many studies in the context of regional entrepreneurship have been conducted in the United States or European countries. Over a longer period, research evidence has been affected mainly by the US literature and its perspective on entrepreneurial activities (Kang et al., 2021). Although our sample illustrates a slight dominant role of the US community (55 percent), a switch towards European research contributions (40 percent) is observable. Interestingly, the years between 2018 and 2021 reveal that the percentage distribution between the US and Europe has become nearly balanced. Analyzing a variety of cases, international research collaborations have been formed. Nationalities that are covered within these studies are the UK, Germany, Greece, France, Norway, Ireland, Italy, Spain, Estonia, and more. This broad range of interest groups is a strong indicator of high awareness across borders. Research articles focusing on areas in developing markets such as Latin America, Asia, and Africa are underrepresented so far. Thus, there is still the necessity to better integrate these additional perspectives.

Methodological approaches

Concerning the methodological approaches applied in the studies, a prevalence of empirical (55 percent) over conceptual (45 percent) can be observed. Accordingly, it can be concluded that the EE approach has grown in maturity and seriousness by overcoming the initial conceptual stage. This finding is remarkable as just two years ago the numbers have been exactly the other way around (Shwetzer et al., 2019). Furthermore, the majority of the identified literature is based on a qualitative inquiry with high utilization of in-depth or semi-structured expert interviews. Additionally, the usage of single case studies is a highly demanded tool in entrepreneurial research (Duxbury, 2012). Analyzing specific conditions in one place to further develop the theoretical foundation addresses this request. Due to the increasing volume of primary data, the necessity for summarizing the knowledge base in secondary studies is fulfilled by literature reviews and discussion papers addressing single aspects of the EE approach. Besides the weaknesses of multi-case studies, the predominance of qualitative approaches reveals a lack of quantitative and mixed methods studies which are still playing a tangential role.

4.6 Findings

The findings of our review emphasize the assumption that well-functioning EEs are critical for restructuring local economies continuously and hence, are a pathway toward

economic resilience. Nevertheless, it is not an adequate behavior to react only when the phase of decline has arrived (Cantner et al., 2021). Upfront preparation is softening the effects of external, unpredictable shocks, increasing the ability to reach the previous status more likely (Walsh, 2019). Building resilience in EE is not a linear process (Cloutier & Messeghem, 2022) and the national-level policy has failed for decades in doing so (Gherhes et al., 2018). Astonishingly, entrepreneurship is often perceived as something that seems to just happen under a certain set of conditions (Isenberg, 2016). In addition, it is a persistent question under which framework conditions entrepreneurial firms shape and how the existence of successful new ventures influences economic, technological, and societal thinking within a regional context (Audretsch et al., 2019; Neumeyer et al., 2019). As the outcome of an EE is rather unforeseen and not predictable, the support of entrepreneurial activities is an inevitable principle (Theodoraki & Catanzaro, 2022).

In the context of EEs, the term resilience is referred to the 'health' of the ecosystem (Roundy et al., 2017). It is defined as the ability of an EE to continuously recover from exogenous shocks and endogenous pressures and to adapt to these shifting conditions (Roundy & Bayer, 2019). The loss of a major anchor employer, deindustrialization, and the change of technological paradigm are potential triggers challenging the resilience of EEs (Spigel & Vinodrai, 2021). Understanding how to reinvigorate an ecosystem becomes increasingly relevant as its evolutionary path needs to consider a strong foundation of existing capabilities and further resources within the EE (Walsh, 2019; Cho et al., 2022).

The overlap between the fields of entrepreneurship and resilience spans several disciplines, not limited to economics and geography (Korber & McNaughton, 2018). Besides the meso- and macro-level perspective (regions, communities, economies), the success of new ventures is depending on the traits of founders and their mental resilience (Bernard & Dubard Barbosa, 2016) and organizational resilience at the firm level (Duchek, 2020). Previous studies reveal weaknesses by focusing on the observation of successful EEs rather than doing in-depth social science (Spigel & Harrison, 2018). Hence, there is a distinct necessity to create a comprehensive understanding of all dimensions regarding EE characteristics to support emergent ventures in an adequate way (Kuratko et al., 2017). Building a resilient EE pursues a long-term horizon, whereby the proper shaping of transformation processes is leading to sustainable growth (Walsh,

2019). In further developing a concrete place, it is essential to be fully aware of all local aspects to set up implications afterward (Theodoraki et al., 2022). Based on the existing literature, we utilize four core dimensions to categorize our findings. First, we build a holistic understanding of all determinants affecting processes within an EE. Second, knowledge about the evolutionary aspects of an EE is gathered in its entirety. Third, we discuss how an EE can be measured and what kind of statements can be derived. Fourth, we present multiple perspectives and critical aspects concerning the resilient growth of EEs.

4.6.1 Determinants of an Entrepreneurial Ecosystem

Contrary to the general perception, the development of an EE is a complex issue, not just based on a two-actor game between policy and the entrepreneurs (Scaringella & Radziwon, 2018). Over the last few years, a lot of work has been done to identify the wholeness of determinants describing an EE (Shwetzer et al., 2019). This understanding is essential to provide entrepreneurs with sufficient framework conditions to be able to unfold the whole potential of their firms without restrictions (Theodoraki et al., 2018). In doing so, the outflow to other places is prevented and resources from outside are attracted to participate (Spigel & Harrison, 2018). Although a widespread critique of the EE approach is that the elements are displayed only statically at a certain point in time, it is indispensable to be aware of them and their functionality (Alvedalen & Boschma, 2017; Cho et al., 2022). Having a comprehensive list of determinants influencing entrepreneurial processes at a specific place became a precondition for further in-depth analyses. Due to this, improvement strategies toward a higher degree of resilience can be set up and implemented afterward (Brown & Mason, 2017; Roundy et al., 2017).

Evoking that the genesis of EEs is built on various roots over a long-term period, the number of potentially influencing factors seems quite overwhelming. Based on traditional hard and soft location factors, Isenberg (2010) restructured relevant determinants into an entrepreneurial setting. The EE approach is based on a framework of six domains (policy, culture, markets, human capital, finance, and support), twelve subdomains, and a total of 51 distinct components. However, the conceptualization is slightly simplified with a focus on the main elements, ensuring practical usage for a broad audience (Cavallo et al., 2019). Nevertheless, scholars have criticized the compilation of determinants as being biased by the US perspective (Maroufkhani et al., 2018; Cao & Shi, 2021; Kang et al., 2021).

Although the EE concept has gained high popularity, there is still the necessity to add aspects for achieving a comprehensive understanding of the underlying conditions and the ongoing entrepreneurial processes (Shwetzer et al., 2019). Consequently, subsequent studies have been questioning the completeness of the EE approach by addressing elements not appearing yet but should be included to reduce vulnerability (Velt et al., 2018; Stam & van de Ven, 2021). In addition, those studies further modified the arrangement to a multi-level perspective (Stam, 2015). Furthermore, Spigel (2017) categorized the attributes into cultural aspects (cultural attitudes, histories of entrepreneurship), social aspects (networks, investment capital, mentors and dealmakers, worker talent), and material aspects (universities, support services, and physical infrastructure, policies, and governance, strong local markets). Using a thorough analysis of existing literature, Maroufkhani et al. (2018) added three further aspects to the EE approach. Whereas 'crowdsourcing' and 'industrial dynamics' are presented as two additional domains, 'incubator funding' is listed as a sub-category of finance. In contrast, Velt et al. (2018) subordinated 'crowdfunding' and 'bootstrapping' to the domain of finance.

The involvement of soft factors such as cultural aspects and social norms is underrepresented (Walsh & Winsor, 2019; Donaldson, 2020). The 'attractiveness of the region' fulfills the social and cultural needs of human capital by securing a high level of worth living (Neck et al., 2004; Audretsch & Belitski, 2017; Nicotra et al., 2018). Worthwhile emphasizing is that the factor 'trust' is an essential ingredient for the processes within entrepreneurial communities, significantly impacting productive entrepreneurship and economic performance (Muldoon et al., 2018). Trust, especially 'interpersonal trust', is increasing in communities with a high level of interactions between all stakeholders (Scott et al., 2021). Nevertheless, it is essential not to fall into the status of blind trust by finding a well-adjusted balance between trust and distrust to keep the entrepreneurial endeavor successful (Muldoon et al., 2018). An entrepreneurial culture that is built on collaboration, cooperation, trust, and reciprocity has a positive influence on the connectivity between all elements which makes the ecosystem more resilient (Scott et al., 2021). A pronounced entrepreneurial culture is influencing traits such as tolerance of failure and risk positively (Roundy et al., 2017). With high standing in society, entrepreneurship is more likely seen as a career choice, increasing the 'preference for self-employment' (Nicotra et al., 2018; Sternberg et al., 2019).

To attract resources from outside, ‘onramps’ and ‘access points’ are needed to minimize the barriers to participating in the entrepreneurial community (Spigel & Harrison, 2018). In addition, the ‘openness of markets’ (Spigel, 2017) and the accessibility of domestic and foreign markets (Nicotra et al., 2018; Sternberg et al., 2019) are critical aspects for resilient growth of startups. ‘Early customers’ and ‘strong networks’ have a significant influence on the exploitation of the full potential by setting up collaborations between young firms and established companies or institutions (Hernandez & González, 2017; Spigel & Harrison, 2018). Due to that, ‘dealmakers’ and ‘mentorship’ for enabling collaborations and connecting the dots are of high relevance (Spigel, 2017; Shwetzer et al., 2019). Hereby, acting as an intermediary is unleashing potential in an efficient manner, especially in an international context (Theodoraki & Catanzaro, 2022). The impact of single determinants changes over the stages of a company. Whereas bootstrapping and crowdfunding are more relevant in the early processes, human capital and risk capital have a larger effect in the growth stage (Velt et al., 2018). Elements may encourage searching for opportunities and starting a business (Cantner et al., 2021), or ensure scaling companies stay in the region (Gherhes et al., 2018). However, for the pathway towards the resilient growth of EEs, more effort is needed to understand what factors are adaptable in the short term and which have to be taken for granted.

4.6.2 Entrepreneurial Ecosystem Evolution

EE literature is rather taking a snapshot of the elements than systematically reflecting on the evolutionary nature (Alvedalen & Boschma, 2017; Velt et al., 2020). However, a listing of factors is not sufficient enough to delineate highly variegated dynamics (Malecki, 2018). As the majority of studies focus on the documentation of the present status, interdependencies between determinants and their evolutionary dynamics are still a deficiency (Mack & Mayer, 2016). Inherent dynamics that lead to the development of an EE have been neglected so far (Cantner et al., 2021) and hence, the evolutionary pathway is undertheorized (Cho et al., 2022). However, the understanding of evolutionary aspects is an indispensable prerequisite to answering the question of how a region might transform into a resilient stage (Walsh, 2019). Observing the presence of resources and their circulation leads to an improved perception of development processes and enables the identification of barriers to overcome (Neumeyer et al., 2019; Guerrero et al., 2021). An evolutionary perspective is valuable to highlight the impact of history, culture, and institutional settings (Mack & Mayer, 2016). The awareness of these systemic linkages

enables distinguishing between different typologies of EEs and particular challenges (Spigel & Harrison, 2018; Xu & Dobson, 2019).

Resilience is an adaptive conceptualization based on dynamic processes with permanently changing circumstances (Martin, 2012; Williams & Vorley, 2014). In the context of EEs, it is the ability to continuously adapt in response to shifting external and internal conditions (Roundy & Bayer, 2019). Hence, using an evolutionary perspective is required to identify which factors lead to sustainable EE development (Theodoraki et al., 2022). For strategic planning, the awareness of in which stage an EE is and how to address the current challenges is crucial (Mack & Mayer, 2016; Cantner et al., 2021). The creation, flow, and transformation of resources and their recycling are key processes towards a resilient landscape (Spigel & Vinodrai, 2021). Although EE literature has thus far been seen as rather static, recent studies offer a novel technique to better understand the transformation processes towards resilience (Korber & McNaughton, 2018; Cho et al., 2022). Improving the resilience of an EE relies on a long-term evolutionary nature rather than a short-term equilibrium (Christopherson et al., 2010). Leadership is obliged to rethink strategic decisions for the sustainable development of regional EEs (Roundy, 2021; Theodoraki et al., 2022).

In recent EE literature, dynamic approaches adapt on either a life-cycle or process-based view (Korber & McNaughton, 2018; Cho et al., 2022). Through the development of an evolutionary framework that realizes the integration of elements and how they evolve, Mack & Mayer (2016) categorize the phases of an EE in birth, growth, sustainment, and decline. Brown & Mason (2017) simplified the classification by introducing embryonic or scale-up ecosystems. Discussing the relationship between different types of governance design and the needs of an EE throughout its evolution, Colombelli et al. (2019) divided the phases into birth, transition, and consolidation. In addition, Cantner et al. (2021) modified the EE life-cycle by adding the fifth phase and renaming them as birth, growth, maturity, decline, and re-emergence. In contrast to the life-cycle approach, Spigel & Harrison (2018) introduced a process-based view, following the assumption that EEs can be differentiated between strong, well-functioning ecosystems and weaker, poorly functioning ones. Strengthened EEs either evolve to a resilient or a weakened stage. Both conceptualizations illustrate the transformation of EEs, required to answer the question of how a region might evolve (Content et al., 2019; Walsh, 2019). By combining

structural aspects with attributes and a dynamic approach with sequences, a whirlwind model has been introduced as a notion of EE path dependence (Cloutier & Messeghem, 2022). In each phase of all models, different particularities are crucial to reach the status of resilient growth (Spigel & Harrison, 2018; Cantner et al., 2021). Additionally, certain challenges need to be fulfilled to proceed to the next phases (Brown & Mason, 2017; Colombelli et al., 2019).

Birth (Nascent, Initial)

In the birth phase, the EE is strongly fragmented in 'satellites' (Walsh, 2019) or relies on the existence of a single anchor organization in the centre (Spigel & Harrison, 2018). The formation of new ventures is based on the decision of individuals to become an entrepreneur (Cantner et al., 2021). The birth rate of new firms is low and the connectivity between the elements is weakly pronounced (Mack & Mayer, 2016; Spigel & Harrison, 2018). Support actors are not linked to high-growth firms and resources are tend to leave to other ecosystems (Harima et al., 2021). However, manifold relationships among EE actors reduce the opportunity costs of new venture creation (Cantner et al., 2021). In this initial phase, the focus is on the exploitation of ideas and the search for entrepreneurial opportunities (Auerswald & Dani, 2017). By connecting 'existing things', spill over effects create a positive thrust (Cantner et al., 2021).

Growth (Strengthening)

The growth stage is characterized by the emergence of entrepreneurship culture, encouraging further individuals to start their businesses (Cantner et al., 2021). Following a 'hub and spoke' metaphor, EE resilience is strengthened by the existence of multiple anchor organizations (Spigel & Harrison, 2018) and a higher level of connectivity between the actors (Scott et al., 2021). Due to the increased coherence, a specific focus emerges and the EE evolves towards a Marshallian economic structure (Walsh, 2019). An increasing number of services leads to higher competition, improving the quality of the support infrastructure (Theodoraki et al., 2018). Dealmakers and mentors are directly connecting the dots in the ecosystem, positively influencing the effectiveness of processes (Shwetzer et al., 2019; Belitski & Büyükbalci, 2021). As intermediaries, these agents create a vibrant entrepreneurial scene, lowering the entry barriers for new projects (Stam & Welter, 2020). For resilient growth, the role of financial capital and human capital is significantly enhanced (Spigel & Vinodrai, 2021). Therefore, new resources have to be

attracted from other places to the region (Spigel & Harrison, 2018). As first success stories lead to a change of culture and increasing social recognition, becoming an entrepreneur is more likely seen as a career choice (Roundy, 2016; Cantner et al., 2021).

Maturity (Resilient)

The maturity stage is characterized by a stabilization of the entrepreneurial processes on a high level, and thereby, the visibility of the EE grows to a national and international scale (Cantner et al., 2021; Bouncken & Kraus, 2022). Subsequently, significant new resources are attracted from outside the ecosystem, supporting the evolutionary nature (Harima et al., 2021). Besides a high level of connectivity between the actors, it is additionally important to set up global connections to other EEs (Spigel & Harrison, 2018; von Bloh et al., 2020). The number of success stories and resulting firm exits is on high level (Mack & Mayer, 2016; Cho et al., 2022). Access to financial resources is guaranteed at any time, not limiting the growth potential of start-ups anymore (Cantner et al., 2021). However, successful companies are in need to hire a skilled labor force, resulting in a high level of salary which makes it difficult for early-stage start-ups to compete (Sternberg et al., 2019). Additionally, this makes it less attractive for talents to create new ventures (Cantner et al., 2021). The support infrastructure has to be adapted to the growing needs of stakeholders and specialized policies have to be refined to set new impulses for reinvigoration (Mack & Mayer, 2016). Although having a focus is leading to spill over effects, a resilient EE is characterized by a promotion of entrepreneurship not limited to a specific type (Oliver et al., 2015; Nylund & Cohen, 2017; Scheidgen, 2021). The internationalization of EEs and the exchange of resources lead to a regional competitive advantage in a global economy (Saxenian, 2007; Harima et al., 2021). However, the support ecosystem has to adapt to the transnational activities of entrepreneurs, facilitating the entry of start-ups into foreign markets (Theodoraki & Catanzaro, 2022). Furthermore, close connections to multinational enterprises and the resulting technological heterogeneity produce a more resilient EE (Ryan et al., 2021).

Decline (Weakened)

If entrepreneurial processes are not functioning, an EE is more likely to fall into the status of a weakened one (Spigel & Harrison, 2018), and subsequently, capabilities are leaving the ecosystem (Cunningham et al., 2019). As the creation of new ventures decreases, networks are more likely to collapse due to the high outflow of resources (Mack & Mayer,

2016). Especially in less developed ecosystems, the loss of companies, entrepreneurs, talents, and financial capital forces high-growth firms to move to stronger entrepreneurial communities (Spigel & Harrison, 2018; Espinoza et al., 2019). Creating an understanding of how to reinvigorate an EE that has arrived in the stage of decline is a crucial success factor for sustainable economic development (Walsh, 2019, Theodoraki et al., 2022). However, the decline stage should be seen as a creative destruction phase, creating a high number of entrepreneurial opportunities (Auerswald & Dani, 2017). In doing so, EEs can recreate their competitive advantage (Cho et al., 2022).

Permanently ongoing processes of reorganization, recycling of resources, and searching for new business opportunities related to upcoming trends and niches avoid EEs to slip into decline (Malecki, 2018; Spigel & Vinodrai, 2021). This self-perpetuating effect prevents outflow, leading to increased resilience (Roundy et al., 2017). Stronger ties of networks within an EE are supportive of entrepreneurial recycling and re-emerge (Walsh, 2019). Knowledge transfer and entrepreneurial learning positively influence the process of recycling, and therefore, dealmakers, business advisors, and mentors need to be involved to a high degree (Brown & Mason, 2017; Guerrero & Espinoza-Benavides, 2021). The reinvesting of cashed-out entrepreneurs as business angels in close geographic proximity is seen as a critical injection for long-term evolution (Spigel & Vinodrai, 2021). This recycling of entrepreneurial resources impacts regional adaptability and leads to the growing resilience of the EE (Wurth et al., 2022).

The pragmatic purpose of an EE is to secure its permanent renewal and survival (Malecki, 2018; Zahra, 2021). This self-driven reformation is inevitably linked to the resilience of the EE (Roundy et al., 2017). Hence, a certain proportion of the EE should continuously search for entrepreneurial opportunities to adapt to new trends and disruptive technologies quickly (Cantner et al., 2021; Sternberg, 2022). However, these processes are already crucial in the previous stages of growth and maturity (Mack & Mayer, 2016; Spigel & Harrison, 2018). Established networks support the reorganization of EEs by accelerating the exploitation of entrepreneurial opportunities and the continuous formation of new ventures (Carayannis et al., 2018; Scott et al., 2021). Socio-cultural factors are likely to harm the evolutionary dynamics of EEs (Walsh & Winsor, 2019). Thus, building social capital is one of the main challenges in sustainable EE development (Madriz et al., 2018; Theodoraki et al., 2018; Colombelli et al., 2019). Additionally, it is

important to address the change in cultural aspects such as trust, fear of failure, and preference for self-employment towards an entrepreneurial mindset (Henn et al., 2022a). Social boundaries need to be minimized so that nobody is left out and the EE can evolve to its full potential (Neumeyer et al., 2019).

4.6.3 Perspectives on EE Resilience

Scope and Spatial Scale

In case the success of an EE relies on a specific combination of single determinants, reproduction to other places around the world would be relatively easy (Bouncken & Kraus, 2022). However, a 'one-size-fits-all' approach is too prescriptive, and not flexible enough to meet local circumstances (Szerb et al., 2019; Belitski & Büyükbalci, 2021; Roundy, 2021). In addition, it remains inconsistent how a 'place' in the EE concept is geographically defined, be it cities, regions, nations, or otherwise (Stam & Spigel, 2016; Acs et al., 2017). Despite the local nature of entrepreneurship, the EE approach has focused on the national level for a long period (Acs et al., 2018). Recently, there is an increasing shift outlining the importance of an urban and local perspective on entrepreneurship (Nylund & Cohen, 2017; Cowell et al., 2018). Although recent studies have repeatedly raised the question about the spatial scale (Schäfer, 2021; Wurth et al., 2022), no generally accepted understanding of EE boundaries has evolved (Malecki, 2018). Therefore, different perspectives and dimensions are needed to describe EEs and resilience in a geographical context (Spigel & Harrison, 2018; Audretsch et al., 2019). By comparing EEs with a noticeable density of entrepreneurial activities, similar patterns of growth and evolutionary paths are observable (Bouncken & Kraus, 2022; Cantner et al., 2021).

To answer the question of to which extent decisive elements are pronounced in a particular context, there is a strong need to identify substantially responsible indicators and to further study the local scale of EEs (Malecki, 2018). Thereby, city, region, and country are presented as layers of analysis targeting entrepreneurship in a geographical context (Stam, 2015). However, the spatial axes need to broaden the EE concept beyond geographical perimeters (Theodoraki & Catanzaro, 2022). The EE framework includes insights on entrepreneurial activities from the micro-, meso- and macro-level (Theodoraki & Messeghem, 2017; Neumeyer et al., 2019). Although entrepreneurship takes place as a local event primarily, global linkages and distant resources are critical for EE

development (Harima et al., 2021) and it is crucial to adopt an 'international lens' (Theodoraki & Catanzaro, 2022). These transnational connections are beneficial to the identification of global business models (Monaghan et al., 2020; Zahra, 2021). In addition, global market reach is outlined as a key indicator of a resilient EE (Gauthier et al., 2017), especially well-conducted in smaller countries such as the Netherlands (Stam, 2015), Finland (Autio & Ranniko, 2016), Isreal (Schäfer, 2017) and Chile (Espinoza et al., 2019). Although strong global relationships are a regional comparative advantage (Cho et al., 2022), the role of transnational bridges between EEs is undertheorized (von Bloh et al., 2020). Building up resilience by strengthening the framework conditions is a worthwhile economic strategy for all kinds of EEs - especially for smaller ones as these tend to be inherently vulnerable (Roundy et al., 2017; Spigel et al., 2020). In summary, including all geographical dimensions is crucial to be able to adapt the strategic orientation towards sustainable economic development (Malecki, 2018; Walsh, 2019; Schäfer, 2021).

Centre or driver – What creates and drives EE?

Although high-performance companies are created in 'spiky regions', these EEs are very heterogeneous (Acs et al., 2017). Therefore, it is a frequent debate about which institutions impact the creation of new ventures and their growth (Brown & Mason, 2017; Cowell et al., 2018). In addition, there is an ongoing discussion about what the focal point of an EE is - the element the ecosystem is built around and driven by (Guerrero et al., 2021). As it is still controversial what institutions impact the structure and performance of an EE (Alvedalen & Boschma, 2017), it is essential to identify the key contributors and their influence at a specific place (Malecki, 2018). Thereby, cognitive, cultural, and social dimensions of EE coordination are influencing the dynamic processes (Roundy 2020), and EEs require strong leadership (Roundy, 2021; Theodoraki et al., 2022). As a result, a lack of leadership may be a barrier to the development of vibrant EE (Venkataraman, 2004; Walsh & Winsor, 2019). In addition, there is a vigorous discussion about the optimal balance between purposive leadership (top-down) and grass-roots leadership (bottom-up) (Thompson et al., 2018; Colombo et al., 2019).

Recent studies on drivers of EEs have identified entrepreneurs (Stam & Spigel, 2016; Lux et al., 2020), universities, and research institutions (Miller & Acs, 2017; Motoyama & Knowlton, 2017; Wright et al., 2017; Malecki, 2018), policy (Colombo et al., 2019;

Colombelli et al., 2019; Belitski et al., 2021), military (Fisher, 2018; Cukier et al., 2020), established industry and multinational cooperation (Neck et al., 2004; Mason & Brown, 2014; Ryan et al., 2021), investors, and accelerators or incubator (Theodoraki et al., 2018; Shwetzer et al., 2019) as focal points of an EE. Thereby, universities have emerged as a central actor, working as a catalyst for opportunity recognition and transformation processes and representing an excellent source for human capital (Acs et al., 2017; Malecki, 2018). Established companies attract skilled employers to the region as well, operating as a source for spin-off firms, and collaborating as pilot customers with early-stage ventures (Brown & Mason, 2014; Alvedalen & Boschma, 2017).

However, some studies argue that there is not only a single driving force, as an EE consists of a dynamic, self-regulating network with various types of actors (Isenberg, 2016). Being dependent on one institution or firm is not of high resilience and therefore, more anchor organizations should emerge (Spigel & Vinodrai, 2021). Although attracting a potential anchor firm is not leading to increased resilience, it impacts the emergence of capabilities supported through labor retention and resource mobility within the region (Walsh, 2019; Ryan et al., 2021). Especially in the early stage, the existence of a driver impacts significantly on the sustainable development of the EE (Spigel & Harrison, 2018). Through inter-organizational networks, the centralities of elements within an EE can be identified and quantified (Hernández & González, 2017).

Specialism versus Diversification

Entrepreneurship is integral to fostering diversification and capacity building at the city-region level (Williams et al., 2013). Similar to biological ecosystems, the diversity of new ventures impacts the stability of an EE significantly (Thompson et al., 2009; Malecki, 2018; Cavallo et al., 2019). The diversification of the regional firm portfolio guards against unanticipated disruptions (Roundy et al., 2017). In addition, a higher collision density is beneficial for the heterogeneity of start-up activities (Nylund & Cohen, 2017). In the context of EEs, diversity does not only refer to a certain industry, but also to participants, venture types, business models, and support organizations (Morris et al., 2015; Roundy et al., 2017; Cowell et al., 2018). Ecosystems with a higher diversification rate are less sensitive to fluctuations of resources (Spigel & Harrison, 2018). The diversity of an EE is in direct connection to the performance, underlining the importance of regional transformation (Stangler & Bell-Masterson, 2015). Widespread entrepreneurial

activities and continuously ongoing search processes for new business opportunities are reducing the dependence on single industries (Auerswald & Dani, 2017; Korber & McNaughton, 2018; Spigel & Harrison, 2018). In combination with coherence, diversity is co-producing EE resilience (Roundy et al., 2017).

However, by following the evolutionary path towards the stage of resilience, EEs tend to transform into a Marshallian district type (Walsh, 2019). Focusing on a core industry or a specific technology can lead to knowledge spill over effects, gaining additional business opportunities (Brown & Mason, 2017). The process of entrepreneurial recycling and the attraction of external resources are more effective in concentrated ecosystems than in diversified ones (Spigel & Vinidrai, 2021). Thereby, new adaptive capabilities are likely to shape local culture and mindset towards entrepreneurial orientation (Venkataraman, 2004; McNaughton & Gray, 2017). With a high degree of specialization, capabilities building is becoming more cost-effective and the processes more efficient (Kaulich, 2012; Theodoraki et al., 2018). Communities with a precise specialism may achieve considerably higher growth than none specialized ones (Roundy et al., 2017; Cho et al., 2022). Additionally, the expertise and quality of support infrastructure increase by addressing programs to the needs of a particular type of entrepreneurship (Theodoraki & Catanzaro, 2022).

Nevertheless, an EE needs to pass a certain point to be able to set a focus on a specific field (Mack & Mayer, 2016; Cavallo et al., 2019). Hence, all kinds of entrepreneurship need to be supported in the birth phase until a critical mass has been reached (Cantner et al., 2021). However, an inordinate focus tends to be dangerous, not leading to resilience anymore (Roundy, 2016; McNaughton & Gray, 2017). Therefore, diversification within an EE is a risk-spreading strategy (Roundy et al., 2017). Continuously searching for new opportunities is balancing the focus and diversity of entrepreneurial activities (Cantner et al., 2021; Zahra, 2021), and finding the ideal mixture between both is a vital success factor for building up a resilient EE (Morris et al., 2015; Oliver et al., 2015; Spigel & Harrison, 2018). Subsequently, the EE-level characteristic, if an ecosystem can respond to shocks, depends on balancing the paradoxical tension between the diversity and coherence of its determinants (Roundy et al., 2017).

Coherence and Connectivity

A vibrant EE is characterized by the unhindered flow of resources and labor mobility between established companies and entrepreneurial firms (Cantner et al., 2021). The availability of resources and their connectivity is directly linked to the strength and functionality of the network (Brown & Mason, 2017; Scott et al., 2021). Therefore, the production of capabilities by internal mechanisms and the process of their recycling are essential (Walsh, 2019; Spigel & Vinodrai, 2021). The resilience of an EE depends largely on the particular tension created by the interplay of diversity and coherence (Roundy et al., 2017). Networks and collaborations established among diverse stakeholders impact the configuration, evolution, and outcome of an EE (Markley et al., 2015; Fernandes & Ferreira, 2022). Interactions between the elements of a start-up community and a high network density between all actors are significant for economic development (Taich et al., 2016; Neumeyer et al., 2019). Emphasizing its importance, relationships need to be strengthened parallel to the evolutionary path of an EE (Theodoraki et al., 2018; Colombelli et al., 2019). Furthermore, large and well-connected networks are considered to be highly supportive of the resilience of EEs (Roundy et al., 2017; Colombo et al., 2019; Walsh, 2019). Strong social networks enable all actors to participate in ecosystem evolution (Theodoraki & Messeghem, 2017). In addition, shared cultural values are formed which leads to a more sustainable number of successful entrepreneurial activities (Malecki, 2018; Donaldson, 2020). Access to knowledge is critical, especially for entrepreneurs, and functioning social networks facilitate the dissemination of knowledge (Cunningham et al., 2019). Support organizations are emerging in the socio-cultural dimension of an EE by influencing cultural, relational, or structural attributes at different levels of analysis (Markley et al., 2015; Theodoraki & Messeghem, 2017). Using inter-organizational networks, the centralities of elements within an EE can be identified (Hernández & González, 2017). Overall, trust has a highly positive impact on these interactions and the connectivity of the networks within an EE (Muldoon et al., 2018; Bouncken & Kraus, 2022). As interactions within an EE are of high complexity (van de Ven. 1993; Neck et al., 2004), many studies have focused rather on the identification of static framework conditions than on interdependencies between single elements (Spigel, 2017). Future research needs to address this shortcoming and answer the question of how elements within an EE are connected and how they influence each other's performance (Alvedalen & Boschma, 2017). The governance of networks

and their dynamics remain one of the main challenges of EE leadership (Cavallo et al., 2019; Colombo et al., 2019).

4.6.4 Measurement of Entrepreneurial Ecosystems

A major criticism of the EE approach is the unsolved issue of how to measure performance and what factors to include in the calculation (Muñoz et al., 2020; Stam & van de Ven, 2021). This vulnerability can be traced back to the non-existence of a clear analytical framework, specifying what cause and what effect is (Alvedalen & Boschma, 2017). Traditional count-based metrics such as the number of firms founded or jobs created may provide an initial benchmark, but do not effectively assess the EE functioning (Roundy et al., 2017). Empirical studies attempt to measure the EE dynamics using indicators as proxies instead (Brown & Mason, 2017). The impact on economic growth as an outcome parameter is more valuable than the pure quantity of entrepreneurs (Sternberg et al., 2019). A quantitative evaluation is required to monitor how individual actions affect the evolution of an EE (Cho et al., 2022). Although having data about the dynamics of start-ups is of paramount importance (Roundy et al., 2017), there is a lack of quantitative modeling and survey-based research yet (Maroufkhani et al., 2018, Fernandes & Ferreira, 2022). Hence, more effort is unquestionably needed to develop nuanced methods of measuring EEs and the processes within (Velt et al., 2018; Walsh, 2019; Cantner et al., 2021).

Although there have been measurement attempts, research on the performance and outcome of EEs remains undertheorized (Theordoraki et al., 2018; Audretsch et al., 2019). Due to the heterogeneity and complexity of EEs, it is still a major challenge to create a holistic perspective (Roundy et al., 2017; Schäfer, 2021). Novel approaches are needed to further stimulate the EE conceptualization, requiring data from economics, social outcomes, and welfare (Autio et al., 2018; Ligouri et al., 2019). Recently, studies face these shortcomings by introducing new sets of measurement criteria (Liguori et al., 2019; Sternberg et al., 2019; Stam & van de Ven, 2021). Density, fluidity, connectivity, and diversity are presented as indicators to measure the vitality of EEs (Stangler & Bell-Masterson, 2015). In addition, density and connectivity are identified as most meaningful to entrepreneurs (Taich et al., 2016; Nylund & Cohen, 2017). Survey-based analyses strongly oriented their framework on the domains of the EE approach (Liguori et al., 2019; Mujahid et al., 2019; Sternberg et al., 2019).

To measure economic resilience, Briguglio et al. (2004) proposed a conceptualization based on macroeconomic stability, microeconomic market efficiency, good governance, and social development. In addition, adaptability, adaptive capacity, and new path creation are categories to quantify the development of local and regional resilience (Dawley et al., 2010; Qian et al., 2013). As Roundy et al. (2017) draw attention to coherence and diversity as critical forces in measurement metrics, recent studies focus on network density, multiplexity, modularity, and network centralization (Neumeyer et al., 2019). Through the orientation on findings of previous studies, Stam & van de Ven (2021) designed an EE index based on ten elements (Formal institutions, Entrepreneurship culture, Physical infrastructure, Demand, Networks, Leadership, Talent, Finance, New knowledge, and Intermediate services). Due to the lack of generalizability and practicability, a commonly accepted measurement tool has been established yet (Liguori et al., 2019; Iacobucci & Perugini, 2021).

Overall, the measurement of EE resilience is struggling similar to the theoretical foundations of the EE approach, and thus, it is still ambiguous what determinants to include and how to identify patterns of long-term regional growth (Boschma, 2015; Stough, 2016). The absence of comparable empirics is a major weakness in EE research (Sternberg et al., 2019). There are several reasons for difficulties with the quality, validity, and reliability of data sources, limiting the generalizability of findings (Carayannis et al., 2018). The process of generating, collecting, and processing data is largely opaque, often not comprehensible, and verifiable for an outstanding person (Wurth et al., 2022) As the definition of a startup remains vague (Malecki, 2018), public sources include different kinds of data (Spigel et al., 2020). Each region collects non-standardized data separately and access for researchers is not guaranteed (Stam & van de Ven, 2021). The merging of available data sets to compare EE is associated with high hurdles and uncertain outcomes (Szerb et al., 2019). As young firms may disappear from the radar before being tracked, the exploration of new ideas is difficult to monitor closely (Cantner et al., 2021). The limitations regarding the usability of existing data lead to strongly restricted dissemination, preventing the breakthrough of measurement tools so far (Shwetzer et al., 2019). Findings from studies based on non-standardized data from only a single region are vulnerable to misinterpretations (Brown & Mason, 2017; Bruns et al., 2017). Applied data may not be available for other regions, forcing researchers to identify and adapt to related indigenous indicators (Stam & van de Ven, 2021). To compare EEs, the

availability of congruent data is crucial to increase the validity and reliability of findings, creating a multi-dimensional perspective (Corrente et al., 2019; Wurth et al., 2022). Due to the generalizability, the applicability has to be given in any geographical context (Liguori et al., 2019; Stam & van de Ven, 2021). The lion´s share of studies is pointing out the importance of future research and is demanding a comparable data analysis.

Entrepreneurship, and thus EEs, do not occur in isolation (Shane, 2003). This circumstance hinders the generation of profound data not diluted by other external influences (Bruns et al., 2017). Hence, the use of general economic data such as GDP, unemployment rate, and poverty index needs to be tempered with high caution (Szerb et al., 2019). As research on EEs and resilience has to be longitudinal (Korber & McNaughton, 2018; Fernandes & Ferreira, 2022), survey-based approaches should be conducted periodically, supplemented by qualitative data (Sternberg et al., 2019).

4.7 Discussion and Conclusion

An immense number of research articles have contributed to shifting the EE literature from a focus on the identification of single factors that enhance entrepreneurship in a geographical context to a much broader perspective. Conducting a systemic literature review our paper analyses the intersection between the EE approach and the concept of resilience. In doing so, we highlight the impact of EEs on regional economic growth and identified resilience as a foremost EE characteristic. The findings confirm the growing popularity of the EE concept in academia and policymakers' circles and its practical usage all around the world. The understanding of how EEs and resilience are connected is beneficial for overcoming obstacles toward the resilient growth of local economies. The role of EEs and their influence on entrepreneurial processes is significant for developed, emerging, and developing markets (Guerrero et al., 2021).

Contribution to scholarship

Our discussion contributes to the theoretical framework of EEs by introducing novel perspectives on how to create EE resilience. Based on the body of existing literature, we identified four main dimensions and the key contributors to the sustainable development of EEs and their well-functioning. It is essential to be fully aware of all determinants given at a specific place to set up implications afterward (Theodoraki & Messeghem, 2017; Cowell et al., 2018; Malecki, 2018). The exploratory nature of this study revealed that building a resilient EE pursues a long-term horizon, whereby the understanding of

dynamic processes and scaling capabilities is leading to sustainable success (Walsh, 2019). As entrepreneurial processes require a high degree of trustworthiness to significantly impact economic performance (Muldoon et al., 2018), our work identified the importance of trust as one of the key characteristics of a healthy and well-functioning EE. Thereby, strong social networks with a high level of connectivity between the ecosystem actors are leading to fundamental confidence, especially important due to the dynamic nature of EEs (Spigel & Harrison, 2018; Scott et al., 2021).

Furthermore, this study addresses the research gap in how to measure the outcome and performance of EEs and the effectiveness of individual indicators (Stam & van de Ven, 2021). We emphasized focusing on the measurement of the correlation between the strength of EE at the local level and the resilience to economic shocks (Iacobucci & Perugini, 2021). As incomparable empirics are one of the main shortcomings of the EE approach (Sternberg et al., 2019), more research has to be done on the development of a measurement tool applicable in any geographical context (Liguori et al., 2019; Stam & van de Ven, 2021). Therefore, it is crucial to establish a clear analytical framework concerning cause and effects in an EE (Alvedalen & Boschma, 2017). The scientific community may draw inspiration from the different perspectives we present and contribute to the advancement of the theoretical foundation. Future research is obliged to take a more comprehensive approach, enabling the exploration of EEs and resilience from a multi-level, cross-national, and longitudinal perspective (Korber & McNaughton, 2018; Spigel & Harrison, 2018; Cho et al., 2022). In addition, the scientific community is encouraged to investigate the significance of international relations within EEs and integrate them into the theoretical framework (Theodoraki & Catanzaro, 2022). In doing so, researchers are enabled to widen their perspective across borders to think of EEs in new spatial settings (Schäfer, 2021).

Implications for policymakers

In general, our study provides a starting point for more a differentiated discussion around the interrelations between both concepts and their long-term impact on sustainable EE development. For policymakers, the findings underline the crucial role of EEs and their framework condition on the resilient growth of local economies. Policymakers need to understand the barriers and challenges in the evolutionary dynamics of EE and reduce them. To prepare upfront for crises and external shocks, policymakers should design

strategies for the configuration and reinforcement of their regional EE based on the perspectives we proposed in this study. The findings of our study enable policymakers and other actors from an EE to generate entrepreneur-led economic growth. Policymakers and support organizations should invest in improving the framework conditions and specific programs to impact EE development with clear governance and leadership (Cunningham et al., 2019; Roundy, 2021).

5 Qualitative Research

For the sake of clarity, it has to be emphasized that the following chapter is the manuscript of a journal article that has been published in the Journal of Small Enterprise Research. The publication with the title “One step back, two steps forward: internationalization strategies and the resilient growth of entrepreneurial ecosystems” is cited under the reference of Henn et al. (2022a).

5.1 Introduction

Over the last decade, entrepreneurial ecosystems (EE) have received close attention from the scientific community, policymakers, and practitioners as fundamentally instrumental in creating resilient economies (Roundy et al., 2018). Due to the growing interest, EE literature has emerged tremendously across different disciplines in recent years (Alvedalen & Boschma, 2017; Fernandes & Ferreira, 2022). However, the concept remains fragmented and its theoretical foundations are underdeveloped (Cao & Chi, 2021; Wurth et al., 2022). Although recent literature has provided a comprehensive list of elements within an EE (Stam & van de Ven, 2021), mechanisms that influence the evolutionary dynamics have been widely neglected (Cho et al., 2021). Enhancing the economic resilience of a specific place builds on a long-term evolutionary nature rather than a short-term equilibrium (Christopherson et al., 2010; Spigel & Harrison, 2018). Therefore, understanding how to support the transformation processes is an indispensable prerequisite to developing well-functioning and sustainable EEs (Walsh, 2019; Theodoraki et al., 2022).

The Covid-19 pandemic demonstrates impressively the challenges entrepreneurship faces in times of crisis and under high uncertainty (Kuckertz et al., 2020; Shepherd, 2020). As job creation is predominantly happening through the formation and scaling of new enterprises, the importance of entrepreneurial processes for economic development is apparent, especially during a period of regression (Devece et al., 2016; Doern et al., 2019). However, the pure existence of entrepreneurship does not automatically lead to “enhanced economic performance and faster rates of economic growth” (Wong et al., 2005, p. 344). Even in times of recession, high-growth companies are the driving force for economic development (Greene & Rosiello, 2020). As local framework conditions significantly impact productive entrepreneurship (Urbano et al., 2019; Szerb et al., 2019), the success of new ventures is highly influenced by these determinants (Lee & Peterson,

2001; Sternberg, 2021). Consequently, entrepreneurs need a conducive environment to implement new business ideas and scale their firms without constraints (Maroufkhani et al., 2018). Hence, EEs are working as a 'conceptual umbrella' beneficial for the formation of high-growth firms, their expansion, and survival (Spigel & Harrison, 2018).

A body of scientific evidence has shown that exhibiting a high level of entrepreneurship increases the ability of local economies to recover continuously from exogenous shocks and to adapt to shifting conditions (Bishop, 2019; Roundy & Bayer, 2019). As regions have to raise their robustness against impending crises and endogenous pressures (Williams & Vorley, 2014), the concept of resilience has been integrated recently into the EE approach (Roundy et al., 2017; Gherhes et al., 2018). To enhance resilience, it is central to prepare upfront and proactively for uncertain events (Walsh, 2019; Maritz et al., 2020). Strong and vital EEs positively influence the capability to resist external shocks and recover from crises swiftly (Iacobucci & Perugini, 2021). However, not every entrepreneurial ecosystem is a successful one, nor a resilient one (Roundy et al., 2017). Especially smaller ecosystems and those in peripheral places face multiple challenges as these tend to be inherently economically vulnerable, due to their remoteness and lack of resources (Xu & Dobson, 2019; Spigel et al., 2020). Overall, it is still a phenomenon why some regions outperform and how those economies overcome crises straightforwardly while others suffer exorbitantly (Venkataraman, 2004; Martin & Sunley, 2015).

The evolutionary dynamics of EEs lead to a permanent recreation of economic regions, ensuring their competitive advantages and survival over time (Cho et al., 2021; Spigel & Vinodrai, 2021). However, there are multiple barriers to entrepreneurship around the world (Amorós et al., 2015), affecting the transformation of EEs towards a strengthened and resilient stage (Guerrero et al., 2020; Muñoz et al., 2020). These obstacles are related to a broad range of different dimensions such as socio-cultural factors (Walsh & Windsor, 2019), social boundaries (Neumeyer et al., 2019), financial resources (Lall et al., 2019), policy (Ferraris et al., 2020), leadership (Fortunato & Clevenger, 2017), institutions (Harima et al., 2021), and infrastructure (Xu & Dobson, 2019). In developing countries, barriers to ecosystems evolving are even more pronounced than in developed countries (Amoros et al., 2015; Guerrero et al., 2020; Belitski & Büyükbalci, 2021). Exploring how a nascent EE may overcome these obstacles is critical "to create flourishing entrepreneurial communities" (Roundy & Bayer, 2019, p. 568). Furthermore,

international entrepreneurship and transnational linkages of EEs may be a pathway to absorb these adverse effects (Schäfer, 2021; Zahra, 2021) and internationalization can lead to a regional competitive advantage in a global economy (Saxenian, 2007; Terjesen et al., 2016).

In an increasingly interconnected world, EEs are essential to the resilient growth of startups and the surrounding region (Bouncken & Krauss, 2022). The international entrepreneurship (IE) perspective addresses the increasing development of globalization and the importance of international business opportunities for economic growth (Jones et al., 2011). Developing and emerging countries can particularly benefit from the impact of entrepreneurial and technological capabilities, outlined by the importance of IE for the Latin American context (Ciravegna et al, 2016; Bianchi et al., 2017). Similar to the EE approach, the IE concept represents a complex system based on multi-dimensional elements simultaneously determining and influencing their status and evolutionary dynamics (Etemad et al., 2022). Phenomenon-based research provides an in-depth understanding of how EEs are supportive of the creation of economic resilience at the local and regional levels (Iacobucci & Perugini, 2021, Theodoraki et al., 2022). By conducting a multi-national analysis across different geographical and institutional contexts, we took a complementarity-based (Belitski & Büyükbalci, 2021) and an international lens (Theodoraki & Catanzaro, 2022) to address the weaknesses in the contextualization of entrepreneurship in local boundaries (Amorós et al., 2015; Stam & Welter, 2020). In doing so, we refine the conceptualization of resilient EEs and their evolutionary dynamics. This study aims to answer the following research questions: 1) What are the barriers and challenges in the evolutionary perspective of EEs towards a resilient stage? 2) How is internationalization supportive of overcoming these obstacles?

The structure of this chapter proceeds as follows. Section 5.2 discusses the theoretical foundations of entrepreneurial ecosystems and resilience, describing the role of evolutionary dynamics in a specific place. Furthermore, we present the general situation of entrepreneurship and EEs in Latin America. Section 5.3 introduces the empirical focus and methodology used to collect and analyze the data. Whereas Section 5.4 reports the findings based on the expert interviews, Section 5.5 critically debates the role of internationalization in overcoming growth barriers of EE and its implications for an enhanced theoretical framework. Finally, Section 5.6 concludes and presents

contributions to theory, policymakers, and practitioners. Furthermore, we present the limitations of this study and discuss future research directions.

5.2 Entrepreneurial Ecosystems and Resilience

From a historical perspective of economic geography, agglomeration is necessary as resource bundling and synergy effects lead to additional value creation and regional competitive advantages (Pitelis, 2012). The significance of the relationship between geography and entrepreneurship in the context of economic development has again been highlighted recently (Sternberg, 2021). However, the national-level policy has failed over decades "to create more entrepreneurial and resilient local economies" (Gherhes et al., 2018, p. 581). The EE approach according to Isenberg (2010) is a highly transdisciplinary concept, influenced by multiple different roots of geographical economics (Acs et al., 2017; Brown & Mason, 2017). In contrast to its antecedents, this approach offers a pronounced viewpoint by placing entrepreneurs and socio-territorial entities as a central pillar of the conceptualization (Brown & Mason, 2014; Muñoz et al., 2020). Although a general understanding of an entrepreneurial ecosystem has not been established yet (Malecki, 2018), definitions include interactions between actors and elements in a given geographical boundary, regulated in such a way that productive entrepreneurship is enhanced (Stam & van de Ven, 2021).

As previous research has principally focused on investigating EE elements as well as characteristics and behaviors of individuals (Cavallo et al., 2019), the path dependence of entrepreneurial activities is still underdeveloped (Alvedalen & Boschma, 2017; Cloutier & Messeghem, 2022). Less effort has been set into the connectivity between these elements and how they influence each other's performance (Roundy et al., 2017). Recently, several authors adapted evolutionary dynamics to the systematic nature of EEs to understand different trajectories (Mack & Mayer, 2016; Cantner et al., 2021). As studies identified a positive relationship between an EE and resilience at the local level (Iacobucci & Perugini, 2021), a longitudinal perspective is required to strengthen the framework conditions (Korber & McNaughton, 2018; Cho et al., 2021). Thereby, entrepreneurs contribute largely to developing, transitioning, and restructuring economies (Ciravegna et al., 2016; Belitski et al., 2021). However, further research needs to engage with requirements for market penetration and growth of new ventures (Onetti et al., 2011; Walsh, 2019). A robust and efficient EE positively affects the diversity and flexibility of

individuals, firms, and institutions, affecting the resilience of the local economies (Iacobucci & Perugini, 2021). Furthermore, international entrepreneurship literature highlights the critical role of global business models on firm performance (Asemokha et al., 2019).

The concept of resilience has emerged significantly in recent publications and is applied in various disciplines, including social science and economics (Williams & Vorley, 2014; Martin & Sunley, 2015; Walsh, 2019). Economic resilience can be understood as "the ability to recover from or adjust to the negative impacts of external economic shocks" (Briguglio et al., 2004, p. 30). Overall, EE resilience is described as the health of an economic region and is based on the tension between diversity and coherence (Roundy et al., 2017). Therefore, short-term responses to crises and long-term adaptation to technological and social changes must be considered essential issues to enhance resilience at a local or regional level (Boschma, 2015). In doing so, adverse effects of external, unpredictable shocks can be absorbed and the capability to reach the previous status level increased (Walsh, 2019). In addition, evolutionary dynamics such as resource creation, flow, and transformation facilitate resilient economic growth (Spigel & Harrison, 2018). Thereby, the recycling of resources is highlighted as a critical evolutionary process of a well-functioning EE (Spigel & Vinodrai, 2021). In addition, studies identified that technology specialism and heterogeneity positively affect an EE´s resilience and long-term competitiveness (Ryan et al., 2021).

The formation and development of EEs toward a resilient stage are fundamentally reliant on the functioning of networks (Scott et al., 2021). As a high level of connectivity among diverse stakeholders impacts configuration, evolution, and outcome, interactions and network density are considered significant for sustainable economic development (Fernandes & Ferreira, 2022). International networks facilitate knowledge transfer and the movement of resources that support the growth of startups and the EE itself (Onetti et al., 2012; Velt et al., 2018). Studies show that international entrepreneurship can lead to higher opportunity recognition and network embeddedness (Jones et al., 2011; Zucchella et al., 2021) Although having solid relationships globally is seen as a comparative advantage, the role of transnational bridges between EE has been widely ignored (von Bloh et al., 2020). Despite the research progress in the area of born-globals (Velt et al., 2018), and digitally enabled cross-border platforms (Nambisan et al., 2019), there is still

a lack of understanding international aspect of EEs. Therefore, the ongoing debate should integrate the IE concept and the born-global perspective to increase the exploration of global business models (Asemokha et al., 2019). Researchers need to 'adopt an international lens' to create a more rigorous and comprehensive theoretical framework (Theodoraki & Catanzaro, 2022) and therefore, link the EE concept to international entrepreneurship literature (Ryan et al., 2021). This perspective allows thinking of new spatial settings across borders to contribute to the understanding of characteristics within EEs (Schäfer, 2021).

5.3 Entrepreneurship and Entrepreneurial Ecosystems in Latin America

In general, political stability and economic growth have been enhanced in Latin America since the 1980s, despite the political, economic, and social problems of some countries over the last years (von Bloh et al., 2020). However, although increasing prosperity and a significant effect on subjective well-being are measurable, almost all nations remain in the stage of developing countries (Amorós et al., 2021). Moreover, based on natural resources and the export industry, economies still have a low rate of innovation-based ventures (Ruiz-Martinez et al., 2021). Hence, politicians and governments increased their awareness of the importance of entrepreneurship in economic development (Romaní et al., 2021). In doing so, competitiveness-enhancing policies and the deployment of more resources lead to improved local competitiveness (Acs & Amorós, 2008; Lafuente et al., 2020).

The economies of Latin America suffer from a significant informal sector, especially in countries with lower tax morale or high levels of corruption (Salinas et al., 2018). Furthermore, most new businesses relate to necessity-driven entrepreneurship rather than too ambitious opportunity-driven entrepreneurship (Ruiz-Martínez et al., 2021). Latin America has the most entrepreneurial countries in the world but struggles with one of the lowest success rates. Therefore, the objective of entrepreneurial policy should be to focus on the quality and the focus of entrepreneurship rather than the number of entrepreneurs (Salinas et al., 2020). Besides Brazil, which is more or less an isolated economy, the most advanced EEs in Latin America are Mexico, Chile, and Argentina (Villegas Mateos & Amorós, 2019). Although these cases highlight favorable developments, there exist a variety of region-specific challenges such as a lack of trust (Quinones et al., 2021), fraud, corruption (Freire-Gibb & Gregson, 2019), inherent institutional instabilities (Reyes &

Sawyer, 2019), and high regulatory burden (Salinas et al., 2020). As networks weaken with low levels of connectivity between all actors, a significant challenge is to create a culture of collaboration networks (Hernández & González, 2017; Lopez & Alvarez, 2018). In addition, the low level of education negatively influences economic development in Latin America (Ferreyra et al., 2017). As dependent on natural resources and service-oriented economies, Latin America is falling behind the technological frontier and innovation-driven growth (Freire-Gibb & Gregson, 2019). Compared to other places around the world, unincisive institutional framework conditions to support entrepreneurship constitute a significant vulnerability (Bosma & Kelly, 2018). However, small- and medium-sized enterprises are emerging their internationalization activities, having identified the critical role of global business models (Bianchi et al., 2017).

Although all relevant countries are Spanish-speaking, except Brazil, markets remain highly fragmented, and the continent is considered one of the most diverse regions in the world (Ruiz-Martínez et al., 2021). Latin America is geographically vast and contains a wide range of socio-cultural differences (Freire-Gibb & Gregson, 2019). Determinants and characteristics of entrepreneurship vary from country to country, requiring major adaptations to achieve a well-functioning environment (Romaní et al., 2021). To address these issues Mexico, Colombia, Peru, and Chile created the Pacific Alliance (PA) as a common free trade area with a potential customer base of more than 215 million people. The purpose of PA was to promote increased growth, development, and competitiveness of the economies and to overcome issues with bureaucracy, administrative obstacles, and customs duties (Puente Castro et al., 2020). As entrepreneurial activities concentrate primarily around the capital which leads to a movement of human capital to the hubs, this "excessive political and economic centralization" hinders the evolution of other regional EEs (Espinoza et al., 2019, p. 755), failing to exploit the full growth potential of a national economy (Villegas Mateos, 2020). Fostering entrepreneurship in peripheral regions additionally can balance the shift towards core regions and make the advantages of both regions usable (Amorós et al., 2013; Xu & Dobson, 2019). Over the past, EEs have been organized as isolated islands, not well-connected to external places. Thereby, the long distances between regions play a critical role as well as insufficient public transport infrastructure (Espinoza et al., 2019).

Although entrepreneurship in Latin America is still in its infancy, already some unicorns have been established as success stories, especially in the technology sector (Kantis & Federico, 2020). Furthermore, there are first positive trends recognizable as the fear of failure is low, not preventing entrepreneurs from starting a business (Freire-Gibb & Gregson, 2019). Historically, the Latin American population is used to dealing with natural disasters, economic crises, and political upheavals (Brenes & Haar, 2012), which educated them on the continuous recycling of resources (Kantis & Federico, 2020). As human and social capital have been identified as drivers of entrepreneurship (Madriz et al., 2018), studies highlight the impact of women entrepreneurship (Kuschel et al., 2017) and senior entrepreneurship (Leporati et al., 2021) as extraordinary.

Overall, the potential of Latin American entrepreneurship is high, but multiple barriers need to be addressed in establishing a supportive environment for ambitious entrepreneurship (Ciravegna et al., 2016; Freire-Gibb & Gregson, 2019). Only a handful of studies have focused on the Latin American context, so the EE concept regarding this region remains undeveloped (Alvarez & Grazzi, 2018). Hence, researching the cases of those ecosystems supports filling the literature gap, leading to an increased understanding of entrepreneurial activities in emerging economies (Lopez & Alvarez, 2018). In contrast, multiple studies about the importance of international entrepreneurship in the Latin American context, provide a rich set of empirical data (Amorós et al., 2012; Bianchi et al., 2017). To ensure that the Latin American EEs successfully develop over the long term, political decision-makers need to make informed strategic actions. These concrete measures can only have a lasting effect by understanding the strengths and weaknesses of the particular entrepreneurial environment and identifying the drivers and economic consequences of distinctive EEs (Freire-Gibb & Gregson, 2019). A new entrepreneurship agenda is needed based on "observed configurations of systemic conditions for entrepreneurship in less developed regions" and its adaption to regional challenges (Kantis et al., 2020, p. 1).

5.4 Methods

5.4.1 Research Design

To contribute to the scientific discourse, the research design of our study follows an exploratory multiple-case approach (Yin, 2014). In this context, the analysis relies on semi-structured interviews with local stakeholders in several places and countries. In

doing so, we adopt an international lens to the increasing body of EE literature (Theodoraki & Catanzaro, 2022) to address the shortcoming of a comparative and multi-scalar perspective (Terjesen et al., 2016; Stam & van de Ven, 2021). In addition, the sample of interviewees covers entrepreneurial actors from various backgrounds in each distinctive EE, securing a high level of validity and reliability (Kvale & Brinkmann, 2009; Tsvetkova et al., 2019). Collecting data from multiple independent sources are favored in terms of further theory development and increases the generalizability of qualitative studies (Cunningham et al., 2017). The application of qualitative data analysis enables us to understand the socioeconomic context of EEs in a broader and deeper context (Creswell, 2009; Mayring, 2014). Therefore, our work embeds a broader system perspective to manage the complex interconnection between EE actors and the local environment (Belitski & Büyükbalci, 2021). In this case, semi-structured interviews are appropriate for studying the dynamic processes within an EE in-depth, aiming at causal explanations (Campbell et al., 2013; Gläser & Laudel, 2013). An interview guideline helps to cover all crucial aspects related to the EE approach of Isenberg (2010) as the focal topic of this study (Tsvetkova et al., 2019). In addition, a concrete guide provides a structural way to create comparable data, securing the coherence of the analysis (Glaser & Strauss, 1967, Miles & Huberman, 1994). Although the guidelines provide a standardized protocol, they must consist of open, transparent, neutral, and unbiased questions to be asked and answered in the interviews (McIntosh & Morse, 2015). This approach guarantees the interviewer flexibility to pursue follow-up queries and to adapt to unexpected directions (Williams et al., 2013; Theodoraki & Catanzaro, 2022). As EE resilience as the subject of this study is an undertheorized phenomenon (Gherhes et al., 2018), we follow this procedure to build concrete case knowledge (Flyvberg, 2006; Cunningham et al., 2017) and match the findings to potentially existing patterns in theory (Sinkovics, 2018).

5.4.2 Data Collection

For understanding the role of EEs in the path towards resilience, the perceptions of actors from both public and private sectors are central (Martin, 2012). Due to the complexity of EEs, perspectives cannot be limited to policymakers and the experiences of entrepreneurs and business owners. Therefore, our work aims to increase the understanding of the framework conditions and their impact on entrepreneurial processes based on insights from all types of EE actors (Tsvetkova et al., 2019). These include experts from

educational, financial, and research institutions as well as from national and regional policy, support organizations, student initiatives, and established companies. Relying on multiple data sources improves qualitative research implications (Cunningham et al., 2017). Therefore, we spread the empirical data collection over four EEs around Latin America. Expert interviews have been conducted by the primary author in San Jose/Costa Rica, Buenos Aires/Argentina, Santiago/Chile, and Lima/Peru over four months. In particular, purposeful sampling of interviewees leads to a richness of findings (Piekkari et al., 2009). The credibility has been secured by having direct access through contact persons in the particular ecosystems, supporting in identifying knowledge carriers.

In total, 35 semi-structured interviews have been conducted in face-to-face conversations based on the instructions of McIntosh & Morse (2015). Table 3 lists the interviewees, specifying their location, function, and role within the EE. The sample includes 25 hours of audio data material with an average duration of 52.8 minutes per interview.

The dialogues took place in the natural environment of the interviewee to avoid negative influences. Thereby, the interviews followed a guideline built on the six domains of the EE approach (Isenberg, 2010), focusing on support practices, evolution, impact, and ecosystem interactions (Theodoraki & Catanzaro, 2022). In addition, specific parts were adopted to the function of the particular actors, addressing their needs and suggestions for improvement. Conducting a pilot study within the university ecosystem of the primary author, the guide´s scientific merit was examined through a pretest with six interviews in the EE of Karlsruhe in Germany.

Table 3. *Detailed list of the interviewee*

Coding	Organization	Function	Domain	Duration [min]
San Jose, Costa Rica				
CR01	Startup	Founder & Business Angel	Entrepreneur / Finance	30
CR02	Startup	Founder	Entrepreneur	25
CR03	Incubator	Director & Program Manager	Support / Finance	43
CR04	Network	Program Manager	Support	32
CR05	Organization	Organizer	Entrepreneur	39
CR06	Ministry	Director	Policy	45
CR07	University	Professor	Education	53
CR08	Startup	Founder	Entrepreneur	40
CR09	Incubator	Director	Support	61
CR10	University	Student	Human Capital	37
CR11	Venture Capitalist	CEO	Finance	53
Lima, Peru				
PER01	School	Director & Lecturer	Education	32
PER02	Initiative	Board Member	Support	53
PER03	Startup	Founder	Entrepreneur / Support	39
PER04	University	Director & Program Manager	Education / Finance	42
PER05	Startup & University	Founder & Professor	Education / Entrepreneur	25
PER06	Startup	Founder	Entrepreneur	58
PER07	Venture Capitalist	Business Angel	Support / Finance	48
PER08	Employee	Graduate	Finance	45
PER09	Government	Director & Program Manager	Policy	34
Santiago, Chile				
CHL01	Startup	Founder	Entrepreneur	32
CHL02	University & VC	Director	Education / Finance	47
CHL03	Startup	Founder	Entrepreneur	56
CHL04	Organization	Program Manager	Support	48
CHL05	Organization	Program Manager	Support	50
CHL06	Startup	Founder	Entrepreneur	53
Buenos Aires, Argentina				
ARG01	Startup	Founder	Entrepreneur	41
ARG02	Startup	Founder	Entrepreneur	47
ARG03	Startup	Founder	Entrepreneur	74
ARG04	Initiative	Board Member	Entrepreneur / Support	33
ARG05	Local Government	Director	Policy	50
ARG06	Startup	Founder	Entrepreneur	36
ARG07	Ministry	Director	Entrepreneur / Policy	27
ARG08	Local Government	Director	Support / Policy	59
ARG09	University	Professor	Education	21
			Total Duration [min]	**1508**

5.4.3 Data Analysis

To analyze the corpus of data, we conducted a thematic analysis according to Miles & Huberman (1994). The audio material was transcribed with the assistance of the software tool Vocalmatic into 502 pages with 220,500 words. For the coding and analysis process, we used the software MAXQDA. Aiming to modify theory from the underlying data, we applied an inductive coding strategy (Gioia et al., 2012). This approach enables the use of analytic imagination in the process of interpreting qualitative data (Pratt, 2009; James, 2012). Thereby, interpretative evaluation of data and interpretive sensemaking are leading to new insights and contribute to theory building (Mayring, 2014; Cunningham et al., 2017). Since the EE approach is a quite young research stream (Alvedalen & Boschma, 2017), methods for early-stage data analysis are applied to identify causal mechanisms (Gläser & Laudel, 2013). The objectivity, reliability, and validity of a qualitative data analysis largely depend on the skill and rigor of the researcher (Johnson & Christensen, 2012; Bengtsson, 2016). Therefore, we applied multiple measures based on the quality criteria of content analysis to guarantee a high-quality standard (Campbell et al., 2013). To ensure the objectivity of the analyst as a content-analytical quality criterion, we compared the coding of the same data material of two researchers and measured the inter-coder reliability (Mayring, 2014; MacPhail et al., 2016). Through intensive discussions, dialogical intersubjectivity has been reached and a common coding foundation was built (Kvale & Brinkmann, 2009; Gillespie & Cornish, 2010). In addition, the intra-coder agreement test was used to increase the reliability of this study (Krippendorff, 2004).

5.5 Findings

The analysis identified the following categories that may negatively influence the resilient growth of entrepreneurial ecosystems in Latin America. Thereby, the insights are arranged according to the EE domains of Isenberg (2010) to cover all relevant fields.

5.5.1 Policy

Historical Aspects

As talking about entrepreneurship seriously started not long ago, EEs in Latin America cannot reflect on a long history [CR07]. However, historical aspects have a high impact on the framework conditions nowadays. Due to historical conflicts between ethnic groups, there are still deep trenches in society and daily life. Having had terrible experiences with different presidents and policies generally leads to mistrust in the system

[PER02, PER07]. Due to a high number of political upheavals in a comparatively short time and policymakers having insufficient economic qualifications, most of the population and businesses went bankrupt during hyperinflations [PER02, PER09]. Although these crises and the subsequent loss of jobs increased the overall self-employment rate, only necessity-driven entrepreneurship in informal sectors emerged. As part of the macroeconomic conditions, these instabilities are harming the evolution of EEs [PER04, ARG05]. Fostering sustainability, prosperity, peace, and human rights for decades, Costa Rica stands out as a successful example of a stable economy in Latin America [CR06].

Bureaucracy

Complex regulations are leading to a high administrative burden for entrepreneurs, especially in the early stage [CR09]. Bureaucracy can be considered an obstacle in almost all countries in Latin America, slowing the entrepreneurial processes down or even preventing entrepreneurs from being successful in starting their own business and scaling it [PER04, CHL03]. In addition, access to financial support programs is associated with bureaucratic expenditures, practically excluding entrepreneurs from these resources [CR06]. However, not only for new businesses but even for support organizations and NGOs, overcoming bureaucracy is a significant challenge [PER02]. Furthermore, it is observable that these complex regulatory situations with high legal barriers prevent business owners from registering their companies officially [PER07]. This circumstance drifts jobs to the informal sector, not contributing to economic growth [ARG02]. The lion´s share of regulations and support programs provided by the government do not differentiate between high-growth firms and SMEs, which makes them ineffective in promoting entrepreneurship [CR09, PER09]. As a result, only a short amount of financial resources is demanded by new businesses [CR11]. Startups must pay the same taxes as big cooperates withdrawing necessary resources to scale as fast as possible [CHL05]. Import taxes of 40 percent is a high barrier for entrepreneurs to buy machines and materials from abroad required to further research and build their products [CR03]. In addition, complex legal conditions prevent business angels and venture capital firms from investing in local startups [CR01, PER04].

Another aspect is that regulations concerning the employment of workers, especially talents from abroad, hinder EEs from becoming more resilient. The legal obstacles in the

social security systems cannot be fulfilled by the majority of early-stage startups, not enabling these companies to hire employees officially [CR01, CR02]. Although overcoming these barriers is possible, a high amount of capital is fixed, which otherwise could be used for growth [CR03]. Furthermore, labor laws are formulated generally to protect the home population from losing their jobs to low-cost workforces, not recognizing the opportunities for startups to attract international talents with high qualifications [PER09].

Centralization of Resources

The economies of countries in Latin America are to a great extent centralized in the capital cities, which is mostly the only EE worth mentioning [CR05, PER08, ARG03]. Creating more EEs around a country could be a decentralization strategy leading to an equal distribution of economic growth and resilience [CR11]. In doing so, policymakers can focus strategically on specific industry fields or technologies to further develop local economies [CR10, ARG05]. Through activating the potential from rural areas as well, additional entrepreneurial resources are created [CR07]. Financial programs support entrepreneurs in creating new businesses in different places outside the center [CHL05]. For example, the Chilean government is doing great to spread entrepreneurial activities across the country using incentives within the Start-Up Chile program and grants promoted by CORFO [CHL05]. In the case of Peru, the city of Arequipa stands out as a center for developers and research in computer science, competing with the capital Lima [PER03].

Infrastructure

To manage the required transition towards a service-based economy, governments must understand the importance of IT infrastructure to increase the potential market size [CR11, PER07]. Digital entrepreneurship and related business models depend on nationwide access to the internet [PER02]. However, these major challenges have been widely ignored by policymakers so far [PER07]. Furthermore, the existence of airports offering sufficient international flights is a critical infrastructural condition to connect to foreign markets [CR11]. Increasing the connectivity to EEs in other countries leads to a beneficial exchange between actors from both places and the emergence of business opportunities [CR07].

Leadership

Local entrepreneurs are not convinced of the governmental leadership and have begun to further develop the EE by themselves as a bottom-up approach. This grassroots movement is driven by people who "have a genuine and strong interest in quality entrepreneurship for a variety of reasons" [CR11]. Returning to their homelands after having made long-term experiences with an advanced entrepreneurial culture, ex-pats engage passionately in their local EEs to improve the conditions for everyone [CR01]. In addition, being disappointed by the inaction of local authorities, students established associations as a platform and created their own spaces for entrepreneurs with their own hands [CR09, PER02].

5.5.2 Culture

Weak Trust

A high degree of mutual trust significantly impacts productive entrepreneurship and economic performance locally (Muldoon et al., 2018; Nicotra et al., 2018). However, the lack of trust throughout society can be traced back to historical events and the non-existence of solid networks between the EE actors. Due to their experiences with economic crises and momentous political decisions, for example, as the government took property from the landowners, most people mistrust the political system and institutions up to today [PER07]. In addition, corruption is still a significant boundary toward a functioning system [CR07, ARG05]. Thereby, new regulations and support programs provided by the government are seen as rather skeptical, not reaching a high level of acceptance from the public. This interplay of history and socio-cultural factors influences the nature of entrepreneurship at a local level (Audretsch et al., 2017). Furthermore, established companies are not likely to collaborate with young companies and freelancers as they distrust their work attitude and reliability [PER03]. On the personal level, the fear that ideas might get stolen by other people prevails, leading to a common mistrust [CR04, CR10, CHL01]. Not communicating and exchanging with other entrepreneurial minds about business projects prevents them from receiving valuable feedback. Hence, in most cases, the full potential of business opportunities and potential business models remains unrivaled. To a certain extent, the term 'egosystem' instead of an ecosystem is used to describe entrepreneurial communities in Latin America [CR04]. However, functioning networks around universities, support organizations, or in a working environment are

supportive to remove reservations, leading to interactions and collaborations between stakeholders. Generally speaking, the strategy should be to promote an entrepreneurial culture that builds trust [CR07].

Entrepreneurial Culture

In general, the entrepreneurial culture in Latin America is still underdeveloped. Nevertheless, having to deal with economic chaos and natural disasters multiple times, citizens are used to building up new things periodically [ARG03]. From a historical perspective, entrepreneurship is mostly seen as being self-employed out of necessity and not as opportunity-driven [CR03]. In the population, there are widespread prejudices against entrepreneurship itself and all stakeholders within an EE [PER09]. Therefore, it is a crucial objective to overcome these stereotypes and clichés to further transform an EE towards a resilient stage [PER02].

Due to the expensive education parents have to pay upfront, their preferred career option for their children is to work for an established company with a secure, high monthly income [PER02, PER06]. Hence, the decision to be an entrepreneur is still seen as skeptical, and not supported in most families [CR03]. This social pressure from the immediate family impacts societal norms such as tolerance for risk and the preference for self-employment [CR10]. As failing is stigmatized from a societal perspective, it is still seen as a negative fact and not as a learning experience [PER08]. In consequence, many unhealthy startups that should usually get bankrupt were kept artificially alive for as long as possible, preventing the recycling of entrepreneurial resources [PER03, CHL01]. In addition, the socio-cultural context is characterized by a risk-averse attitude in a large part of society, subsequently influencing the preference for self-employment [CR03, PER09]. People are afraid not to have success with their first business, which prevents them from giving it a try [CR06]. Even investment funds focus more on real estate and traditional businesses instead of providing venture capital to early-stage startups [PER08, CHL04]. By integrating an open debate about entrepreneurial failure and risk tolerance in academic courses and support programs, prospective entrepreneurs get sensitized and increase their awareness of how to deal with these issues in a better way [PER05]. Furthermore, students can make experiences in a simulation environment as a safe space [CR07]. In the accelerator program of UDD Ventures founding team who failed with their initial idea is welcome to rejoin with another business opportunity [CHL02]. This approach minimizes

the fear of failure of the participants and avoids the outflow of resources through the immediate recycling of human resources. Having the educational experience that failure is part of the entrepreneurial process may lead to higher personal resilience of individuals and teams, highly beneficial to overcome the upcoming crisis [CR05]. Furthermore, speaking about failure experiences in public events such as the internationally established Fuckup Nights contributes substantially to the creation of an entrepreneurial culture [CR07].

Another cultural aspect the EEs in Latin America have to deal with is the lack of ambition, drive, and hunger [PER08]. Most people are satisfied with low-hanging fruits, not willing to leave their comfort zone [CR03]. For those, it is easier to find obstacles than going for the big shot instead [CR07]. Hence, entrepreneurial activities are too sedate, preventing startups from thinking bigger and scaling internationally sooner [CR09, PER08]. Support programs are addressing this shortcoming, encouraging lifestyle entrepreneurs to turn into serious businessmen [CHL04].

To overcome the lack of entrepreneurial culture, the exchange with more advanced EEs is highly beneficial as a starting point. During the first years of the Start-Up Chile program, the participation of entrepreneurs from all around the world gained enough momentum to start a cultural change in entrepreneurial thinking [CHL06]. Even if some critics may argue that it is a waste of money when startups leave immediately after the program to go back to their home country, the impact on the local culture has been tremendous [CHL01]. Having a distinct entrepreneurial culture has a strong influence on societal norms, increasing the ecosystem diversity and the experimentation that occurs in EEs (Roundy et al., 2017).

5.5.3 Markets

Market Size and Access

All actors generally describe the market potential of single countries in Latin America, except for the isolated ecosystem of Brazil, as too small to create a scaling and impactful business in the long term [CR01, PER04, CHL03]. The number of customers, as well as the economic power, is not sufficient to reach a particular stage [CR10]. Being aware of this fact, entrepreneurs are obliged to think globally and search for international business models from day one [CR01]. As the internal economy is a disaster, Argentinian entrepreneurs are strongly oriented to markets abroad [PER04, ARG02]. Having an

internationalization strategy is seen as a competitive advantage for early-stage startups [CHL01]. However, entrepreneurial courses in universities and support organizations need to be adapted to this strategic orientation [CR07]. Having only a small home market is not necessarily considered a bad thing [CHL06]. For the exploitation of new ideas up to achieving the proof-of-concept, EEs with limited market sizes provide an appropriate environment for experimentation, testing, and validation of business opportunities [CR01, CHL03].

Historically, Costa Rica and Chile began to build trade relations and economic partnerships with many countries for a long time [CR06]. All these trade agreements enable their startups to access these markets and export their products and services to a high number of global economies [CR11]. In addition, Mexico, Colombia, Perú, and Chile created the 'Alianza del Pacífico' as a common free trade area, with a potential customer base of more than 215 million people [PER04]. However, from the perspective of young entrepreneurs, customs regulations and legal obstacles are still seen as barriers to entering adjacent markets easily [CHL03]. Future economic development planning should include more economies to create an expanded market, building on good relationships with Bolivia, Paraguay, Uruguay, and other countries [CHL02]. Through these economic partnerships, the connectivity between EEs increases to a higher level, leading to an exchange of goods, knowledge, and resources. Furthermore, access to markets is guaranteed, enabling startups to scale according to their potential [CR11]. In addition, an entire infrastructure of public and private support organizations has been established to guide local companies on how to export their products around the globe [CR01, CR06]. Starting a business in a smaller country with lower costs of living but being able to sell products and services to big markets provides a highly competitive advantage [CR01].

Furthermore, the rise of digital entrepreneurship is predicted as a promising solution to overcome the barriers of single markets. Exploiting the PlayStation platform as a marketplace to sell video games globally is exemplary for new capabilities and the impact on the local economy in San Jose, Costa Rica [CR06].

Openness of Markets

As having a risk-averse mentality, most of the population sticks to well-known products, not willing to reflect on their buying behavior [CR10]. For most young companies, it is

troublesome to make people use their products as early customers [PER06]. However, it is observable that the new generation is more open-minded to innovative products and services [CR10]. However, industries in Latin America are often dominated by only a few established companies with significant market power in the possession of influential families [CHL02]. These oligopoly situations (e.g. Telefonica in Peru or the bus and mining companies in Chile) are a high market entry barrier for startups, negatively influencing their growth [PER06, CHL05]. Open digital markets may provide an opportunity for small and medium-sized companies and physical stores to overcome these obstacles, increasing their market potential and the number of sales [CR06, CHL01]. Through a wide range of companies being competitive with established top dog companies, the economic growth will become more resilient [PER09].

Focus and Differentiation

Over decades, no differentiation between the needs of high-growth firms and normal SMEs in the economic orientation of developing countries has been made [CR03]. Entrepreneurship is still often perceived as something that seems just to happen [CR11]. Furthermore, young EEs are not highly focused on a special kind of technology or industry [PER02, PER09]. However, to contribute to the evolutionary dynamics of EEs and to ensure international competitiveness there needs to be targeted support [CR11]. By bringing startups together with existing stakeholders from the local area such as established companies or research institutions, new resources are attracted to the EE. In doing so, collaborations with EE abroad with similar strategic specifications can be built up, leading to a comparative advantage through synergy effects [CR09, CHL05]. Incubator programs are using the advantage of a concrete focus to create a unique characteristic [PER06]. Focusing on key areas makes it more likely to attract venture capital firms specialized in these concrete fields leading to a higher amount of investments [CR06, PER09].

However, in nascent EEs, any field of entrepreneurship should be promoted first to reach a critical mass first [CR08]. To design support programs, it is necessary to analyze the core industries of a country first and understand their particular impact on the economy first [CR09]. Up to today, governmental funding programs are designed to promote entrepreneurship in general [CR05]. A differentiation between small businesses and high-

growth startups would prevent “spending money on useless things”, impacting the sustainable development of local economies [CR11].

Nevertheless, entrepreneurial actors from all countries see first strategic orientations towards a specification of entrepreneurial activities related to the strength of the countries and their cultural identity [CR09]. The region around San Jose, Costa Rica, is seen as a place for businesses with a focus on environmental-friendly and green technologies [CR03, CR06, CR09], social entrepreneurship [CR03, CR06, CR07], biotechnology [CR09], IOT [CR06] and orange economy [CR03, CR04, CR06]. In Lima, Peru, new businesses in the fields of FinTech [PER06, PER04, PER08], AgrarTech [PER02, PER09], socially responsible solution [PER05], smart cities [PER06], and food products [PER05] are evolving. Whereas, computer science and IOT are prominent in Arequipa [PER03]. Santiago de Chile is named a hub for healthcare and life science [CHL02], technology-based entrepreneurship [CHL05], and B2B business cases [CHL06]. To build on these tendencies, leaders can encourage dynamic entrepreneurship in each country [CR03]. However focal points are not supported systematically through governmental decisions yet, first small-scale projects evolved [CR11]. Finally, focusing on global business models would significantly impact the resilient growth of the EEs in Latin America [CHL06, ARG05].

Business Models

Entrepreneurial activities in Latin America are mostly driven by very traditional businesses instead of innovative concepts [CHL05]. Over decades, established businesses have been based on trading and exporting natural resources (soybeans, fruits, etc.) and raw materials [CR11]. Furthermore, the public discourse lacks differentiating between self-employment with small businesses and high-growth firms based on innovative solutions [CR03]. In addition, the majority of entrepreneurs implement business ideas that are focused on solving local problems only [PER01, PER08]. However, the potential and the scalability of these kinds of business models are limited [CR06]. Nevertheless, financial institutions are still more likely to give loans and investments to traditional business models [CR11].

The robustness of business models is supportive of the growth of young companies and impacts significantly on transforming economies sustainably [CR09, CHL02]. The transition toward a service-based economy has been on the political agenda for a while

but only proceeded slowly [CR06]. To increase the resilience of EEs, it is indispensable to further strengthen the transformation from a service economy to a value- and innovation-based economy [CR11]. Thereby, the internationalization of business models is offering a new path of how to scale more promising [PER06]. Not including this global reach in the conceptualization process and the early-stage of startups already is seen as a shortcoming of entrepreneurial activities in developing countries [CR07]. Opportunity recognition and business model generation is not educated adequately [CHL02]. University courses and support programs are not structured yet to steer early-stage and scaling startups towards the development of global business models [CHL01]. Once entering these programs, grants are getting paid out without differentiating between the scale of business models or reviewing the worldwide potential [CR08].

The first approaches of incubator programs having internationalization of startups and their business models on the agenda were overwhelmingly positive [CR09]. Especially to be emphasized is that having the entrepreneurial skills to identify a global business idea separates a good entrepreneur from an excellent one [CHL01]. In recent years, the importance of international business models to create a growing EE with a high resilience has been recognized by governmental and support institutions [PER09]. However, the transformation process and the implementation of concrete measurements have not progressed very far [CR06].

Networks

The EEs of Latin America consist of small networks with weak connectivity [CR09, PER02]. Productive entrepreneurship is mainly happening in bubbles within the environment of private and public universities, incubators, and accelerator programs separately [CR07, PER07]. Additionally, entrepreneurship is still considered an exclusive community for well-educated persons with wealthy family backgrounds [CR11, CHL01]. Established companies and institutions are acting non-innovative and thus, not fully integrated into the EEs [CHL05]. In addition, large corporations prefer to create communities around them instead of joining local networks [PER06]. As local stakeholders are not open-minded toward collaborations with entrepreneurs, networks are considered underdeveloped [CR04].

Therefore, connecting people by building up the right conditions is on the radar of ministries, administrations, and support organizations [CR06, CHL05]. A lot of effort has

been set into community building, but not on increasing the interactions between different programs [CR03]. Depending on funding from governmental support programs, institutions encourage entrepreneurs to stay only in their environment instead of exchanging with other networks. This phenomenon prevents collaborations and leads to the creation of sub-ecosystems, evolving separately from each other. Thereby, all actors tend to protect their interests instead of contributing to the big picture [CR01]. In particular, the bonds between universities and industries need to be promoted to impact the transformation in practice [CR06, CR07]. Having a large entrepreneurial community with well-connected actors will be beneficial for everyone in the ecosystem [CR02].

Networks need to be used as platforms [CR07] for sales, networking, sharing ideas, and building relationships between entrepreneurs and other actors [CHL02]. Within these networks, talking to each other, sharing ideas, and learning from each other are working well [CR01, CR11]. By increasing interactions with entrepreneurs and stakeholders, more projects were evolving [CR03]. Making deals and sales or at least using contacts through networks is a significant advantage [PER05]. Getting funding provides also a network besides only "smart money" [PER06]. Distribution networks [PER08]. Being well-connected increases the chances to raise funding and advance faster [CR08, CHL05]. Acting alone and not belonging to a network makes it almost impossible to scale a business successfully [CR07, ARG01]. However, some people want to work only for themselves [CR04]. Overall, the functioning of networks depends on good leadership and organized proceedings [CR08].

Onramps to the Ecosystem

Hence, onramps as access points are beneficial to reducing the barriers to participating in the entrepreneurial community [CR08]. Therefore, it is the role of institutions to create relations with other parties at a specific place. In doing so, access to the whole entrepreneurial community can be offered to startups within their programs [CR07]. This building of pipelines has been working very well in Peru recently, having a high impact on connectivity [PER09]. Competitions, accelerator and incubator programs, and other events are door openers for persons to join networks simply connecting entrepreneurs with the local ecosystem [CHL05]. Global organizations like Endeavor or Startup Weekend are providing their networks with contacts from all over the world to startups within the programs [CR04, CHL04]. Furthermore, attending global competitions and

winning them creates high visibility [CR08]. In doing so, the obstacle of weak local networks can be reduced and the own network with international experts can be set up [PER06, CR08]. As the younger generation uses digital platforms such as LinkedIn to get in touch with the community more easily, barriers to accessing networks get vague [PER08]. In addition, a key advantage of senior entrepreneurs is that they can rely on their long-standing business network [CHL01].

Mentorship and Dealmaker

Mentors and dealmakers are supportive to overcome the issue of not existing networks and mistrust among local actors [CR03]. These persons can set up direct contacts with potential customers or partners and thereby increase the reliability of the startups by guaranteeing their reliability [PER05, ARG01]. However, mentors are not only successful businessmen with a strong network and free-of-charge consulting services [CR03]. Former successful entrepreneurs want to give something back to the community and engage themselves as business angels [CR01]. Furthermore, the role of dealmakers who can open doors for you as a young company without any history is underrepresented [CHL01]. Endeavor offers more than 100 high-level executives as mentors [CHL04, ARG07]. These dealmakers are extremely important to balance the vulnerability of weak networks by making recommendations and thereby increasing the trust between parties [PER06]. Getting direct introductions to national and international partners impacts highly on the growth of startups [ARG01]. With the increasing success of a startup, more and more people are acting as dealmakers for your company [PER06].

5.5.4 Human Capital

Although public education in Costa Rica and Chile has a relatively high standard and is available for free to everyone, there is a lack of access to educational services in most Latin American countries [CR04, CR07]. In particular, the educational level differs between urban and rural areas to a large extent [CR11, PER01]. Furthermore, it is an exciting phenomenon that only a small percentage of young people study after high school as there are cultural and social expectations and the necessity to earn money to support the family [CR07]. Over a long period, entrepreneurship has been considered a kind of exclusive community for well-educated persons with wealthy family backgrounds [PER02, ARG03]. These entrepreneurs, mostly graduates and alumni from private universities, can afford to start a business without requiring an income from the

beginning. As their behavior tends to be “very demanding and picky”, the attitude of some talents, even graduates from the best universities in the country, is not the best [PER06]. Nevertheless, a variety of young people are open-minded and motivated to work in meaningful jobs which makes it easy to hire good student employees [CR08]. The best people want to work in a place where they have an impact [CR01], promoting entrepreneurship from the bottom-up [CR11, ARG04].

Entrepreneurial Education

Educational systems are designed to produce workforce for established multinational companies quickly, not entrepreneurs or entrepreneurial thinking employees [CR05]. As the profiles of lectures and courses at universities contain traditional education concepts, students are trained to work in corporate jobs [PER08]. The heavy workload requires complete concentration on learning stuff for courses, resulting in no time for undergraduates to try things out [CR10, PER02]. Being unable to work on entrepreneurial side projects within their studies prevents students from getting inspired and making valuable experiences [CR07]. Recently, universities and governmental institutions made a solid effort to swift concepts and promote entrepreneurs [CR08, PER08]. Due to the high student demand, universities began to change their curricula including innovative concepts such as design thinking and business model generation [CR05, PER03, ARG04]. Furthermore, the learning objective of classes has been changed towards entrepreneurial competencies and testing business ideas in practice [CR07, CR10, ARG09]. Business plan competitions and fairs are publicly accessible and create visibility beyond the campus [PER06, PER02]. As most business ideas concentrate on minor local problems only [PER01], there should be more focus on teaching opportunity recognition and the identification of problems that need to be solved [PER05, ARG07]. Furthermore, entrepreneurial education is rather related to business administration and management studies than to engineering or social science and most students never heard anything about entrepreneurship [CHL05; ARG09]. To attract talents from all areas as a valuable resource to join the startup community, entrepreneurial education has to be widened to all studies [CR07]. The weaknesses of public entrepreneurial education have been recognized by private actors such as incubators and other support programs [CR03, CR04].

Important Groups of Talent

Although the entrepreneurial communities are quite small, two groups of human capital are of outstanding importance. A lot of young women are confident and take the opportunity to be an entrepreneur, leading to a powerful female entrepreneurship culture [CR07, PER06]. The mentality of female founders in Latin America is fitting to the skills required as an entrepreneur [CR07]. Furthermore, senior entrepreneurship is also powerful as these people have a great network and a lot of business experience. As well-established in the ecosystem, they have built up trust [CHL01]. Besides female founders and senior entrepreneurs, there is another very important source of educated talents. After studying and working abroad for quite some time, more and more expats are moving back to their home countries. These people with a lot of working experience and quite some savings are bringing entrepreneurial spirit from international places to the EE [CR01]. For them, it is extremely important to impact the local conditions, and therefore, they also are open to investing in young startups [CHL01]. Additionally, support programs such as Start-Up Chile aim to attract entrepreneurs from around the world [CHL05]. This international exchange has been an excellent strategy to increase human capital, but it significantly impacted the transformation of culture. Onramps for these people should be set up and visa regulations have to be modified to attract more international talents [PER09, CHL05]. However, trade and visa agreements can lead to the labor movement towards industry countries, as high-qualified engineers and IT specialists leave the ecosystems [CHL01].

Established Companies

The existence of multinational companies is a curse and blessing at the same time. On the one side, many jobs are created leading to economic growth [PER09, CHL01]. On the other hand, established companies with high market power hinder the entrepreneurial attitude as people prefer to have a fixed salary instead of being self-employed or working in a startup with a low income and unpredictable future outlook [CR02, PER02]. Moreover, global companies are absorbing good graduates to work for them which is very competitive for startups [CR05]. Hence, it is not easy to recruit someone as there is already a permanent fight for talents [CR02, ARG03].

5.5.5 Finance

In the whole of Latin America, EEs lack financial capital, making it difficult for startups to get funded according to their potential and growth strategy [CR05, CR09]. Overall, most of the actors in the finance sector act highly risk-averse and invest mainly in real estate [PER08, PER09] or traditional businesses [CHL01] instead of funding new ventures with high-growth potential. In addition, financial institutions are more open to giving loans to established business models than to young and innovative ventures [CHL01, CHL04]. For a long time, first investments have been possible almost exclusively through private networks, family, and friends [CR01, ARG03]. Entrepreneurs are not used to risking capital, and being afraid to lose their company and mistrust the financial system, decline to talk to investors [CR06]. In particular, there are still general concerns about business ideas getting stolen by wealthy businessmen [CR04, CR09]. The latest successful examples of funded companies such as Slidebean in Costa Rica and Cinepapaya in Peru change these obstacles slowly, creating a more venture capital-friendly culture [CR06, PER08]. While working abroad, highly-educated returnees have experienced how the equity game works, describing it as a win-win situation for everyone involved if the company will be successful [CR01].

Lack of local VC

Although an awakening in the financial market is noticeable, receiving funding from local investors is still rare and startups need to search for capital outside of their countries [CR01, CR07]. As there are complex legal frameworks for funding, it takes far too much time until the final investment can be made officially [CR08]. In particular, the required financial resources to scale a company are only insufficient available on-site, forcing the founders to search internationally [PER03]. Global venture capitals specialized in Latin American markets exploiting these vulnerabilities [PER06].

Policymakers have recognized the need to provide additional financial resources to high-growth firms [CR06, ARG07]. Through working on new regulations, alternative funding concepts are becoming available [CR11]. Enabling crowdfunding or a stock market for business angels increases the financial possibilities of local startups to a high extent. Furthermore, allowing pension funds to invest in risk capital is seen as a powerful tool to foster the growth of startups [PER04]. Furthermore, financial support from public institutions as from governments has been established so far [CHL03]. CORFO is putting

a lot of money into entrepreneurship and its influence on the entrepreneurial process is evident [CHL01, CHL06]. However, financial support programs are in the majority of cases not targeted at a strategic goal, and money is spread by the scattergun approach [CR09, ARG01]. Furthermore, grants keep startups alive which better should have given up, negatively impacting the recycling of resources. Additionally, this makes it difficult for private actors to compete, as there is no fair competition possible.

Business Angel Networks

First local venture capitalists have established and funding in startups successfully [CR02, CR11]. Especially in the environment of private universities and alumni networks. Incubators and accelerator programs are integrating investment vehicles [PER08, CHL04]. Including stock options for the institutions running the programs [CHL02]. High impact on the local economy [CR11]. Due to inadequate regulations, private VC firms and funds are faced disadvantages [CR06, CR11]. However, experts working abroad for several years return to their home country, using their savings to invest in local businesses [CR01, PER06]. Business Angels organize themselves in networks, e.g. Chile Global Angeles, following the mission to support the transformation of local and national economies [PER04, CHL04, CHL05]. Spending this money on young companies contributes to their vision to change market conditions sustainably [CHL05]. Nevertheless, the few numbers of business angels and investors lead to a missing competition between them and weaker investment deals for startups [CR02, CHL01, CHL05]. Although the existence of business angels and private investors cannot rely on a long history, the numbers developing favorably in recent years [PER02, PER04].

Competitions and Prize Money

Unable to raise money quickly, competitions and prize money play an essential role in financing an early-stage startup [PER06]. In addition, the visibility through winning awards increases the probability of receiving investment [PER05]. However, access to financial resources in the early stage enables young entrepreneurs to build minimal viable products and prototypes up to the application of patents [CR03, ARG09]. Without this initial push, it is observable that students and young graduates are more likely to not continue with their projects and leave the EE [CR10]. Small funds provided by universities are highly supportive on the way from the initial idea to a practical implementation [CR07, PER03]. Even a small amount of around 5,000$ helps student

entrepreneurs to overcome the first gaps and test their prototypes to reach product-market-fit [PER05]. The whole situation is unfavorable for startups willing to follow high-growth business models. As negatively influencing the birth of these business models, most startups decided to grow organically [CR05].

5.5.6 Support Programs

Support organizations play a critical role to increase the survival of new ventures in Latin America as "it is very difficult to start a new project or new company here" [CR03]. Thereby, support for entrepreneurs is necessary on multiple levels such as education, obtaining financial resources, networking building, and legal obstacles [CR04]. Furthermore, the objective of these institutions is to provide resources not accessible to single entrepreneurs and startups [CR11]. Due to political actions, a high number of public and private initiatives have evolved over the last decade [CR11, CHL01, ARG05]. In particular for universities, it became mandatory to offer incubator and accelerator programs promoted by public funding pools [CR04, CR06]. Nevertheless, entrepreneurial education should not start first for students and graduates [PER01]. Hence, primary school and high school education are considered indispensable by these support organizations [PER01, PER02]. Although in some places this governmental support has been highly effective after a short time, not all countries have an entrepreneurial support agenda yet [CR11 ARG05]. Highly supportive infrastructure has evolved in Santiago de Chile, whereas other ecosystems still have an insufficient landscape [CR10].

Entrepreneurial Competencies

As the teaching of entrepreneurial skills is not advanced at schools and universities yet, the courses given through support organizations are highly demanded by potential founders [CR03]. For a long time, there has not been "a lot of help for people that have just the idea" [CR08]. A learning process only based only own experiences would be highly time-consuming for startups and therefore, support organizations "need to teach them how to shorten the startup process" by focusing on the core questions primarily [PER07]. There needs to be more focus on opportunity recognition of relevant problems and global business models [CHL03]. Therefore, early-stage programs should include the identification of a problem, looking for solutions, and exposing them to technology [PER07]. By also providing a small amount of financial support, young companies can fully concentrate on reaching product-market-fit [CR03, PER06]. For startups,

participation in programs is also increasing their visibility [CR11]. However, the majority of programs do not have formulated success targets and KPIs to reach. Due to this vulnerability, startups are kept alive that should fail faster, preventing the founders away from learning to fail, and pivot [CHL01].

Nevertheless, programs should be conceptualized to bring the participants out of their comfort zone to improve their entrepreneurial attitude [ARG02]. In doing so, there is a noticeable impact on the change of culture towards an entrepreneurial mindset [CR03, CHL03]. At some universities, it is allowed for employees to use resources and machines to work on their ideas [CR08]. However, this beneficial situation is not the case for every and also not for all students and other groups [CR10]. Institutions providing a maker space as part of their infrastructure provide the possibility to work on prototypes and the further development of products and services [CHL06]. Some of the institutions offer all-in-one packages including support with legal obstacles up to human resources developing an MVP quickly [CR04). As incubators have mainly non-specific selection of participants, the further development of the EEs has to lead to more focused support programs as well [CR06]. Besides different fields, there need to be special programs for startups in all stages (idea, seed, growth) as further steps to increase the value for participants [CR04]. Additionally, first institutions offer programs for SMEs that can pay for incubation [CR05].

Community Building

As there are no strong networks yet, community building is a fundamental objective of support institutions in Latin America [CR05, CHL04]. Strong relationships with other actors inside the EE as well as with external partners and providing them to the participants is an advantage. By sharing their contacts with entrepreneurs, support institutions are essential onramps to the EEs. Thereby, a strong community can be managed through events with high exchange and good leadership. Support organizations have evolved nearby universities as the environment is really good and direct contacts to entrepreneurs can be set [PER03]. The collaborations between support organizations are underdeveloped as governmental funding is based on the number of startups avoiding the exchange of startup teams [CR04, ARG05].

International Programs

International support programs and their networks are highly attractive to the growth of young technology-based companies [CHL04]. Contacts to potential customers all around the world are leading to business opportunities, which are essential for the resilient growth of startups [CR03]. Therefore, organizations need to support startups to identify global business models from the beginning [CR01]. Existing programs to go abroad, e.g. to Mexico as a way bigger market, are beneficial to overcoming the obstacles of insufficient home markets [CR11, PER06]. In addition, institutions are helping startups with the export of products to foreign markets [CR01, CR06]. Having solid international networks is also valuable to share cultural backgrounds to improve the entrepreneurial mindset in former traditional economics [CR05, PER07]. Inviting entrepreneurial thinking persons from all around the world to join their program, Start-Up Chile had a significant impact on the local conditions for entrepreneurs [CR11, CHL05].

5.6 Discussion

literature on entrepreneurial ecosystems is still in its infancy. However, a growing number of research articles have contributed toward shifting the focus from identifying single factors to an evolutionary pathway with a much broader perspective (Cho et al., 2021). Addressing the importance of multinational analyses of entrepreneurial activities to generate meaningful contributions, we performed 35 interviews in four EEs (Terjesen et al., 2016). In doing so, we identify barriers that prevent the effective functioning and resilient growth of EEs in different geographical contexts. Additionally, we develop an understanding of how international orientation can stimulate the evolutionary momentum of early-stage ecosystems (Bianchi et al., 2017; Harima et al., 2021). Therefore, insights from born-global and IE literature need to be transferred and included in the EE conceptualization (Ryan et al., 2021). To provide an overview and outline the critical challenges and barriers to the resilient growth of EEs, Figure 9 presents a summary of the findings. Thereby, the main elements are linked to the EE domains of Isenberg (2010).

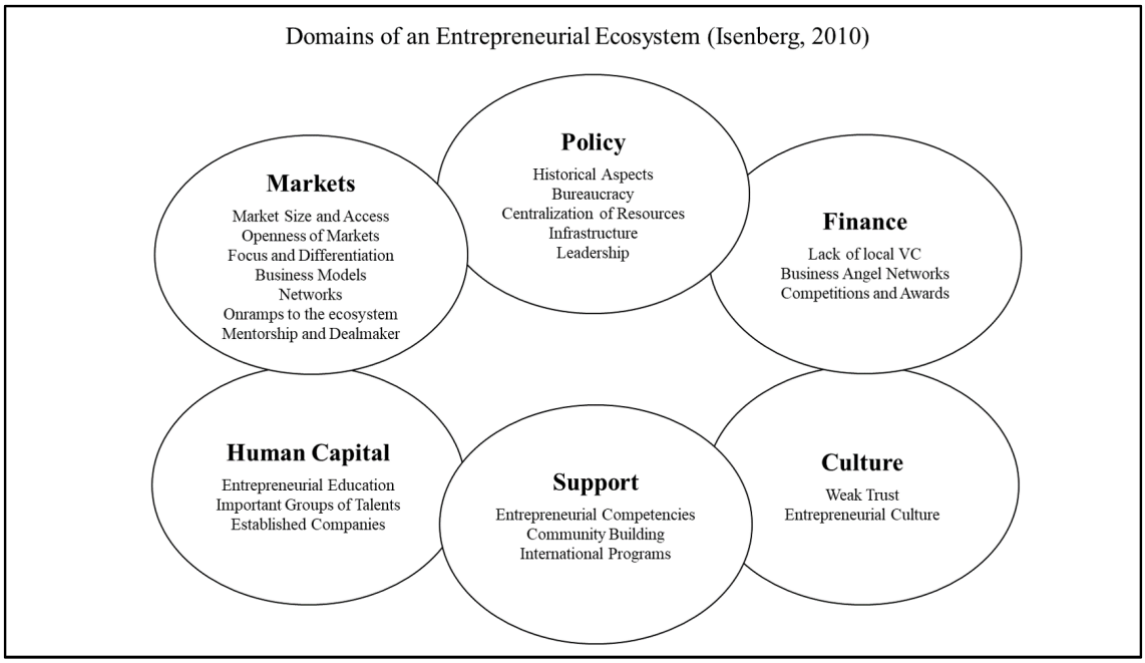

Figure 9. *Challenges and barriers to the resilient growth of entrepreneurial ecosystems*

The findings of this study confirm the existing literature that entrepreneurship in Latin America suffers from multiple obstacles, negatively influencing economic development across the continent (Freire-Gibb & Gregson, 2019). We could identify a variety of challenges related to all stakeholders across various fields including political, social, cultural, historical, legal, and educational aspects. First, the lack of trust between the participating actors remains a highly relevant issue for entrepreneurial activities in all countries of Latin America (Quinones et al., 2021). This mistrust results from the non-existence of solid networks (Scott et al., 2021), historical events, and political instabilities (Reyes & Sawyer, 2019) as well as ongoing fraud, and corruption (Freire-Gibb & Gregson, 2019). Furthermore, a historically founded aversion against institutions and complex legal framework conditions result in a high level of informal entrepreneurship (Salinas et al., 2018). Most home markets in Latin America are insufficient for high-growth firms and access to global markets is not guaranteed (Ruiz-Martínez et al., 2021). As laws and regulations do not match the needs of new ventures, entrepreneurs face bloated bureaucracy and high administrative burdens (Salinas et al., 2020). Numerous examples have shown that policymakers and governmental institutions tend to spread financial support through the scattergun approach without differentiating between particular types of entrepreneurship. This procedure leads to ineffective support programs, negatively affecting the entrepreneurial outcome (Wurth et al., 2022). Instead

of teaching entrepreneurial competencies and practicing them in a safe environment (Tittel & Terzidis, 2020), education systems are aimed to produce workforce quickly for established companies. Therefore, young talents do not have the time and resources to develop an entrepreneurial mindset and identify entrepreneurial opportunities. Due to all of these barriers, the support infrastructure has emerged tremendously over the last decade. By supporting young firms on multiple levels, these institutions play a crucial role in promoting entrepreneurship in developing countries. However, the program design and the objective must be adapted to specific target groups. Additionally, there have been positive developments in EEs in Latin America. The successful integration of female and senior entrepreneurs exploits new potential, creating a competitive advantage related to developed countries.

In our study, we identify that stakeholders adapt their strategies necessity-driven to the existing barriers and the resulting lack of resources. Entrepreneurial actors from all fields discover that developing an internationalization strategy is supportive of overcoming the obstacles of their home ecosystems. Interestingly, this phenomenon is driven bottom-up by the entrepreneurial communities, not policymakers and leaders. Thereby, internationalization happens as the local framework conditions do not provide the necessary support for entrepreneurs and high-growth firms to fully unleash their potential and not fulfilling their needs. Therefore, fostering international entrepreneurial relationships is highly relevant to overcoming the challenges, especially for new ventures in smaller internal markets, increasing the possibility of reaching the stage of a strengthened and resilient EE (Amorós et al., 2012; Amorós et al., 2015).

Our findings indicate that internationalization aspects affect local entrepreneurial activities on multiple levels. Public events with internationally established organizations contribute substantially to the creation of an entrepreneurial culture. The exchange within global networks facilitates knowledge transfer between entrepreneurs and increases the movement of resources that support the growth of startups. Furthermore, attending global competitions may increase visibility far beyond the border. Internationally successful startups can influence the motivation of young talents to start a business. For internationalization, it is imperative to partner with well-known and established stakeholders, as trust is essential and those players can provide solid networks. Having relations to partner with strong networks enable high-growth firms to enter global markets

and work with local partners. Access to global markets is vital to enhance entrepreneurial and technological capabilities (Bianchi et al., 2017), increasing the firm performance (Amorós et al., 2012). Therefore, it is mandatory to focus on exploring global business models (Asemokha et al., 2019). In addition, raising venture capital from abroad reduces the lack of financial resources. The exchange of entrepreneurs worldwide increases the entrepreneurial mindset of stakeholders from the EE.

The Start-Up Chile program and its international aspects highlight the impact on the regional entrepreneurial community. It stands out as a positive example of how political deciders can design well-functioning programs without hindering startups with inefficient regulations. The attraction of external resources to the ecosystem and the flow of resources between ecosystems through global connections are significant for the evolutionary dynamics of EEs already in the nascent stage. As this contradicts the process theory of Spigel & Harrison (2018), our findings contribute to the theoretical foundation by focusing on internationalization strategies right from the beginning. The concept of internationalization has to be included in entrepreneurial education courses and support programs as young entrepreneurs tend to focus on small, local problems than on global business models (Onetti et al., 2012). It is especially important for countries with a smaller home market and limited access to funding. Hence, EEs need to foster business model innovation (BMI) by linking the international entrepreneurship (IE) perspective to the local framework conditions (Amorós et al., 2012; Asemokha et al., 2019). In doing so, participants can be sensitized to the importance of international entrepreneurial activities for sustainable and resilient growth. To attract human capital from around the globe, barriers with visa regulations for born-globals must be removed and a suitable infrastructure such as airports with regular international connections built.

In addition to internationalization, we identify digital entrepreneurship as a great opportunity to reduce the negative influence of barriers. In particular, startups from smaller ecosystems are enabled to participate in high-volume markets reaching customers around the globe. Through digital platforms, trade restrictions are reduced, and access to markets is guaranteed. However, Latin America struggles as a high number of citizens, especially in rural areas, are not able to connect to the internet. For this reason, they cannot sell their products and services as entrepreneurs digitally, nor are they included in the potential customer base. Furthermore, access to digital networks such as LinkedIn

compensates for the weaknesses of physical networks (Hernandez & Gonzalez, 2017). Therefore, policymakers are invoked to create the necessary digital infrastructure to access the global platforms which may be a future advantage for regional competitiveness. Additionally, digital entrepreneurship enables entrepreneurs from all areas to onramp so that entrepreneurial activities decentralize and more resources become available. In doing so, economic development is enhanced, not focused on capital anymore. Overall, regions need to improve their framework conditions towards international entrepreneurship with low barriers to increase global competitiveness and resilience growth.

5.6.1 Contributions to Scholarship

Over the last decade, the lion´s share of studies has identified lists of determinants that enhance entrepreneurship at a local level and on traits and characteristics of individual entrepreneurs and founding teams (Shwetzer et al., 2019; Velt et al., 2020). Recently, research has shifted the EE literature towards a process-oriented focus (Cho et al., 2021). As a contribution to the further development of the theoretical foundation, we shed light on how the evolutionary dynamics of EEs over time and across space can lead to the resilient growth of local and regional economies. Through a cross-national analysis of four cases in Latin America, we identified multiple barriers and challenges EEs face toward higher economic resilience. This study enhances the previous models of process theory (Spigel & Harrison, 2018) and life-cycle theory (Mack & Mayer, 2016; Cantner et al., 2021) by integrating the international entrepreneurship perspective (Jones et al., 2011; Ciravegna et al., 2016). Furthermore, the insights are reflected in the concepts of born globals (Velt et al., 2018), ex-pats (Lall et al., 2019), and transnational entrepreneurship (Harima et al., 2021). In addition, we highlight the role of internationalization strategies to overcome the identified obstacles new ventures from nascent EEs have to deal with (Amorós et al., 2012; Asemokha et al., 2019). Our findings show that building relations with other places around the world should be included already in the birth stage of an EE. Attracting resources from outside leads to accelerated growth that cannot be done by individual ecosystems acting independently. In particular, we observed a significant influence on the level of entrepreneurial education and a happening cultural change toward an entrepreneurial mindset. In doing so, international entrepreneurship stimulates the resilient growth of startups by identifying global business models and increasing their survival rates (Bianchi et al., 2017; Etemad et al., 2022). Adopting an international

perspective opens a new debate on the contextualization of entrepreneurship (Stam & Welter, 2020) and the necessary support infrastructure (Theodoraki & Catanzaro, 2022). In doing so, our results show that EEs need to "transcend physical boundaries" through international entrepreneurship to transform further into knowledge-based economies (Neck et al., 2004), increasing the resilient growth of local economies (Ryan et al., 2021; Zahra, 2021; Zucchella, 2021).

5.6.2 Implications for Policymakers and Practitioners

The EE approach has become a robust guideline for policymakers to build framework conditions that foster the creation of new businesses and enhance the development of local economies (Theodoraki & Catanzaro, 2022). Authorities and their strategic decisions are highly relevant in promoting entrepreneurial-led growth (Gherhes et al., 2018). As multiple studies documented a lack of efficacy between government support programs and entrepreneurial outputs (Hechavarría & Ingram, 2019), an optimal balance between purposive leadership and grass-roots movement needs to be pursued (Thompson et al., 2018; Colombo et al., 2019). Instead of designing unspecific support programs to promote entrepreneurship, policymakers should focus on infrastructure expansion to enable entrepreneurial processes without constraints. Creating the right competitiveness conditions for a region to do business is more relevant than a scattergun approach without any differentiation between types of new businesses. Furthermore, local deciders and entrepreneurial actors need to increase their collaboration on transparency to rebuild institutional trust (Belitski et al., 2021). In doing so, transparent governance impacts EE quality and development (Cunningham et al., 2019). Policymakers need to understand the barriers and challenges toward the resilient growth of local economies through strengthened EEs. In doing so, it is feasible to adapt the framework conditions upfront to be prepared for crises and external shocks. Especially nascent ecosystems (Spigel & Harrison, 2018) and ecosystems in developing countries (Guerrero et al., 2020) face multiple challenges in their evolutionary dynamics (Spigel et al., 2020; Schäfer, 2021). As our study shows, internationalization has a crucial role in overcoming the barriers and obstacles in the evolution process of EEs toward a resilient stage. Therefore, we recommend politicians aim at creating an infrastructure enhancing the international perspective of entrepreneurs and local actors. The legal framework and other established systematic conditions must be adapted to the new circumstances to stimulate global relations. Politicians in Latin American countries can still modify public policy. In doing

so, particular fields of entrepreneurship can be promoted to create a competitive advantage (Cho et al., 2021).

Practitioners, entrepreneurs, and institutions should widen their networks and actions to a global scale. Community building and establishing strong relations within the boundaries of the own ecosystem and internationally are crucial for the resilient growth of new ventures. Having networks with a very high level of connectivity between the ecosystem actors impacts social-cultural factors such as trust and leads to increased effectiveness of the entrepreneurial processes (Shwetzer et al., 2019). However, as networks in developing countries are still weakened, actors and institutions have to act as mentors and dealmakers to enhance the growth of new ventures. We have observed that support organizations or specialized programs focused on internationalization highly support the global activities of startups and their firm performance.

5.6.3 Limitations and Directions for Future Research

Conducting a multinational analysis of EEs and their actors offered a significant opportunity to understand the evolutionary dynamics of EE resilience and effectiveness from an international perspective. However, this study has several limitations that should be considered. First, the focus on four EEs in Latin America with similar characteristics influences the generalizability of the findings. As our study relies on insights from the capital cities, further research should include EEs with different geographical, historical, and political characteristics. In addition, a cross-national analysis between developed, emerging, and developing economies should be performed to include diverse perspectives (Guerrero et al., 2020). Furthermore, the impact of international entrepreneurship should be analyzed in more advanced EE with a more extended history of entrepreneurship. Researchers should address whether internationalization strategies play a similar role in countries that have a small market but are surrounded by many other countries and geographically isolated ecosystems (Theodoraki & Catanzaro, 2022). In addition, further investigation should be conducted in countries with a big enough market, such as the US, China, and India, or economic communities such as the European Union. These insights will strengthen the role of international entrepreneurship inside EEs according to the geographical features of the territory. The exploratory nature of this study is based on interviews conducted over a single period. The data collection should be repeated later to measure the impact of concrete internationalization actions. Longitudinal data are needed

to understand how ecosystems develop, evolve, and increase their resilience (Korber & McNaughton, 2018; Spigel & Harrison, 2018). Although the conducted qualitative content analysis delivers valuable insights and further develops the theoretical funding of EE evolution, a further quantitative data-driven analysis is needed to illustrate the evidence of the findings. Therefore, future research should address the lack of quantitative modeling and survey-based research in the field of EEs (Maroufkhani et al., 2018; Liguori et al., 2019).

5.7 Conclusion

In this study, we used a multinational perspective to identify how barriers and challenges of EEs affect their resilient growth. The critical contribution of this article is to highlight the role of internationalization strategies in overcoming these obstacles toward a sustainable EE evolution. In doing so, we refine the process theory towards an increasing resilience of EEs and contribute to the emerging demand for using an "international lens" (Theodoraki & Catanzaro, 2022). This perspective extends the previous models that focused on economic development within local boundaries. Integrating international entrepreneurship already in the nascent stage of EE will strengthen the process theory of EE development. In doing so, policymakers and stakeholders from each EE are enabled to create the right competitiveness conditions for resilient local economic growth.

6 Cases from the EE of Karlsruhe

6.1 The Entrepreneurial Ecosystem of Karlsruhe

As an example of the effects of far-reaching technological changes on regional economies, the following section describes the considerable structural change in the city of Karlsruhe and the surrounding area. Thereby evolutionary dynamics have been influenced, among other things, by the increasing importance of information technology (Henning et al., 2006). The economic capacity and innovative strength of the region are illustrated by the Regional Innovation Scoreboard (RIS) of the European Commission, identifying Karlsruhe as the regional innovation leader in Germany and part of the top 6 in Europe (European Commission, 2021). Over the past forty years, industrial development went from mainly manufacturing to an economic structure that is predominantly characterized by innovative technologies and services in the sectors of IT, energy, and mobility. The transformation process towards a service society is emphatically confirmed by the current trends in entrepreneurial activities and figures about the performance of startups (Henn et al., 2015). Overall, the characteristics of Karlsruhe are consistent with other peripheral post-industrial places such as Thessaloniki, Greece (Williams et al., 2013), Sheffield City Region, UK (Williams & Vorley, 2014, Gherhes et al., 2018), Dublin, Ireland (Walsh, 2019), and Guildford, UK (Xu & Dobson, 2019).

Although only around 300,000 people live in the city area, more than 1.7 million inhabitants belong to the region Mittlerer Oberrhein and the Karlsruhe TechnologyRegion (Henning, 2006; Kowalski & Schaffer, 2012). The best-known companies with the highest turnovers in the region include EnBW, dm, and SEW Eurodrive (Marcusanu, 2019). Besides its economic strength, the importance of Karlsruhe for German society is illustrated by the existence of the two highest courts, the Federal Constitutional Court (BVerfG) and the Federal Court of Justice (BGH) (Höpner, 2021). As being located in the center of Europe, Karlsruhe is part of the economic powerhouse of Europe. The city is highly connected to national and international neighboring regions such as Paris, Munich, Frankfurt, Basel, and Zürich through direct high-speed train connections of only around two to three hours.

Groundbreaking innovations and significant technological milestones highlight the region's long tradition of great inventiveness. These include the invention of the ‘draisine’

by Karl Friedrich Freiherr von Drais in 1817, the discovery of electromagnetic waves by Heinrich Rudolf Hertz, and the development of the first automobile by Carl Friedrich Benz in the 1880s (Störmer, 2017; Csernalabics, 2018). However, looking at recent history, the local economy has not been always as flourishing as one might assume from today's perspective. In the 1980th, a large number of manufacturing companies, such as the Pfaff sewing machine factory or the Badische Maschinenfabrik, had to be closed as a consequence of a takeover by foreign corporations (IG Metall Karlsruhe, 2011). As a result, a lot of workers lost their jobs and entire industrial spaces became vacant. Being confronted with the collapse of anchor firms, the 'recycling' of a talented workforce, financial capital, and business ideas is a major challenge for the whole EE (Spigel & Vinodrai, 2021).

Nevertheless, policymakers were aware of this difficult situation and used the crisis to initiate a deliberate structural change, through which the business location of Karlsruhe could be rebuilt quickly and its conditions strengthened. After the failure of these large companies, a focused strategy was created subsequently to promote the development of new technology-based firms. Old industrial buildings, such as the 'Technologiefabrik' or the 'RaumFabrik Durlach', were converted, renovated, and turned into hotspots for fast-growing startups from the field of information technology and creative companies. In recent years, the area 'Alter Schlachthof' has been transformed into a creative hub additionally, offering new venture shipping containers as an extraordinary and inspiring place to work (Kaiser, 2020). Nowadays, around 4,200 small and medium-sized enterprises (SMEs) in the field of IT are located in the technology region of Karlsruhe, having created more than 40,000 jobs (Csernalabics, 2018). The overall industry landscape consists mainly of smaller companies with between 10 and 20 employees and flat hierarchies. Those firms have found their niche in which they are successful and are known as 'hidden champions' beyond the borders. Through their organizational structure, the ability to adapt quickly and flexibly to economic changes and exogenous shocks is pronounced. Such an industry distribution can be advantageous in overcoming crises and is certainly a success factor for sustainable EE development (Theodoraki et al., 2022). The founding of the first computer science faculty in Germany at the Karlsruhe Institute of Technology, the former University of Karlsruhe, and the establishment of the CyberForum as the representation of interests for all IT companies are pointed out as important milestones for the process of transformation (Gräber, 2021). The over 20-year

success story of the CyberForum impressively highlights the positive influence on the function of the network among entrepreneurs and stakeholders (BNN, 2017). Some of the success stories that emerged during this period such as Web.de, and Gameforge, have been presented in in-depth case studies preciously (Rau, 2007; Runge, 2014).

Recent studies and rankings confirm the successful structural transformation of the local economy and describe the region's strength as an interplay between technology focus (de Prato & Nepelski, 2014), cultural offerings (Montalto et al., 2017), an entrepreneurial university (Frank et al., 2016), and an outstanding outlook for the future (von Radecki et al., 2016; Jentsch, 2018). The location of Karlsruhe is characterized by extensive innovation activities, excellent degree programs, and a large number of research institutions (Henning et al., 2006; Stahlecker et al., 2014). Beyond its technological focus, Karlsruhe is characterized as a green and liveable city (Cassing, 2021), awarded multiple times as the most bicycle-friendly city in Germany (ADFC, 2020).

A study by the European Union ranked Karlsruhe in 4th place in a comparison of high-performance locations for information and communication technology (ICT), directly behind the metropolises Munich, London, and Paris (de Prato & Nepalski, 2014). Furthermore, Germany's largest and most important data center, which handles more than 50% of national e-mail traffic is based in Karlsruhe. Therefore, the city is also referred to as the ‘nation's mailbox’ and the secret IT capital (DPA, 2018). In addition, the cultural and creative potential is appreciated by the study ‘The Cultural and Creative Cities Monitor’ of the European Commission in which Karlsruhe ranks 2nd place behind Edinburgh among medium-sized cities with between 250,000 and 500,000 inhabitants (Montalto et al., 2017). In 2019, this success could be repeated, achieving 2nd place behind Florence, Italy (Montalto et al., 2019). Due to its richness and uniqueness of flourishing cultural and creative offers, Karlsruhe has been awarded the first UNESCO City of Media Arts (UNESCO, 2021). In total, 13.3 percent of local businesses can be categorized in the culture and creativity sector (Montalto et al., 2017).

The 2nd place of the Karlsruhe Institute of Technology (KIT) among German universities in the ‘Gründungsradar 2016’ underscores the relevance of entrepreneurship in the academic context (Frank et al., 2016). Besides excellent results in the following years (Frank & Schröder, 2018; 2021), the KIT has been counted to be one of the best entrepreneurial universities in Germany by the ‘Deutscher Startup Monitor’ (Kollmann

et al., 2021). Through the years, the KIT became the leader in developing interdisciplinary entrepreneurship courses such as the Student Innovation Lab (SIL), including industry partners ZEISS, Siemens, Vector Informatik, SEW Eurodrive, and Akka Technologies to the conceptualization (Belgardt et al., 2021). At the prestigious 'Deutscher Gründerpreis', which has been awarded in Berlin since 2006, the startups Restube (2015 - 1st place), Nanoscribe (2016 - 2nd place), and INERATEC (2018 - 1st place) achieved outstanding success and were able to generate a high luminosity for the EE of Karlsruhe beyond the borders (KIT, 2015; PTJ, 2018). The success of new technology-based firms with innovative business models is a driver for economic growth and exemplifies sustainable structural changes. This sustainable development is confirmed by the 'Morgenstadt City Index' of the Fraunhofer Institute for Industrial Engineering (IAO), which listed Karlsruhe as the most future-proof city in Germany (von Radecki et al., 2016). In addition, Karlsruhe has been featured as the tech center of the future ahead of Aachen and Ingolstadt, highlighting the skilled human capital in the region (Jentsch, 2018).

To further advance the strategic orientation toward a resilient ecosystem, a various number of projects with different focal points are in the planning stage or have already been implemented. In doing so, the research and start-up landscape is becoming more diversified on the one hand, but also more focused on technologies with high future potential otherwise (Stadt Karlsruhe, 2018). As an example, the 'Smart Production Park' is a project in which access to production systems is granted to entrepreneurial teams in the early stage. In this area, the founders are enabled to test their business ideas and concepts under real-life conditions and can produce initial prototypes if required. In addition to a large storage area, workspaces will be created as a platform for the meeting and communication of founders and established companies intending to generate synergies.

Due to the future-oriented focus and the increasing relevance of the topic, an increasing number of technology-based start-ups related to artificial intelligence and robotics have emerged, especially in the vicinity of the Karlsruhe Institute of Technology (KIT). Because of these entrepreneurial activities, a high number of renowned research institutions, and its long-standing tradition in the field of information technology, Karlsruhe has been honored as the 'Digital Hub for Artificial Intelligence' by the German Federal Ministry for Economic Affairs and Energy (de:hub, 2018). Thereby, one of the

most important locations for AI-based startups within Germany was created and the region's great potential was highlighted beyond borders. Looking at the recent startup activity in the field of artificial intelligence, which is done by the 'Initiative for Applied Artificial Intelligence', Karlsruhe is placed in 3rd place behind Berlin and Munich (AppliedAI, 2018). To name just a few a selection of AI-based startups are apic.ai, heliopas.ai, lengoo, Qymatix Solutions, renumics, thingsTHINKING, understand.ai, and Zana Technologies (Henn & Terzidis, 2019). In addition, Karlsruhe gained high popularity in the field of autonomous driving, as the 'Test Field for Autonomous Driving' (TaF) has been opened in May 2018. In doing so, it is possible to test autonomous mobility in normal road traffic, which is unique all over Germany. Thereby, Karlsruhe was able to win the competition against Stuttgart and Ulm and was founded with €2.5m by the State Ministry of Economics and Construction (FZI, 2018).

Over the last years, a considerable number of high-growth firms received impressive investments. Among others, these include Chrono24 with $213m (Dealroom, 2022a), Blue Yonder with $75m (Heeg, 2018), Ineratec with $20m (Becker, 2022), and HQS with $15,7m (Dealroom, 2022b). Despite this number of success stories, local venture capitalists are still rare. Therefore, five alumni of the student club PionierGarage founded First Momentum Ventures (FMV), Germany's first and currently only student-led investment fund (Neuhaus, 2018; Schäfer, 2018). FMV is focusing on the pre-seed stage, to close the funding gap that has not been served so far due to the lack of profitability for classical investors.

In addition to the well-functioning startup support ecosystem, entrepreneurial-minded actors provide a large network to promote entrepreneurship. Institutions from the private and public sectors create valuable offers in different areas to ensure the required support for start-ups with a certain focus on industry, technology, or maturity level. In doing so, entrepreneurs who are eager to start a company are already supported in the idea or project phase to keep them in the region. As an example, the AXEL accelerator focuses on new ventures from the energy sector (Csernalabics, 2018) and the Cyberlab has been named the IT accelerator of the state of Baden-Württemberg (BNN, 2017).

Finally, it is worth mentioning that the municipal administration has a strong orientation concerning start-ups and economic interdependencies, attempting to create an entrepreneurial-friendly environment (Selchert, 2021). The efforts in the digitalization of

administrative processes have been awarded 1st place in the 'Smart City Index' (Bitkom, 2020). Furthermore, projects and cooperations are not only thought at the regional- or national level but also globally to strengthen the resilience and growth of the regional economy (Theodoraki & Catanzaro, 2022). Cross-national partnerships have been established with cities such as Pune, India, and several countries in East Africa, mainly Uganda, and Djibouti. In this context, the joint initiatives 'Start-up Round Table India' and 'Digital Hub Africa' build the basis for transnational entrepreneurial activities and the exchange of knowledge (Rahner, 2021).

6.2 Primary Case Study Research

The role of case studies in academia is a conundrum (Gerring, 2007). Although many investigations are using this methodology successfully, there is also strong resistance to case study research in some areas. Its use has been rather narrow, often restricted to exploratory research, leading to confusion in the research community (Dul & Hak, 2008). Nevertheless, this has gradually changed over the years and the usage of case studies is highly demanded in entrepreneurship research (Duxbury, 2012; Shwetzer et al., 2019). Subsequently, in recent EE literature, case studies have become predominant and are included in most of the empirical research designs (Maroufkhani et al., 2018; Cao & Chi, 2021). Prominent examples to be named in this context are articles about the EEs of Seatle, US (Thompson et al., 2018), Dublin, Ireland (Walsh, 2019), Turin, Italy (Colombelli et al., 2019), Waterloo, Canada (Spigel & Vinodrai, 2021), and Montpellier, France (Cloutier & Messeghem, 2022).

To gain an in-depth systemic, holistic view concerning the impact of the EE framework condition on the resilient growth of new ventures, conducting primary case studies can lead to valuable insights (Yin, 2014). This perspective is beneficial to analyze and understand the complex issues of entrepreneurial activities in practice (Creswell & Poth, 2018). Although conducting single cases has increased tremendously, a lack of comparative and multi-scalar analyses is still reducing the generalizability (Stam & van de Ven, 2021). Hence, in the following chapter, the evolution of the two companies RESTUBE and heliopas.ai from Karlsruhe is presented in detail and linked to the previous findings. In doing so, cross-case conclusions can be drawn and the theoretical foundation further developed (Belitski & Büyükbalci, 2021). Illustrating the complex relationships regarding new businesses and the influence of the EE on their evolutionary process

indicates findings that can be transferred to companies in a similar context (Mayring, 2001). Both studies have already been published under the references Henn & Niermann (2020) and Henn et al. (2024) separately in advance.

6.2.1 Methodology

Case studies are used as a systematic tool for collecting data to build and test theories, which is beneficial to gaining insights not have been discovered yet (Dul & Hak, 2008). Although there are still misunderstandings about the validity of case study research and its scientific acceptance remains challenging, the advantages outweigh possible concerns (Flyvbjerg, 2006; Henry & Foss, 2015). Among others, the strengths of the case study approach include (1) the understanding of complex social phenomena, (2) allowing researchers to focus on a single case in depth and within its real-life context whilst maintaining a holistic perspective, and (3) the merge of data from a variety of evidence (Baxter & Jack, 2008; Yin, 2014; Shwetzer, 2020).

Overall, conducting case study research requires a linear but iterative process (Yin, 2014). Following a structured procedure is important to ensure controllability, deductibility, repeatability, generalizability, and finally a high validity of the findings (Eisenhardt, 1989; Rowley, 2002). However, the framework conditions of each region are unique at any specific place, influenced by historical development, and depend on not changeable variables (Mason & Brown, 2014). Therefore, ecosystem configurations are not easy to generalize and findings should only be used with caution (Spigel, 2017). Especially in cross-case conclusions, a structured procedure is a prerequisite (Yin, 2014), and therefore, this study is following the multiple-case study design illustrated in Figure 10.

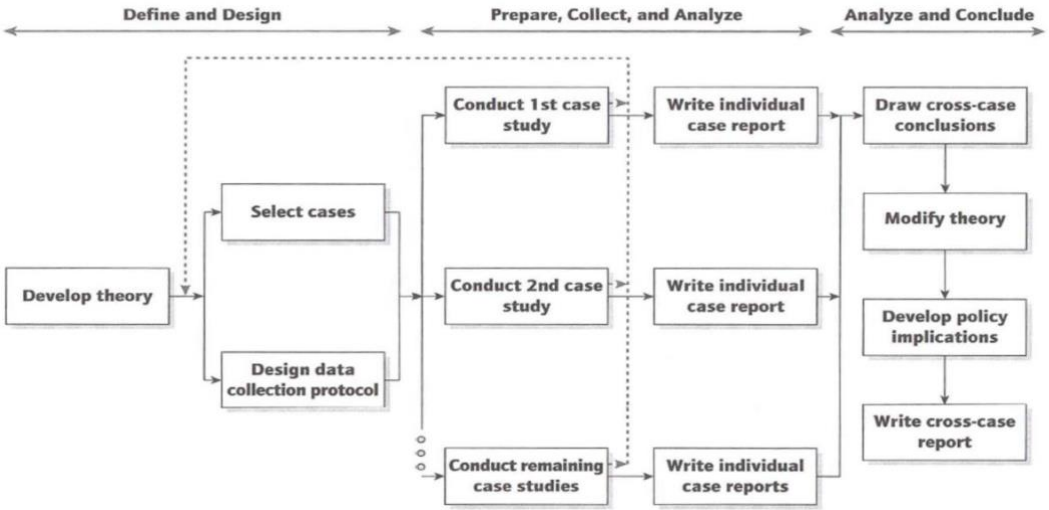

Figure 10. *Case Study Method (Yin, 2014)*

As EEs are locally embedded within boundaries, their characteristics are appropriate to the application of a case study research strategy (Fraiberg, 2017; Creswell & Poth, 2018). The same applies to startups as a concrete bounded system of organization. The thriving EE of Karlsruhe, Germany, is fulfilling the requirements to test theoretical foundations, expand previous work, and develop theoretical assertions. Pre-established theoretical propositions can be used to guide the procedural model (Yin, 2014). Therefore, the case study design is based on the EE approach of Isenberg (2011) and the findings from the previous chapters. As relying mainly on primary sources (expert interviews and discussions), the EE elements have been transformed into an interview guide to cover all relevant aspects. Each of the case studies consists of a whole study, in which convergent evidence is presented regarding the evolutionary dynamics of a young company and the influence of the EE framework conditions. Subsequently, the insights are referred to the conceptual approaches obtained from the systematic literature review and the qualitative analysis of EEs in Latin America. Thereby, it was thoroughly tested if new findings may lead to a further modification of the original propositions or even a novel theory (Eisenhardt, 1989). For reviewing the quality of a case study research, the criteria of construct validity, internal validity, external validity, and reliability should be addressed (Yin, 2014). As presented the strategy of conducting a case study is highly supportive to achieve the aims of this research project.

6.2.1.1 Case Selection

As the quality of the findings strongly depends on the cases, the selection of those remains one of the most challenging aspects of conducting a case study (Yin, 2014). The decision on which a case is worthy to integrate into the research has to be thoughtful and well-justified (Creswell & Poth, 2018). The decisive argument for choosing the businesses has been their relevance to the current topic and the willingness of the founders to share their journey. In particular, receiving detailed company insights from an expert interview is a major advantage of primary research, providing an understanding of internal decision-making processes (Kvale & Brinkmann, 2009). In addition, another important criterion has been the availability and richness of secondary data such as reports, newspaper articles, media posts, and website publications. For the search process of suitable companies, a list of requirements has been compiled. These included that potential cases had to be founded in the region of Karlsruhe and still be headquartered there, technology-based, and could lock back on a longer track record with highs and lows. Furthermore, it

has been guaranteed that extreme cases or outliers were rejected so that the insights are comparable to other young companies. However, these sources of evidence have only been available for a limited number of companies. In consequence, the cases of RESTUBE and heliopas.ai have been selected to analyze the influence of EE elements on startup performance. RESTUBE has developed a small safety system for water sports consisting of a pocket with a folded buoy that can be worn around the waist or on the harness (RESTUBE, 2019). The product of heliopas.ai is an AI-based solution for reducing water consumption in the field of industrial agriculture (Gailhofer et al., 2021). The founders of both companies have been active in the EE community of Karlsruhe consistently. Each of these cases represents a new technology-based venture with an innovative product or technology and high-growth potential.

6.2.1.2 Data Collection

Due to the richness of the phenomenon and the extensiveness of real-life context, the data collection in case studies is characterized by a high level of complexity (Yin, 2014). To balance the absence of routine procedures and to increase the quality and validity of case studies (Ghauri & Gronhaug, 2002; Ridder, 2017), it is advisable to follow three main principles as suggested by Yin (2014). First, it is essential to rely on multiple, not just single, sources of evidence. Second, the creation of a case study database is highly advantageous. Third, it is recommended to maintain a chain of evidence sharply. Furthermore, it is crucial to establish a case study database (Baxter & Jack, 2008) and follow a case study protocol to increase reliability (Yin, 2014; Cresswell & Poth, 2018).

Relying on a variety of data sources enables the application of a triangulation method to support, cross-check and strengthen the findings (Gibbert et al., 2008). The decisive strength of the case study research is its ability to deal with a full variety of evidence (Yin, 2014). Therefore, the data for this study has been collected from multiple sources, including semi-structured interviews with the founders and first employees, direct observations of the companies functioning in their natural environment, and publicly assessable documents as secondary data. As expert interviews provide a unique opportunity to receive insights and perspectives (Yin, 2014), the research design has been built mainly around this methodology. The flexibility of semi-structured interviews enables the interviewer to react spontaneously and guide the discussion toward interesting causal inferences and explanations (Eisenhardt, 1989; Saunders et al., 2009). As the

objectivity, reliability, and validity of a qualitative analysis largely depend on the skill and rigor of the researcher (Johnson & Christensen, 2012), the interviews have been based on the instructions of McIntosh & Morse (2015). Therefore, the elements of the EE approach and previous assumptions have been transformed into an interview guide to cover all relevant aspects. In doing so, face-to-face interviews with team members with extensive experience, and adequate information about challenges, pivots, crises, and successes, integral to the growth of the companies, could be examined from different perceptions. The average duration of the interviews has been between approximately around 75 minutes. As startup activities take place in real-world settings, additional information could be received through participant observation (Creswell & Poth, 2018). Finally, relevant secondary data such as reports, newspaper articles, and other media have been identified through a systematic search of web sources (Kamins & Stewart, 1999; Kraus et al., 2020). However, the documentation assists the argumentation rather than providing insightful discoveries (Yin, 2014).

6.2.1.3 Data Analysis

As the collected data consists of a multitude of different pieces of evidence from different sources, a major challenge is to merge it into a uniform data basis (Rowley, 2002). To draw empirically-based conclusions, the data analysis insists on examining, categorizing, tabulating, testing, or recombining evidence (Yin, 2014). In doing so, this procedure is helpful to concentrate on significant facts, avoid unnecessary and distracting information, and organize the entire case study evaluation. Thereby, the level of internal validity can be increased by establishing a stringent causal relationship between raw data to cross-case conclusions (Creswell, 2009; Yin, 2014).

For this research, the audio data of the expert interviews have been transcribed with the assistance of the software tool Vocalmatic. Subsequently, the qualitative data analysis of the transcripts followed an open structure (Mayring, 2014) with a deductive coding approach (Saldaña, 2021). In doing so, multiple measures based on quality criteria of content analysis are applied to guarantee a high-quality standard (Campbell et al., 2013). For the coding process and the analysis, the software MAXQDA was utilized. In the first step, each case has been written separately, describing the historical development of a particular company. Thereby, these cases are only presented as descriptive, without any thoughts from the authors (Yin, 2014). Finally, to adopt a multiple-case perspective, the

findings of the individual studies have been analyzed, compared, and cross-case conclusions drawn and linked to theory (Yin, 2014; Henry & Foss, 2015).

6.2.1.4 Quality Criteria

To ensure a high level of quality in case study research, it is mandatory to comply with construct validity, internal validity, external validity, and reliability as major criteria (Yin, 2014). By establishing those criteria, rigor and trustworthiness can be achieved and it is enabled to evaluate the credibility, transferability, dependability, and confirmability of qualitative research (Morse, 2015). Whilst a particular research phase, different tactics can be addressed to meet the quality criteria (Yin, 2014).

6.2.2 The Case of RESTUBE

The following chapter is a modified version of the case study about the startup RESTUBE published through KIT Scientific Publishing and therefore, is based to a significant extent on the working paper with the reference Henn & Niermann (2020).

6.2.2.1 The Company

The new technology-based venture RESTUBE is a nowadays established company located in the region around Karlsruhe, Germany. It was founded in 2012 by Christopher Fuhrhop and Marius Kunkis, two water sports affine student entrepreneurs from the Karlsruhe Institute of Technology (KIT, 2015). The mechanical engineering graduates set themselves the goal of developing a ‘helmet for water sports’ (Schweiger, 2016).

Product innovation

The product (see Figure 11) is a small safety system consisting of a pocket containing a folded buoy that can be worn around the waist or on the harness (RESTUBE, 2019). An energetic pull on the trigger will cause the buoy to inflate so the person in the water can hang on to it and stay afloat. Waving with the long yellow buoy, the user can make him visible. He can drag the buoy behind him to swim fast also after he triggered or help others by handing over the buoy. With its compact design and all these options to use, RESTUBE is the most versatile and wearable safety tool for water activities existing. However, it is important to emphasize that the RESTUBE system can not replace a classic lifejacket, as it only works if the wearer is conscious. It does not match the standards for swimming aids, as it is not body-worn. Like any disruptive type of product without created standards, it is allowed to sell such a product as long it conforms to the local

product safety laws, as well as clear documentation of a risk analysis. For avalanche backpacks, it took for example 25 years until there came up with a standard (Fuhrhop, 2018). Nowadays, the RESTUBE is officially an additional backup that provides more safety for all activities in and on the water.

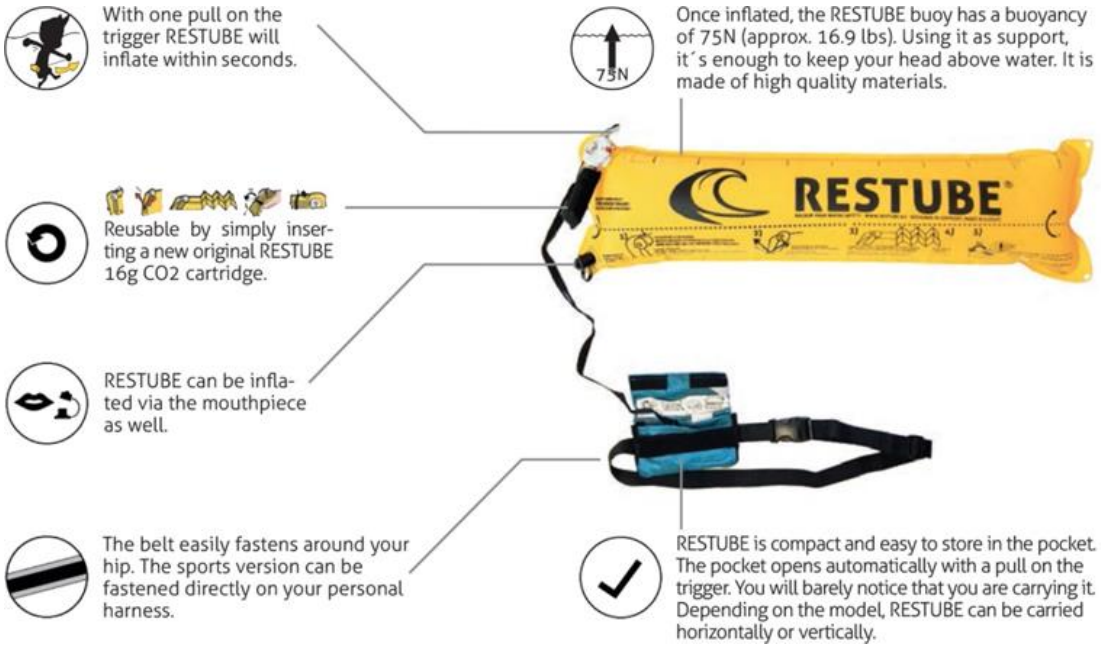

Figure 11. *Features of the RESTUBE system (RESTUBE, 2019)*

Depending on the variant, the bag can be worn horizontally or vertically and thus can be adapted to every person's needs. A vertical attachment reduces the drag while swimming to a minimum. In addition to the basic version, a whistle and a small key pocket are integrated into the bag as additional extras. The key feature of this small security system is the buoy. When inflated, it has an uplift of 75N, enough to keep the person's head safely above water. The buoy is made of a material that meets the requirements of the rescue vest standard DIN EN ISO 12402, ensuring longevity. All products are reusable by simply replacing the gas cartridge. The buoy can also be inflated at any time by blowing it up. After using the buoy once, it can be folded up and stowed in the bag and is ready to be used again.

The current product range is including the following product versions: RESTUBE basic, classic, swim, sports, PFD, and lifeguard (RESTUBE, 2019). Customers can choose a product version, depending on their particular water sports discipline. The starter product RESTUBE basic is suitable for activities on and in water and offers no added extras and is sold for a starting price of €59.95. The next model is the RESTUBE classic which is

available for €74.95. It is also suitable for activities on and in the water, can be worn both horizontally and vertically, and has an integrated key compartment and a whistle as additional extras. The RESTUBE swim, which was awarded the ISPO Gold Award 2016/17 in the category action (ISPO, 2016), is the next step in the variety of products and with just 210g the lightest RESTUBE. With its compact dimensions of only 12x6x4cm and its light weight, it is designed for the needs of swimmers. The RESTUBE sports, which has no split, was the first product to be developed and served as the foundation for further developments. Unlike other product models, the special split system prevents the buoy from unintentionally inflating in high tides or other extreme conditions and can be used for all extreme water sports, from kitesurfing to windsurfing or kayaking. It can be attached to the harness and is available for €99.95. The RESTUBE PFD (personal flotation device) was developed with the help of the German Accelerator Program for the US market and has been released in 2018. It is the smallest certified PFD on the market.

In addition to water sports and other water activities, RESTUBE also focuses on sea and water rescue and has developed the RESTUBE lifeguard (Schweiger, 2016) in close cooperation with the SLRG, lifeguards of the Royal National Lifeboat Institution, German lifeguards, and the German Wasserwacht. It is a professional rescue tool that complements traditional life-saving equipment and can be easily worn around the waist like the other RESTUBE products. In contrast to the other versions, it is designed for rescue and specially adapted to the needs of lifeguards and lifeboat crews. Thanks to two kinks in the buoy, the RESTUBE can be placed around the casualty's body and secured with carabiners using four eyelets. A 1.9-meter-long safety leash with a quick-release buckle for dangerous situations and reflector strips for better visibility in the dark provide increased improved safety for the rescuers.

Figure 12. *RESTUBE Lifeguard (RESTUBE, 2019)*

Another disruptive product has been released in 2018, which is also specially designed for sea and water rescue: the RESTUBE automatic. It is attached to a drone, is dropped over the person in trouble in the water, and automatically triggers when it comes in contact with water so that the person can hold on to it until help arrives (Schneider, 2018). In 2008, Christopher Fuhrhop developed the idea of using drones for sea and water rescue as part of a student research project at the Karlsruhe Institute of Technology. A prototype was built and ten years later with the help of advanced technologies, the idea could be implemented (Westphal, 2017). The drones enable the rescuer to reach the accident site faster than it would be possible on the conventional way with a boat.

History

The conceptual idea behind RESTUBE originates from Christopher Fuhrhop finding himself in a life-threatening situation while kitesurfing on the open sea (Stenftenagel, 2017). Shocked by this incident, he realized when talking to others that many people had been in similar situations, but had not talked about it (Fuhrhop, 2018). Protection vests or life jackets were already on the market at this time, but they wouldn´t have been helpful to him in this specific situation. Back at university, he took the opportunity to attend a seminar at the Center for Interdisciplinary Entrepreneurship (CIE), where he further developed the original idea together with a friend. During the whole seminar Mo Meidar, the former owner of MAG IAS, which is one of the world's largest machine tool companies, acted as a personal mentor. Thanks to his supervision, they were able to learn basic skills in business planning and storytelling. Additionally, the university funded detailed market research by which they were able to confirm their presumptions. All in all, this provided the basis for founding RESTUBE together with his fellow student Marius Kunkis as well as applying for the EXIST start-up scholarship (Schweiger, 2016).

Parallel to attending the workshops, Christopher Fuhrhop was doing an internship at Flysurfer, a kite and paragliding company from Marquartstein, Germany. Having access to products, materials, and market insights, he had the opportunity to build an initial prototype during his diploma thesis. At the same time, Marius Kunkis focused on their idea in his diploma thesis and received support from the Institute for Product Development (IPEK). The moment the two founders were awarded the EXIST start-up grant, the following step was to buy a production machine. Even if it meant considerably more work, it was from their point of view essential to avoid possibly being dependent

on a single producer (Fuhrhop, 2018). While the initial prototype was constructed using a friend's old sewing machine they were able to develop further prototypes themselves. By doing so they could acquire deep knowledge which was invaluable for future negotiations with suppliers and producers.

The vision of both entrepreneurs was to scale RESTUBE rapidly and 'conquer the world' right from the start (Fuhrhop, 2018). In this context, external financing played an important role, and company growth without venture capital could not have been realized. Overall due to six investment rounds and two crowdfunding campaigns on Seedmatch and Kickstarter, a total number of 3.6 million Euros were collected (Stenftenagel, 2017; Schweiger, 2016). RESTUBE raised considerable attention, and not only from the investors. Over the years, they were honored with various awards, including the prestigious German Founder Award 2015 (Deutscher Gründerpreis, 2015), the 2015 OutDoor Industry Award (Outdoor Magazin, 2015) as well as the ISPO Gold Award 2014/15 and 2016/17 (ISPO, 2016). Three-month coaching from Porsche Consulting in the form of weekly visits and assistance in the implementation of specific topics was made possible after winning the German Founders' Prize. Thanks to this support, the team was able to develop the sales topic with the appropriate sales funnel, implement the LEAN theory for the RESTUBE production and establish the important topic of corporate identity (CI) for RESTUBE. The development of the CI, the cultural identity of the company, was an important step for RESTUBE to capture its vision, create a culture and make it transparent to those outside of the company, whether for new employees, partners, or distributors, or the customers. Instead of creating negative communication and focusing on the danger of drowning, the team has chosen positive communication to build up the story behind RESTUBE. However, in addition to the time and the challenge involved in the finance negotiations, there was also a structural change in the years following the Founder's Award, as co-founder Marius Kunkis decide to leave the RESTUBE project for personal reasons. The collaboration on the management level between him and Christopher Fuhrhop was not always harmonious, resulting in Fuhrhop being the sole owner of the business since then.

Due to new investments and a successful seed match campaign, the company and the team grew. The target group was extended to the field of sea and water rescue when the RESTUBE lifeguard for professional use was developed. In early 2016, RESTUBE was

selected for the German Accelerator Program, a funding program funded primarily by the Federal Ministry of Economics and Technology. It allows founders to work for some time in the US to develop and access the American market. At that time, the stand-up paddling sport was becoming more popular in the US, which is why the government decided to make a life jacket of some kind obligatory. The lifejacket does not have to be worn, but can be attached to the board - at this point, Fuhrhop and his team grasped the opportunity and developed the RESTUBE PFD (Personal Flotation Device). With the support of those involved in the German Accelerator Program, a Kickstarter campaign was launched to access the American market. However, only half of the supporters on Kickstarter decided to buy the PFD, the other half bought the standard RESTUBE swim. The campaign did not expand as hoped and sales in the US market fell short of expectations. These and other problems led to a profound restructuring of the company and a reduction in the number of employees in early 2017 to a smaller core team of seven members. From now on, the focus was set on sales in the form of marketing and distribution rather than innovation. As a consequent step, the logistics were outsourced to the cooperation partner ‘fashy’ to be able to concentrate again on their key activities.

Structure

RESTUBE currently employs six employees besides the founder and managing director Christopher Fuhrhop and has three core areas: sales, marketing, and operations (see Figure 13). This functional structure makes it possible to work in a compact team with a clear distribution of tasks and it is planned not to exceed a maximum number of twelve to fifteen employees in the future. This small size means there are no levels of hierarchy, so each employee has their function and role, and the tasks are self-governing without any need for the founder to intervene.

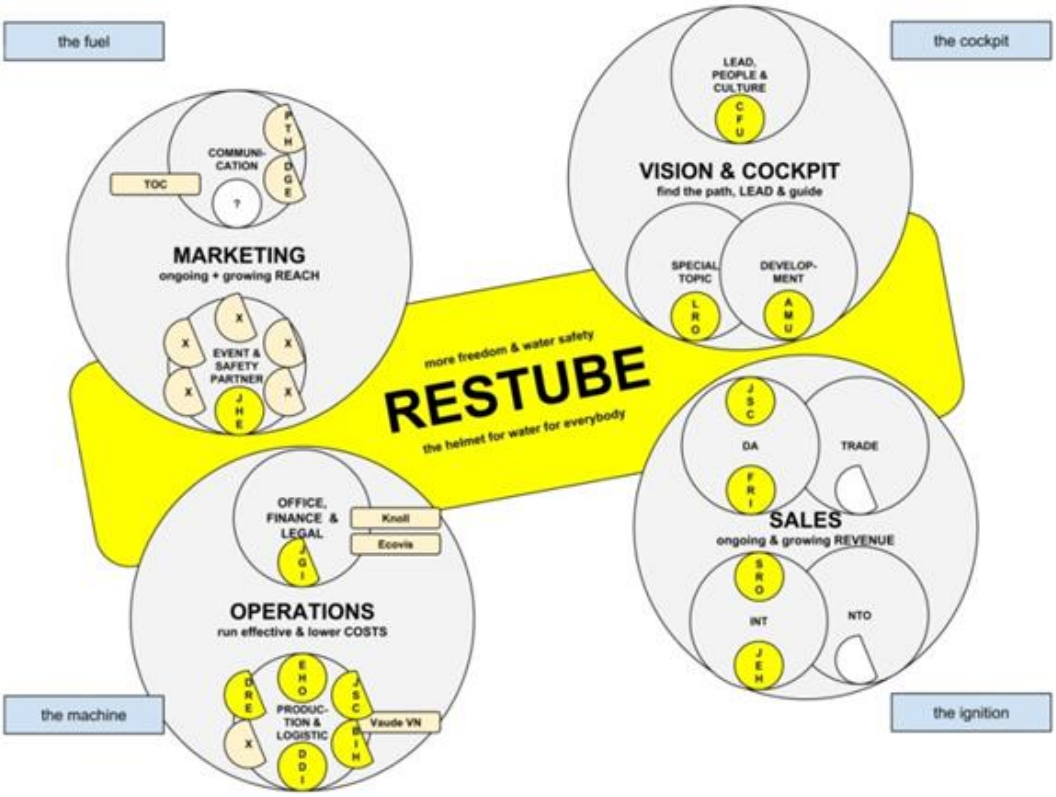

Figure 13. *RESTUBE organigram (RESTUBE, 2019)*

6.2.2.2 The Market

One of the six dimensions of an EE according to Isenberg (2011) is the business environment in which the company operates. It significantly influences the development process and contributes to the growth of the company. In the following subchapters, the relevant factors that affect this dimension and thus create the basis for the RESTUBE idea are discussed in detail.

Target customer

Due to the universal applicability of the product in all water sports, there exists a high number of potential customers as well as various types of use: surfers, kitesurfers, windsurfers, swimmers, stand-up paddlers, outdoor enthusiasts of all kinds, boaters, canoeists, or rowers, anglers, lifeguards, etc. RESTUBE was developed with these different customers in mind and offers a wide product range, especially for these different interests. There are around a billion water sports enthusiasts worldwide and more than 100 million active people doing open water activities (Schweiger, 2016). Combined with professional water rescue, this results in a market that is significantly larger than the market for classic life jackets.

Channel of distribution

In contrast to the recommendations to focus initially on one country or the domestic market in Germany, the founders decided to have a deliberate wide diversification. A network of national and international distribution partners was established through personal contacts at trade fairs with dealers and distributors representing different channels of the sports industry (such as the mountain sports world) or the mass market (such as BAUHAUS). In addition to brick-and-mortar retailing, the products are also distributed directly via the company's online shop to the end customer in Europe as well as to organizations for professional use. Due to the winter months in Europe being water sports-free, marketing was not only concentrated on Germany and the EU but also on all other potential countries were taken into. In addition to Germany, which serves as a test market and where RESTUBE is developing its distribution, a distribution network has been established with partners in more than 20 countries from Mexico to Japan. Each of these partners or partner companies was individually selected, briefed, and regularly provided with sales knowledge and product news to spread the RESTUBE vision abroad.

In addition to the distributors, regular attendance at trade fairs and water sports events within the scope of safety aspects is essential to increase awareness. To increase safety at water sports events, wearing a RESTUBE is obligatory for all participants. Potential customers can experience the product first-hand and can purchase it after the event. In addition, RESTUBE is in regular dialogue with professional opinion leaders, such as Janni Hönscheid or the Stecher-twins, and provides its dealers with the support they need to be able to tell the story behind the products and establish RESTUBE.

Competitors / Competition

Lifejackets, swimming wings, and pool noodles already existed at the time of the founding of RESTUBE, but no product comparable to the RESTUBE. Initially, the RESTUBE did not meet the existing norms and certifications, which meant that the founders faced skepticism from some lifejacket manufacturers, who were convinced that, without a license, the idea was doomed to fail. As a result, a potential major competitor decided not to enter the market. The founders of RESTUBE were told by the German and American certification authorities, that a standard could be written for the product in cooperation when the sales volume reached one million RESTUBEs. Other countries are adopting the high standards of Germany and the US, so this should not cause a problem

in the future. The founders did not allow themselves to be discouraged by the lack of certification and continued to work on their product.

In 2015, Kingii was the first competitor on the market to offer a similar product. A significant difference was that they decided to use a wristband to attach the system. Similar to RESTUBE, Kingii launched a crowdfunding campaign to be able to enter the market. However, the product did not work flawlessly which resulted in bad score ratings on the internet. In recent years there has been little news about the rival company. A German company called PLOOTA attempted to launch a security system in 2017, by trying to gain support from a Kickstarter campaign. The PLOOTA safety system was designed to be worn around the neck and triggered by sensors when the bather or the swimmer is in distress. However, in June 2017, before the campaign had ended, the company terminated it prematurely. The reason was that they had received considerable feedback and had decided to add additional features to the PLOOTA and create the ultimate safety device for swimmers (PLOOTA, 2017). In early 2018, the PLOOTA founder offered Christopher Fuhrhop his company for sale.

Although both competitors did not manage to enter the market, they attracted a great deal of attention in the field of water safety, just like the classic buoys, which have long been used in swimming competitions. RESTUBE is benefiting from this attention, which their competitors created.

Cooperation partners

Right from the start, RESTUBE focused on cooperation: with athletes, associations, and event organizers. Due to this commitment, RESTUBE is the safety supplier or safety partner for several prominent events in the swimming, kitesurfing, and triathlon scene, as well as being a partner of the Swiss Life Saving Society and receiving support from the top wave surfer Sebastian Steudtner and the surfing world stars Janni and Sonni Hönscheid. As far as the production of the RESTUBEs is concerned, the company has cooperated with VAUDE, a well-known mountain sports equipment supplier, since the beginning. Based on the support of Albrecht von Dewitz, the founder of VAUDE, the RESTUBEs bags are produced in the VAUDE production in Vietnam.

In 2018, further collaboration with fifteen brands is planned, including the largest lifejacket manufacturer in Europe. Each RESTUBE can be attached via an interface, a small patch to the collaborating companies' products. At the time of purchase, this patch

has a hang tag with the story of RESTUBE, so that the buyer can directly understand the story and idea behind RESTUBE. These cooperation partners open up new possibilities for RESTUBE and should contribute to the popularity of the brand.

6.2.2.3 Founders and team

The dimension 'human capital' according to the entrepreneurship ecosystem approach from Isenberg (2011) is divided into two topics: Founder and team. Isenberg (2011) focuses in this dimension of his model on the quality of education and degrees as well as entrepreneurship training. These aspects only play a secondary role in this case study and are dealt with in a slightly modified form in Chapter 5.

Number of employees

Following the award of the EXIST start-up scholarship, the number of employees in the RESTUBE team rose from one to four. In the following years, it developed to such an extent that at the peak, after the fourth bout of finance negotiations, up to 25 people working for RESTUBE, including student assistants and trainees. The next step was the introduction of the second level of management to relieve Christopher Fuhrhop and create shorter communication channels. The two largest divisions, Marketing / Sales and Operations, were each given head of department. These persons received more responsibility and regular daily contact with Fuhrhop was set up to ensure he was kept informed. However, the introduction of this first level of hierarchy was more problematic than expected, resulting in a certain level of dissatisfaction within the company.

As a result of this experience and restructuring in 2017, the team was reduced to a core of seven people, which is expected to grow to a maximum of 12 employees soon. It is planned to ensure that the RESTUBE team remains compact with a simple structure. This seems to be necessary to remain capable of acting and not to lose motivation, as has happened in the past.

Expectations and motivation

Due to the diverse target group, it was already obvious very early on that focusing on a niche would not be the right method and not consistent with the long-term vision to create and offer an *'affordable helmet of water sports'*. However, the guiding theme meant the young and inexperienced team was faced with some major challenges. Although when RESTUBE was founded lifejackets, water wings, and pool noodles already existed.

However, no similar product to RESTUBE was sold and therefore no one had in-depth knowledge about this particular market.

By remaining a small team, the demands on the new employees changed. In the beginning, the founders were looking for employees who were able to work specifically in their area. At that time there was no focus on extensive integration. However, the small size of the team meant that there was an increased willingness and motivation to keep track and also pay attention to the details. This also demanded a high degree of flexibility as the employees could also be required to work in other areas, for example in production - when help is needed.

To facilitate the integration into the core team, new employees must receive extensive training and the expectations must be communicated clearly. This is essential to prevent tasks from being done differently than expected. From the founder's point of view, transparency also plays an important role in this context. To keep track and identify errors or problems at an early stage, the management needs to be well informed. In addition to the demands on new team members, working at RESTUBE offers many opportunities and chances for development. There are regular opportunities for this in the form of coaching, workshops, or classical further education in sales topics. Employees should not only be motivated but also be able to develop personally to support and strengthen the company and its culture (Fuhrhop, 2018).

Role of the founders

However, in addition to flexibility and simplicity, a small team means that not all roles and tasks can be distributed and that some tasks are not dealt with in sufficient detail because there are simply not enough employees. RESTUBE founder Christopher Fuhrhop sees his role in integrating these tasks and dealing with exactly these gaps, which otherwise would not be filled. He, therefore, works on tasks that are necessary and also of great importance to the company, such as the preparation of reports and communication with investors. He aims to create a framework in which every employee is as happy as possible and can concentrate on tasks that match their skills.

In the early days of RESTUBE, the founder also had to take on all the tasks, but over time Christopher Fuhrhop was able to continue to withdraw from specific areas and concentrate on other topics. As mentioned above, he now takes on tasks that are important to the whole business and focuses on the development of the company.

The mentality of the founder

Christopher Fuhrhop is not the only entrepreneur in his family. His brother Sylvester Fuhrhop is part of the founding team of the university spin-off 'Corvolution', an innovative MedTech start-up in cardiovascular prevention and diagnostics (Corvolution 2019). Their parents, grandparents, and other relatives of the family created companies with 50 up to 1000 employees, which had a major influence on the decision of the two brothers to start their businesses likewise (Fuhrhop, 2018).

Even before the founding of RESTUBE, Christopher Fuhrhop worked on the organization and execution of projects. Whether as a lead singer of the New Metal band 'Wirksystem' (Stenftenagel, 2017), where he took over the booking and organization of a US tour or as the organizer of a festival with over two thousand guests (Fuhrhop, 2018). In his words, he has always enjoyed implementing projects that others thought were not feasible. In the beginning, the founders had the feeling that prominent life jacket manufacturers bet against the RESTUBE project because in their opinion the product would not receive the necessary approval. Nevertheless, he remained believing in his vision and fulfilled every task as long as it served the further development of the enterprise. His original goal of creating something sustainable and enduring has already been achieved with RESTUBE, despite many doubting it.

6.2.2.4 Culture

The image and the perception of the company have been particularly important for the young RESTUBE company, to gain support for their vision and to develop a 'helmet of water sports' that is affordable for everyone. As a safety supplier for top events in the kitesurfing, swimming, and triathlon scene as well as through cooperation partners and the support of numerous water sports stars, the company has been able to build up a reputation in the scene. Along the way, numerous stories about lives saved by RESTUBE buoys have enabled the company to develop a detailed corporate identity and win numerous awards (Deutscher Gründerpreis, 2015; ISCO, 2016).

Corporate Identity

Winning the German Founder Award meant the company was given three months of support from Porsche Consulting (Deutscher Gründerpreis, 2015), which helped to develop the corporate and cultural identity of the company (Fuhrhop, 2018). This was an

important step for RESTUBE in the direction of realizing their vision and the creation of a story behind the company. With the help of the written CI, the mutually-agreed goals for employees, partners, and even new customers could be made transparent and understandable.

The most important aspect of the CI is the positive emotional branding and communication, which was decided by the team. Even though it was incomprehensible to many at the beginning, they opted for the supposedly more challenging way forward. Since the products are not life jackets, they were not allowed to communicate for legal reasons that a RESTUBE could save the life of the wearer. This fact also helped to keep the style of communication positive. They consciously wanted to emphasize the idea of security, as well as freedom in the water instead of the theme of rescue, to initiate positive communication in all channels. All of these steps and decisions were not only designed to put products on the market but also to build a brand around the RESTUBE Company and make them known.

Awards and appreciation

At the time of its founding and initial search for suitable producers and partners, recognition and respect from other companies played an important role for the team members and their idea. The production machine, bought with the financial support of the EXIST start-up scholarship, meant that the first 5,000 RESTUBEs could be manufactured by the team. Out of it, the founders could gain important knowledge about production and its challenges. As a result, they were able to carry out their production optimization and enter into cooperation negotiations with concrete ideas, which earned them the respect of their partners for the RESTUBE sports.

Not only partners and water sports enthusiasts could be convinced by RESTUBE. The appreciation of various juries was immense since the company‘s foundation. Christopher Fuhrhop and the RESTUBE team have received many awards for the idea and their products: among others: the ISPO Gold Award for the RESTUBE sports in 2014/15, the German Founder Award in 2015, the most important award for young companies, as well as the Outdoor Industry Award for the RESTUBE lifeguard as an innovative product for outdoor rescue also in 2015 and the ISPO Gold Award 2016/2017 for the RESTUBE swim.

While these awards and prizes did not have a financial impact, they provided better recognition within society, the region, as well as with partners and suppliers. Although RESTUBE already had a certain media presence before the awards, renowned events such as the German Founders' Prize or the ISPO Awards lead to a broad reach and media interest, attracting not only new customers but also potential investors.

6.2.2.5 Policy and support

Based on its clear ambition for growth and vision of developing a 'helmet of water sports' affordable for everyone, the team initially needed a lot of support to master the new challenges. The team received this support from all directions: from the lecturers and supervisors at KIT, the government in the form of the EXIST start-up scholarship, the German Accelerator Program, and their investors in the form of direct contacts and networks. Besides that, the EE of Karlsruhe with its growing start-up community has a major influence on local entrepreneurial activity, especially in technology-based entrepreneurship (Henn & Terzidis, 2019). This leads to a culture from which new businesses can benefit enormously and success stories were created.

Support from the university

The first steps towards founding the company were taken during a seminar at the CIE, in which Christopher Fuhrhop and Marius Kunkis participated in their studies. Due to professional mentoring from Mo Meidar, they had the opportunity to work on their ideas and develop them further. This support as well as market research, financed by a department of their university, formed the basis for the founding of RESTUBE and the application for the EXIST Start-up Scholarship.

After completing the seminar successfully, both Christopher Fuhrhop and Marius Kunkis continued to work on their ideas during their diploma theses. Thanks to the support of the supervisors Prof. Dr.-Ing. Jürgen Fleischer (WBK) and Prof. Dr.-Ing. Albert Albers (IPEK) as well as the Research Center for Computer Science (FZI) at the KIT, the founders could use their mandatory academic studies to further develop their ideas and to test them as well.

EXIST start-up scholarship

The EXIST start-up scholarship is a funding program of the German Federal Ministry of Economics and Energy and supports young founders of universities or non-university

research institutions who want to realize their ideas and implement a business plan (Kulicke, 2017). The focus of this funding lies on innovative technology-oriented ideas, as well as innovative knowledge-based services with positive economic prospects for success. The support provided by the scholarship is designed to last a maximum of one year and is primarily a guarantee of personal livelihood. The amount of the subsidy varies depending on the educational attainment of the beneficiary.

The EXIST start-up scholarship was an important support for the RESTUBE team because they could then buy their production machine and therefore build further prototypes and produce the first 5,000 pieces themselves. The experience gained from this production setup and the production optimization enabled them to avoid dependencies on suppliers and acquire practical knowledge.

German Accelerator Program

At the beginning of 2016, RESTUBE was selected for the German Accelerator Program, a growth acceleration program funded primarily by the German Federal Ministry of Economics and Technology and supporting founders planning to enter the US market (Kyriasoglou, 2016). The start-ups selected by the program are supported during a three-month stay in the US to establish themselves sustainably and successfully in the US and world markets (German Accelerator, 2019). The three months are characterized by reflection and optimization as well as mentoring and coaching on a variety of topics: from financing to marketing, to communication strategies and rhetoric training. With the support of the team of the German Accelerator Program, a Kickstarter Campaign was launched to develop the American market (Fuhrhop, 2017). The RESTUBE PFD, a small and lightweight swim vest, was specially designed to be launched in the fast-growing stand-up paddling market, as it became compulsory to carry a life jacket.

Networks

Special founder meetings or networks played only a minor role for RESTUBE in the early stage. Due to the very special product and the combination of various target groups, no one could help the founders with their product queries. Accordingly, it was the task of the founders and their team to experiment and thus gain some important experience. However, the founders' networks were helpful for the business component. Furthermore, the investors and their business contacts were always available to offer new impulses to them and to optimize the company processes.

6.2.2.6 Funding

Growth, especially in total turnover numbers, should be an important goal for the majority of young companies and start-ups (Kollmann et al., 2016). The founding team of RESTUBE decided from the beginning that they did not want to build and grow their business slowly, step by step, but rather progress quickly. An important component of this growth strategy was and still is external financing by investors and crowdfunding campaigns.

In a total of six rounds of financing negotiations, which were primarily aimed at investors, RESTUBE collected a total of €3.6 million. Over time, the company has been able to convince renowned investors, such as Prof. Susanne Porsche as well as Manuel Blanc and Frank Straub (BLANC & FISCHER Family Holding) as private persons. Each of the investors has made the individual growth stages possible and continues until today to support the team with their expertise and professional network.

In 2018, a new investor has become aware of RESTUBE and made far-reaching changes in the circle of investors. Nathalie Pohl, daughter of DVAG-CEO Andreas Pohl, has joined RESTUBE with a high growth investment of 25 percent (Hornung, 2018). She will be an important strategic partner with a strong connection to water activities and the water sports community. This will help in the long term with new financial resources and great interest, to expand the vision and upscale RESTUBE. As a result, three existing investor groups have been replaced, so that in the future only four investor groups will influence and support the company.

However, due to the special product and a special market, confidence in the RESTUBE team prevails within the circle of investors, leading to little operational influence. Once a month, investors are informed through a comprehensive report on current events and figures and are otherwise available for questions and support.

To gather support from water sports enthusiasts and to open up the mass market, a crowdfunding project was launched in the middle of 2016 in the form of a Seedmatch campaign in which €600,000 were collected from 640 supporters (Schweiger, 2016). To test run and validate a new product in the US, there was also a Kickstarter campaign, launched at the end of 2016 (Fuhrhop, 2017). As part of this campaign, €20,529 were collected with 211 supporters, but interest in the RESTUBE PFD was lower than expected, so it has not advanced further than this test run.

6.2.2.7 Problems and crises

According to Greiner (1998), problems and crises are mainly because every growth over time necessitates adaptations of processes, structures, and functions to the new size. RESTUBE, too, has faced some problems and challenges in the growth process since its founding, which are explained in the following subchapter.

Founder team and employees

As already established by Volkmann & Tokarski (2006), the founding team of a company is a decisive factor in the success or failure of a young company. Four years after its foundation, RESTUBE faced critical challenges concerning the work balance between the two founders Christopher Fuhrhop and Marius Kunkis, and a clear distribution of roles among each other. After intensive personal discussions, Marius Kunkis decided to leave the company on good terms. Christopher Fuhrhop took over the management with sole responsibility and has remained in this position as the CEO until today.

It is natural in a growth process that even within a team, small stumbling blocks may be encountered (Fuhrhop, 2018). A real crisis occurred within the RESTUBE team when in 2015, in the period just before the German Founder Award, customers did not pay for their goods. There was a lack of funding and the situation became existentially threatening for the company. After the restructuring worked out and the economic situation improved again, in addition, a successful Seedmatch campaign was implemented. New employees were hired, and the team grew again. The logical consequence was the introduction of an intermediate level in the hierarchy. Pretty much right after the team structure was finalized a second big crisis came up in spring of 2016 when one of the employees died in a car accident. Directly after funding, the team had to move closer together to handle the beginning of the new season and overcome the crisis. The total numbers in sales were still growing, but slower than expected. In this dramatic situation that nobody, even in the experienced shareholder circle, had experienced before, RESTUBE faced a real threat. Coming out of a seeming ‘perfect setup’ after the Seedmatch funding and the hired team. However, the crisis was recognized as an opportunity for profound change. With major restructuring measures in 2017, downsizing to a core team of currently seven persons was indispensable.

Focus

Another problem, according to Fuhrhop, was the evaluation, reflection, and implementation of test results to find the focus for the company. Although outsiders advised them to be focused right from the beginning, it was important for the team from the start to spread their efforts to gain an overview of the opportunities. As a result, business contacts could be set up and established where there was real interest, regardless of whether they were cooperation partners, distributors, or investors. In his opinion, however, although the team tried and learned due to the wide focus, there was also little opportunity for reflection which led to a deficient test framework. They were therefore not able to implement any knowledge gained about which channels perform well and to reflect on how they can use it to reach their goals. As a result, the learning process from the experience already gained is still lacking.

Especially in the initial years, many areas and tasks needed the team's closer attention. According to Fuhrhop (2018), these years can be compared to a tray with balls and no rim. All the balls need attention, and if you have to deal with one ball more intensely, another ball is in danger of falling off. In the history of RESTUBE, the first phase was focused on the development, which in the next step turned into sales, so that the development became only secondary and limited. When first partners and distributors were found, attention shifted towards marketing to increase awareness and attract customer attention. The next step is the scaling up of the production to one million pieces a year so that the topic of operations comes into focus once more and consequently all other areas shift out of focus. According to Christopher Fuhrhop, a reason for this focus shift was the small number of employees, because it was not possible to work in different areas at the same time. This led to situations where many areas demanded attention as well as liquidity problems and employee issues also arising.

However, according to the founder, RESTUBE learned from these challenges and focused on its strengths: product and communication. The first step in this direction is the planned outsourcing process of the logistics to 'fashy' so that the team can focus more on their product, the market, and the resulting strategy issues. The strategy, derived from the RESTUBE vision, is divided into area strategies and a so-called 'Fight plan' for each area to pursue one's own goals and monitor their attainment. With the help of this 'Fight plan'

and the focus on their product, RESTUBE now wants to get a step closer to realizing the company's vision of developing an affordable helmet for the water.

6.2.3 The Case of Heliopas.ai

The following chapter is the preprint on the case study about heliopas.ai which has been published under the reference of Henn et al. (2024). The teaching study aimed to promote STEM entrepreneurship in the European context and heliopas.ai delivers an interesting case for this purpose.

6.2.3.1 Company

The new technology-based venture heliopas.ai has been formally founded in 2020 in Karlsruhe, Germany, where it is still located today (Henn & Terzidis, 2019). The company has been established by an industrial engineer and a computer scientist, both graduates of the Karlsruhe Institute of Technology (KIT). The value proposition of heliopas.ai is to utilize satellite data to improve agricultural processes on a big scale. Considering the European Union's Green Deal, the potential of artificial intelligence plays a central role in transformation (KI Bundesverband, 2021). In the field of agriculture, heliopas.ai serves as a promising AI-based solution for reducing water consumption with its application of technology (Gailhofer et al., 2021).

Product and technology

The product and focus of heliopais.ai is an application called 'WaterFox', which is available on the App Store and Google Play Store for mobile users since March 2020 (Brecht et al., 2021). Additionally, it has been published as a browser-based web application for desktop users at a later stage (Wolff, 2020). The app is supporting farmers, agricultural consultants, and other actors in the field of agriculture to monitor the soil moisture on their land (Jung et al., 2021). Based on data analytics, irrigation recommendations are presented to the users (Plattform Lernender Systeme, 2020). Therefore, the application uses the irrigation process of Geisenheim that calculates the water requirements of open land crops based on local rainfall, a plant-specific coefficient, and evapotranspiration rates (Paschold et al., 2009).

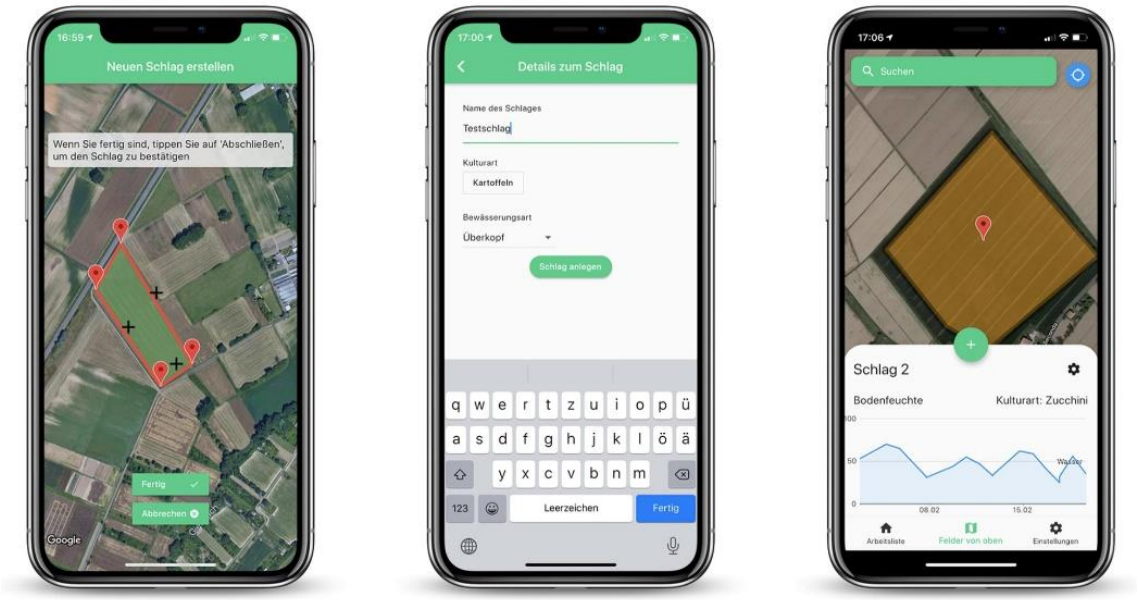

Figure 14. *Illustration of the WaterFox mobile application (heliopas.ai, 2021)*

WaterFox is quick and simple to configure, enabling farmers to gain an overview of the soil moisture situation on their farmlands without requiring the installation of expensive hardware (Heidelberger, 2020). Users can choose between the illustration of soil moisture levels based on satellite image spectral data or water deficits of their fields based on the Geisenheimer irrigation model. Thereby, spectral data from the RGB channels of high-resolution satellite images is prepared and trained on historical data from the International Soil Moisture Network initiative (ISMN, 2021). In doing so, it is possible to predict the relative soil moisture from ground level down to 50cm below the surface (Plattform Lernende Systeme, 2020). heliopas.ai uses new data fusion and machine learning methods that enable more frequent updates and higher resolution accuracy than previous approaches. Currently, the application updates the data information automatically with a resolution of 100 by 100 meters every 24 to 36 hours. These data are subsequently interpolated to offer a more detailed view to users. Time and efforts are made to further develop the applied models to achieve an update frequency of twelve hours and a resolution accuracy of ten by ten meters (ESA-BIC, 2021). During conducting the first research experiments, the general possibility to reach these numbers could be verified. However, due to the limited reliability, this function has not been integrated into the application. The Geisenheim irrigation model used by heliopas.ai relies on the combination of weather data, more precisely rainfall and evapotranspiration, and data about the required irrigation provided by the user. Thus, the water deficit for each field

and crop type can be calculated. WaterFox currently supports around 35 common field crops, for which detailed data on water requirements in each plant stadium have been collected. Additional features, which have been added one by one in the months after the initial launch, are logs of irrigation and rainfall as well as the integration of existing weather stations (Brecht et al., 2021).

During the registration process, users can map their farmlands by drawing squares around their fields (see the left screen of **Error! Reference source not found.** 14). In addition, field details which include name, crop type, irrigation type, soil type, seeding date, and the planned harvest date have to be added to WaterFox. Alternatively, existing field record files can be uploaded to the system, and data are automatically generated. As most farmers own at least a simple weather station that collects rainfall levels and wind data, users can integrate them into the application in the same manner as their fields. The addition of weather stations allows heliopas.ai to obtain more accurate local weather data for their models which is leading to better predictions for all users. It is planned to include almost all regional weather stations until the 2021 summer season as a lack of accurate regional weather and rainfall information was found to be a pain point among early adopters. Additionally, heliopas.ai plans to partner with hardware manufacturers to offer affordable weather stations that automatically input generated data into their system. For further development, the founders decided to run a customer-centric approach. Through a message button, users can express their interest and suggestions for improvement directly. In addition, the application is built on a quality user interface (UI), relying on symbols and as little text as needed. Although WaterFox is only available in German yet, the app's simplicity is paramount for its use among non-German speakers, which make up a large percentage of farm employees usually responsible for carrying out irrigation tasks. To overcome this obstacle, heliopas.ai is currently working on a translation to English and other languages.

Concerning the revenue stream, heliopas.ai decided to align a freemium business model. The pricing model is based on a 30-day trial period with unlimited access to all features to attract new customers to the platform. After the probationary period, users can either choose to pay an annual subscription for the price of €5 per hectare or continue to use the service for free, limited to overseeing two hectares of their fields (heliopas.ai, 2021). The estimated potential of a single customer is given by the average farm size for vegetable

farmers in Germany of 21.5ha (Statistisches Bundesamt, 2021). As agricultural land needs to recover periodically, the number of hectares paid can be adjusted season-dependent by simply deactivating them in the app (Heidelberger, 2020). Depending on the future demand, heliopas.ai may introduce a two-tier pricing model, aiming at smaller and larger farms respectively. Addressing larger farmers with dedicated irrigation planning specialists, foremen, and irrigation workers, heliopas.ai is currently working on adding user roles and tasks to their digital solution. Customer feedback has revealed this to be a great way to digitize slow paper-based processes which saves time and money and increases the customers' willingness to pay (Brecht et al., 2021).

History

The concept behind heliopas.ai originates from a business idea developed during the Industry Hackathon in Bielefeld, Germany, in 2017 (Brinkdöpke, 2017). Initially, the concept was to fuse harvest yield data from combined harvesters with satellite images to forecast crop yield (Wolff, 2020). The company CLAAS, a large German agricultural machinery manufacturer, was open to close cooperation from the beginning (CLAAS, 2018). During the hackathon, the team around Ingmar Wolff developed the first version of the prototype (Brinkdöpke, 2017). Due to a lack of quality data and because the legal rights to the crop yield data were not being owned by CLAAS, the project failed. Nonetheless, the business opportunity of extracting value from satellite data to support agricultural actors was recognized and pursued from then on. Starting to evaluate potential markets, Ingmar Wolf rediscovered the innate desire to become an entrepreneur. In the search for a co-founder with a technology background throughout the personal network, Benno Ommerborn joined the project via a machine learning group at the Karlsruhe Institute of Technology (KIT). During the master's degree, the computer scientist was curious about large quantities of ground truth in combination with the use of satellite data. In addition, the agricultural company CLAAS was still interested in the concept of pursuing a satellite data-driven approach in agriculture and offered a potential investment to the founding team (Ommerborn, 2020). As a pilot customer, the agricultural company CLAAS participated in a workshop to explore further collaboration with the founding team. In particular, the personal contact with the CTO of CLAAS and its mentorship was highly beneficial for the early stage of heliopas.ai. As Ingmar Wolff was working full-time as a business development consultant, while Benno Ommerborn was

still in his studies, it took six to nine months to prepare large quantities of data which – in the end – never came to fruition (Wolff, 2020). In retrospect, the founders conducted more or less paid research for CLAAS without owning any of the data, and hence, the cooperation was discontinued (Ommerborn, 2020). At the end of 2018, another data scientist joined the founding team, and in addition, the original business idea pivoted to the extraction of information from spectral image data. Having the opportunity to combine technological development with a topic of the master thesis led to synergy effects, and Benno Ommerborn could spend significant time on research and machine learning advancements. Although the technological process was significant, the founders did not focus too much on conducting further market research until early 2019.

At a conference for innovative agriculture, direct contacts with the German Farmers' Association and other important actors in agriculture could be established (Wolff, 2020). In conversations with potential customers, plant diseases, fertilization, and soil moisture were mentioned as interesting aspects of entrepreneurial opportunities. In addition, the insights from problem interviews reinforced these impressions and revealed that there was only a little competition concerning soil moisture yet (Ommerborn, 2020). Experiencing the consequences of the record drought in the summer of 2018, the founders decided to pursue the topic from the perspective of insurers and reinsurers (Henn & Terzidis, 2019). Through their network, it was relatively simple to receive valuable feedback from experts at the senior management level. As insurers and reinsurers constituted a higher market potential than farmers, the business model further evolved in this direction (Stenftenagel, 2020). With a clear focus on the field of InsureTech and the academic background of the master thesis, heliopas.ai fulfilled the application requirements of EXIST Start-up Grant, a Germany-wide support program provided by the German Federal Ministry for Economic Affairs and Energy (BMWi, 2021). During the application phase, the founders count themselves lucky to receive valuable support from the university, mentors, and other individuals from the EE in early 2019. Although a lot of time and effort was used to search for suitable business models, a satisfactory solution could not be identified for a long time. Even though an analysis of various business cases and testing of hypotheses following the ‘Lean Startup’ approach had been done, the main assumptions were adopted from internet research and feedback from mentors. Having only little interaction with potential customers, the founders didn´t recognize the potential of these insights (Wolff, 2020). Under tremendous time pressure

and only just before the application deadline, the first concept of WaterFox was added as a second option to the original business idea. Nevertheless, heliopas.ai could convince the selection committee and receive the EXIST Start-up Grant for 12 months (BMWi, 2021). Having secure funding for one year enabled the founders to prior on their new technology-based firm full-time (Budig, 2019). Complementing the team with a third co-founder was troublesome, and the position had to be replaced halfway through.

At the beginning of the funding period, heliospas.ai set a clear focus on the development of an InsureTech solution for the agricultural sector (Henn & Terzidis, 2019). However, the insurers wanted to validate directly, these pilot customers were not able to provide sufficient data to do so. This circumstance led to a restructuring of resources to obtain validation data and resulted in a delay in their project plan. At the end of 2019, insights from customer interviews with local farmers were transformed into paper prototypes. These initial visualizations served as the basis for the following hard coding of the application. Before publishing the first version of the WaterFox app, heliopas.ai was formally founded as a GmbH (the German equivalent to a Limited Company) by Ingmar Wolff and Benno Ommerborn (heliopas.ai, 2021). In February 2020, an industrial engineer with some design thinking experience joined the core team, introducing a new approach to understanding customers. User-centric processes were established and intensified substantially to gather feedback for the product continuously. Through this proceeding, it became clearly and explicitly visible that there was a lack concerning the product-market fit. As a result, tumultuous times were ahead for heliopas.ai. Simultaneously, a business and marketing unit was built to promote WaterFox on social media and in the press. Running experiments on customer acquisition and gathering feedback on the value proposition and the product itself were additional tasks of this group. During this time, the number of employees increased quickly, leading to higher complexity and additional efforts sunk into team coordination and management. When technical problems on the backend occurred in June of 2020, the personal relationship between the founders was challenged vehemently.

As still no significant revenue was generated after the first half of the funding period, further business models were explored and consulting services were offered in addition to the core business. Besides securing additional revenue streams, the consulting projects were seen as a door opener toward customer acquisition and as a sales instrument for the

application WaterFox. Through working closely with customers, the understanding of their actual needs was increased (Wolff, 2020). Due to the high fluctuation of student employees, the staff had to be rebuilt permanently. Thereby, heliopas.ai shifted its priority from marketing and business development to improving the application at the technical level for the 2021 summer season. Introducing new features as requested by the customers, heliopas.ai is following a user-centric approach strongly as suggested by Julian Seidel. In particular, free accounts should be attracted to convert into paying customers.

Structure

Besides the two co-founders Ingmar Wolff (CEO) and Benno Ommerborn (CTO), heliopas.ai currently employs six employees, consisting of student freelancers and internships. The business unit under the leadership of Ingmar Wolff is responsible for business development, including the areas of marketing, sales, and customer relationship management. In addition, this team takes care of product management and customer feedback. The technical team, managed by Benno Ommerborn, is responsible for developing the mobile and web application of WaterFox, implementing the user feedback and improving the model, data, and algorithms on the backend.

General administrative tasks and recruiting activities are shared equally by both founders. While accounting and other financial matters are assigned to Ingmar Wolff, his co-founder Benno Ommerborn is primarily responsible for all kinds of legal affairs. In the beginning, the vision was to scale up quickly and subsequently increase the team size to a large extent. However, since the founders have been confronted with the exponentially increased effort of managing a larger team, the strategy changed to rely on a small but focused team until market needs require more resources in the future (Wolff, 2020). In doing so, no hierarchical levels are required at the moment, and all team members directly communicate all issues with one of the founders.

6.2.3.2 Market

One of the six domains of the EE approach introduced by Isenberg (2011) is the business environment in which a company operates (Henn & Niermann, 2020). This area significantly influences the evolutionary development process and contributes to the growth of a new venture. The following subchapters discuss in detail the relevant parameters that affect these dimensions for heliopas.ai.

Target Customer

The application WaterFox is targeted at farmers watering their fields with artificial irrigation. Due to crops requiring constant watering, irrigation is used mainly in vegetable and fruit farming. In 2016, a total number of 10.2 million hectares of agricultural land in the European Union has been irrigated (EUROSTAT, 2019). Although Spain and Italy account for 48.3 percent of the irrigable agricultural land in Europe, heliopas.ai is currently available only in the DACH region (Germany, Austria, and Switzerland) due to their language settings. Addressing countries with high market potential, future expansion is already in planning. Another constraint is the type of irrigation in use. The principle behind WaterFox is only applicable to open field farming and any farming techniques that cultivate using tarps and foils. Due to this limitation, crops such as asparagus have to be excluded from the current target market. Inside greenhouses, the application is only functional when additional sensors are installed and connected to the API. Furthermore, sophisticated drip irrigation systems with e.g. in-situ tensiometers[1] disable WaterFox for use cases with very high margin crops. Through the development of new features such as connecting WaterFox to weather stations, multi-user permission management, and task management, heliopas.ai aims to appeal to a wider range of target customers, including industrial agriculture farmers. As using WaterFox requires no hardware installations in the form of sensors and the pricing structure dynamically adjusts to the farm size, it may be attractive to small farms and the industrial landscape. At the same time, the approach allows a bundled overview of fields that may be scattered over dozens of kilometers and is especially applicable for large farms. Additionally, heliopas.ai plans to prepare anonymized data collections to offer high-quality services to other stakeholders within the agricultural industry, such as agricultural commodity traders, agricultural insurers and reinsurers, irrigation associations, and agricultural contractors.

Channel of Distribution

Since the services of heliopas.ai are based on mobile and web applications, physical stores or points of sale are not required and traditional channels of distribution have not necessarily been established. The app can be downloaded for free on both iOS and Android, so logistics do not present a bottleneck. However, the key activity for heliopas.ai

[1] In-situ tensiometers are a type of soil moisture sensor that is locally employed and can be part of a connected automated irrigation system.

in distribution is to build up a marketing strategy to advertise WaterFox and its value proposition among the target customers, encouraging the number of downloads first of all. Brand awareness is especially important in a market with established structures and non-innovative enterprises as customers. Building a strong brand leads to trust and reliability, which can be a key competitive advantage. In the beginning, heliopas.ai followed a strategy with native posts, advertisements on social media, Google Ads, articles in newspapers, and agricultural publications.

Before the global Covid-19 pandemic hit, the founding team planned to visit agricultural fairs to get in contact with potential customers directly (KIT Gründerschmiede, 2020). In addition, heliopas.ai set up partnerships with agricultural universities to further research the link between big data and farming technologies. After the global pandemic efforts will be intensified anew. To test the effectiveness of different distribution channels, the business development team carried out multiple experiments and calculated the Customer Acquisition Cost (CAC) precisely. Market research has shown that word of mouth and personal referrals among farmers play an essential role in increasing reach. Hence, heliopas.ai set up a referral program that grants both the existing and the new user gifts such as a certain number of free hectares upon registration. To acquire early customers, especially near Karlsruhe, farmers were contacted classically by telephone calls and emails. Through this structured procedure, engaged pilot customers could be identified and close cooperation established. Additionally, this group of customers and their feedback were included in the product development process. In return, the farmers became part of the ‘fox family’, receiving further discounts and benefits. For future strategic orientation, heliopas.ai is willing to explore further cooperation with irrigation associations, agricultural influencers, or other agricultural actors to leverage their reach.

Competitors / Competition

Although various players are working on digitalizing the agricultural industry, the sector is still fragmented and no market-leading company has evolved so far (Jung et al., 2021). The lion’s share of those is either an established company or a spin-off of large corporations such as BASF, the world's largest chemical company. Nevertheless, the number of new technology-based firms exploring entrepreneurial opportunities in the agricultural sector is increasing tremendously in recent years (MarketsandMarkets, 2021). In general, the competitor landscape of heliopas.ai can be categorized into classic field

record managers, all-in-one farm management software, operators of connected weather stations, and other firms focusing directly on soil moisture mapping and smart irrigation management. The market niche in which heliopas.ai positioned itself is not yet a mature market and therefore, only a few direct competitors offer the same services. Two of the competitors, HELM-Schlagkarteien and Acker24, are located in Germany as well. These field record managers are offering services to store the geolocations of their fields in combination with crop data like type, seedtime, harvest time, and harvest yield at the end of the season. Farmers rely on these systems to calculate their earnings and compare yields of different soils and fertilizers. In addition, documentation is offered which is required to comply with regulations. However, these products are not in direct competition with WaterFox, as potential users have to be convinced to invest in additional software and the integration process needs to be seamless.

Farm management software solutions such as Xarvio FIELD MANAGER by BASF and NextFarming by FarmFacts in Europe, or FarmCommand by FarmersEdge in North America aim to be an all-encompassing digital platform for agricultural players. Thereby, Xarvio focuses more on crop production and health, by offering fertilization recommendations and disease warnings among other services. Whereas FarmCommand provides a unified stakeholder view to enhance how growers, agricultural professionals, and agri-businesses interact with data through vertical integration driven by full-farm connectivity. Especially in Germany and Europe, data privacy concerns of farmers who distrust large corporations such as BASF can be an advantage for trustworthy small companies.

Besides established companies, a variety of fast-growing start-ups is entering the competition recently. Sencrop which has collected 10 million Euro Series A funding in 2019 offers full weather stations or singular rain, wind, and leaf moisture sensors that function remotely and aggregate their data in an app that can be accessed on mobile or desktop. Users pay for the hardware as well as a yearly fee for the service which enables them to connect to multiple weather stations and sensors throughout their land. Additionally, it is possible to collaborate with neighbored farmers and share the data from each other's devices. Although Sencrop has already grown rapidly, it has to be classed as direct competition to heliopas.ai in the field of the integration and sale of automated

weather stations. On the other hand, cooperation with complimentary services has to be considered a valid option for the future.

SmartCloudFarming from Berlin, Germany, is a relevant start-up in the field of soil moisture and irrigation space. They aim to provide 3D soil maps of soil moisture and nutrients and soil organic carbon monitoring. SmartCloudFarming received a German government grant in 2019 and can be described as a direct competitor to heliopas.ai. Due to limited available information about the company and no released product yet, the companies stay a black box. In addition, 'raindancer' from Berlin is a provider of smart sensors and apps to control and schedule irrigation pumps as well as track irrigation via GPS. The concept of 'raindancer' is not in direct competition with the current core business of heliopas.ai. Though they are collecting enormous volumes of data through their sensors, they are likely working on something similar to WaterFox behind the scenes.

Cooperative Partners

Cooperative partners of heliopas.ai are currently limited to the farmers within the 'fox family', the special group of dedicated early adopters who provide detailed feedback on the app and test prototypes of new features before launch. By joining the 'fox family', members agree to provide product testimonials, which will be instrumental in building the brand and trust among target customers. As soon as WaterFox is closer to product-market-fit and a functioning business model, the members of the fox family could be leveraged as spokespeople or multipliers in their regional network of farmers. As mentioned in subsection 'Product', heliopas.ai is currently searching for cooperative partners to manufacture cost-effective connected weather stations that could be sold to WaterFox users. Besides the product itself, partnerships to promote WaterFox or future products or services of heliopas.ai with agricultural influencers or agricultural associations are conceivable.

6.2.3.3 Founders and Team

Human and social capital are identified as drivers for entrepreneurship (Madriz et al., 2018). This case study divides the dimension of human capital as a domain of the entrepreneurship ecosystem approach according to Isenberg (2011) into the topics of the founders and the team. The focus in this dimension on the quality of education, general degrees, and entrepreneurship training is slightly modified. As these aspects play a

subordinate role within this case, they are picked up briefly in subsection 5 about policy and support.

Number of Employees

From the first idea in 2017 to the achievement of the EXIST start-up scholarship in 2019, the team of heliopas.ai consisted of the two founders Benno Ommerborn and Ingmar Wolff (Budig, 2019). In addition, one or two other varying freelance contributors, mainly data scientists, worked for them but often stayed on for only a couple of weeks (Wolff, 2020). During the early days, one data scientist, whom Benno Ommerborn called their first employee (Ommerborn, 2020), supported the team out for the second half-year of 2018 and early 2019. However, he declined his options on part-ownership of heliopas.ai and decided to take a corporate job instead of staying on throughout the EXIST period (Wolff, 2020). During the EXIST start-up scholarship, one full-time employee joined the core team but has to be replaced at the halfway mark. Beginning from the end of 2019, a working student was hired to reduce the workload in the fields of administrative and financial processes. Other tasks included leading the application process for awards and website maintenance. Additionally, two thesis students supported CTO Benno Ommerborn with research projects to further develop the technological basis. In early 2020, another student joined for an internship in the field of business supporting Ingmar Wolff in his role as CEO.

Throughout Q2 of 2020, the team size of heliopas.ai increased significantly. At its peak, the company consisted of two founders, one full-time employee funded by the EXIST scholarship, three thesis students, four student freelancers, and two interns. An external funding application writer and a part-time designer supplemented the staff. Increasing the number of employees in a short time along with the tumultuous product launch led to miscommunication and dissatisfaction within the team. Especially, the prevalence of part-time workers resulted in exponentially increasing team coordination efforts (Seidel, 2020). This experience and the end of the EXIST grant led to the decision to focus on a more efficient core team again. It is planned to keep the team at heliopas.ai compact with a simplified structure until external influences require to scale up again.

Expectations and Motivation

After recognizing the initial entrepreneurial opportunity, Ingmar Wolff searched for a motivated co-founder with an entrepreneurial mindset and deeper technical background

to support him in his endeavor. Throughout his network, he got into contact with Benno Ommerborn, who joined his project without hesitation. As a next step, they initiated a hiring process for data scientists and developers to support them in research and the development of a product. Besides having technical skills, these persons should be enthusiastic about personal growth and gaining entrepreneurial experience, as heliopas.ai was not founded legally yet and therefore, unable to provide compensation. However, the majority of the data scientists were mainly interested in the technology of data science, not identifying with the founders' vision. Consequently, they neither remained in the team for a long time nor increased productivity, according to the perception of the founders (Wolff, 2020). After the data scientist as a potential third co-founder was not willing to join the EXIST start-up scholarship, Ingmar Wolff as CEO, and Benno Ommerborn as CTO wanted to complement their technical and creative skills with someone to take care of the responsibilities of a COO in the areas of finances, internal organization, and processes. Although the selection process was managed carefully, the final decision was unlucky and their first full-time employee did not fit the company's vision. Not being fully committed, all parties agreed on terminating the arrangement with the data scientist. This leads to them being under pressure to replace the position quickly. Although there was a big overlap between Julian Seidel´s profile and Ingmar Wolff's core competencies, his background in Design Thinking convinced the team to work with him for at least six months (Wolff, 2020). Feeling a lack of support from the rest of the team in his role as a product manager, dissatisfaction of Julian Seidel arose when the staff grew and the development of the first product prototypes ran into problems (Seidel, 2020).

Through a team-building workshop and extensive talks within the group, it was determined that expectations and roles need to be communicated more clearly. In doing so, the satisfaction of the team member's needs increased and motivation stayed at a high level. Both founders realized the importance of being well-informed, transparency in decision-making processes towards their employees, and awareness of upcoming errors or problems early on. Additionally, these experiences enabled the founders to recognize that the individual motivation of team members may vary. Hence, expectations had to be communicated clearly from both sides, founders, and employees, in the beginning, to avoid misunderstandings and dissatisfaction at a later stage (Ommerborn, 2020). To this day, heliopas.ai aims to offer regular opportunities for coaching and workshops to employees and both founders are open to sharing their experiences with the team.

Role of the Founders

The understanding of the respective roles of both founders evolved strongly. As Benno Ommerborn initially joined the team as CTO, he was responsible for everything related to research and app development ever since. However, both founders were involved in market research to a large extent. During the product development stage, Benno Ommerborn additionally assumed responsibility as the product owner of WaterFox (Wolff, 2020). The role of Ingmar Wolff underwent more substantial changes throughout the growth of heliopas.ai. While he initially developed the business idea and vision behind heliopas.ai, his full-time job as a consultant did not allow him to invest a lot of time into the project (Budig, 2019). Being an outgoing person who presents and creates partnerships with ease, he was mainly responsible for networking and setting up contacts with decision-makers from potential customers. His job description shifted from product owner to team management, marketing, and sales to growth hacking and then back to being the product owner. As Julian Seidel joined the team, Ingmar Wolff was unsure of his concrete role for quite a while (Wolff, 2020). Nowadays, both founders understood their role as creating a framework and environment in which all team members can thrive. As their main tasks, they focus on leadership, provide strategic direction as well as address gaps that otherwise would not be filled (Ommerborn, 2020). Having a concrete organizational structure creates flexibility to work on non-operative tasks such as the preparation of reports and communication with mentors. Furthermore, freed capacities could be used to meet with possible investors, grant application admissions, and consulting projects for customers.

The Mentality of the Founders

Ingmar Wolff is not the only person with a prevalence of entrepreneurship within his family. His brother founded startups in Munich and Berlin, while one of his cousins is part of the entrepreneurial community in Hamburg. Ingmar Wolff previously gained plenty of experience with entrepreneurship by himself. Besides founding a startup in Munich, he worked for a VC company and as a start-up consultant for innoWerft, a high-tech startup initiative by SAP and the state of Baden-Württemberg (Wolff, 2020). As a student, he already led the local branch of the international student association AIESEC, which is dedicated to youth leadership. His attitude is driven by a strong belief in sustainability and ecologically thinking, and he tries to promote those values through the

vision of heliopas.ai (Budig, 2019; Dechansreiter & Grote, 2020). Although Benno Ommerborn does not have a particular entrepreneurial background, he has continuously demonstrated high intrinsic motivation to learn and challenge himself. In addition to his participation in two separate iterations of the German Federal Competition for Computer Science (BwInf) as a high school student, he could win the Facebook hackathon in 2014. Furthermore, he was awarded the Google EMEA Students with Disabilities Scholarship in 2015.

6.2.3.4 Culture

For heliopas.ai, the company image and public perception are of paramount importance due to their bootstrapping approach in an old industry with risk-averse companies (MarketsandMarkets, 2021). In general, obtaining research grants and government funding requires public interest and good standing among universities, research institutions, and other agencies. Therefore, the founders carefully drafted and created the vision of supporting farmers in producing more sustainably through space technology (Plattform Lernender Systeme, 2020). Communicating this story through press releases as well as their social media channels is ever since then a key activity for heliopas.ai. In doing so, they have managed to create an outstanding image among stakeholders within the company's ecosystem. Over time, they were able to receive various grants. However, more effort has to be set into gaining traction among target customers. Increasing their excitement about WaterFox will lead to more effective product promotion through word of mouth.

Corporate Identity

Due to the high number of pivots regarding the product idea and the business models, corporate identity (CI) was not a priority in the early stage. Before the development of WaterFox began, the team picked a color and font scheme for heliopas.ai and collaborated with a designer to create the logo for the app. Packaging the vision of heliopas.ai in a story that creates emotion and resonates with the perceptions of people, has been a clear aim for Ingmar Wolff. Thereby, he has been deeply influenced by his granddad being a farmer as well (Mescoli, 2019; Stenftenagel, 2020). From the beginning, the communication strategy was built on simplicity and low barriers to entry by prioritizing the free-of-charge hardware and the use of novel space technology (Plattform Lernender Systeme, 2020). In particular, the easy-to-use approach is thus a focal point of the

WaterFox application. However, business experiments show that the high-tech approach does not seem to be feasible for all groups of diverse target markets. While digitally affine farmers are quite excited about new technologies, others show great skepticism towards the accuracy of recommendations based on satellite images. Thus, heliopas.ai has to invest major effort in adapting its CI to resonate with a broad range of potential customers, especially with scaling in mind.

Awards and Appreciation

After winning 1st place at the Founder's Hack in Bielefeld, Germany, the contact with the company CLAAS led to premature praise and credibility within the agricultural industry (Brinkdöpke, 2017). Having direct contact with the CTO of CLAAS provided a reference that was beneficial to opening doors at other large corporations for sales pitches and building a strong network (Wolff, 2020). During the following periods, Benno Ommerborn and Ingmar Wolff successfully participated in several founder competitions and scholarship programs. Thereby, they could win multiple awards, which gave them a lot of credit. After winning the hackathon, heliopas.ai attended the Innovative Agriculture Bootcamp 2018 organized by the Agricultural Pension Bank (Rentenbank, 2021). Furthermore, they completed the PreLab program at the CyberForum Karlsruhe successfully, which culminated in their admission to join the CyberLab Accelerator in 2019 (d'Aguiar, 2019). Besides entrepreneurial education workshops, additional services such as discounted office space, mentoring through start-up consultants, and assistance in all aspects concerning the daily business of an early-stage start-up were offered. Within one year, heliopas.ai attended the Fraunhofer Ventures AHEAD program (Fraunhofer, 2021), won the Cyber Champions Award (d'Aguiar, 2019), and received the ‘Most Scalable Business Model award’ at the GROW competition hosted by the KIT student group PionierGarage (karlsruhe.digital, 2020). In July 2019, their application for the EXIST start-up scholarship was accepted (BMWi, 2021) and heliopas.ai became a project partner in the entrepreneurship workshop ‘student2startup’ of the University of Hohenheim (Wolff, 2020). In addition, they joined the Business Incubation Center of the European Space Agency (ESA-BIC, 2021) and passed the fourth edition of the Meisterklasse by Gruendermotor, which supports start-ups to scale with direct contacts to potential customers from the industry and access to VC money (Gründermotor, 2021). At the ESA-BIC startup summit 2020, the team managed to win the ‘Investors Best

award' (BWIHK, 2019). Furthermore, they have been awarded Amazon Cloud €90,000 credit, which was immensely useful to increase the server capacity for model training and other research (Wolff, 2020). Besides the financial value, those awards had a great impact on their recognition within the entrepreneurial community, target market, society, and further partners. Renowned funding programs further increase reach, media interest, and coverage, which supported the acquisition of new customers and attracted potential investors.

6.2.3.5 Policy and Support

Being confronted with technical challenges in the fields of remote sensing and artificial intelligence, the young company required support from various sides to constantly overcome new obstacles. The founders were lucky to receive aid on a massive scale: from professors and supervisors at KIT, government grants such as the EXIST start-up scholarship (BMWi, 2021), to mentors and advisors who consulted them with business decisions and networking. Additionally, the growing start-up community in the EE of Karlsruhe also has a major impact on local entrepreneurial activity regarding technology-based ventures (Henn & Terzidis, 2019). This influence is elucidated in the amount of motivated and skilled talents employed for heliopas.ai as cost-effective labor in the form of thesis students, interns, and working students (Wolff, 2020).

University Support

Methodically, the interpretation of satellite image data using artificial intelligence is closely related to the scientific research Benno Ommerborn conducted during his master thesis at KIT (cv:hci, 2018). At the Institute of Photogrammetry and Remote Sensing (IPF) his supervising professor, as well as the advisors, continued to support and advise heliopas.ai in the ideation stage (Ommerborn, 2020). In addition, the Institute of Technology for Pervasive Computing (TECO), supported them in the application processes for research grants in 2020. The TECO institute also enabled Ingmar Wolff to be on the payroll with a part-time Ph.D. position after leaving his full-time consultant job, which he used to transition into working on heliopas.ai full-time. The structure of the EXIST start-up scholarship requires a positive recommendation from a technology transfer office at a German university. Relying on trustworthy cooperation with the service unit Innovation and Relations Management (IRM) at the KIT, they received full support during the whole process (Budig, 2019).

EXIST Startup Scholarship

The EXIST Business Start-up Grant is a one-year funding program by the German Federal Ministry of Economic Affairs and Energy (BMWi), supporting upcoming founders with a university background in transferring their ideas into practice and implementing a business plan (BMWi, 2021). The focus of this scholarship is on innovative technology-driven ideas and innovative knowledge-based services with significant new features which will most likely lead to positive economic effects. The maximum funding period is one year and primarily constitutes a guarantee of personal livelihood for the beneficiary. The scholarship consists of a monthly founder's salary for three recipients and an equipment fund of €35,000. Thereby, the amount of salary is determined by the highest educational attainment. For the young entrepreneurs, the EXIST Grants meant the opportunity to be fully committed to implementing their idea. Not having to worry about a salary, they focused on research projects around their technology and building a product out of it. Furthermore, it enabled them to hire their first student freelancers, marking a significant step in the evolution of heliopas.ai.

ESA Business Incubation Centre

In early 2020, heliopas.ai was chosen to be part of the European Space Agency - Business Incubation Center (ESA-BIC, 2021). Through this accelerator program, approximately 150 companies per year are supported throughout more than 20 centers all over Europe. It is specifically aimed at entrepreneurs to realize their innovative business ideas and disruptive products based on space technology, robotics, or artificial intelligence. ESA-BIC is the world's largest network for aerospace technology and the regional centers provide their start-ups with reputable partners for technical support. During the incubation period of up to two years, helioipas.ai is planning to reach product-market-fit and explore further revenue streams (Wolff, 2020). Additionally, the founders will have access to a network of business angels and venture capitalists when the product and the team organization are prepared to scale.

Networks

Having strong personal and university networks, played a key role in the growth of heliopas.ai thus far. In particular, Ingmar Wolff had recognized the importance of networking in his previous career and continued to connect with people, even when his role in the start-up was temporarily unclear. Based on his connections and networking

skills, meetings with deciders in various corporations and agencies could be arranged (Wolff, 2020). Being able to discuss their ideas with experts from the industry, they got valuable feedback, especially on the analytics side of the business. Through intensive networking, the founders got access to agricultural advisors and irrigation associations, which was helpful for product feedback as well and could be leveraged to contact farmers in the future. Their relationships with the Karlsruhe Institute of Technology, business angels, and other entrepreneurs were extremely beneficial to heliopas.ai and provided multiple opportunities they have not been aware of. In the case of heliopas.ai, it is observable that making contacts is almost exclusively done by Ingmar Wolff (Ommerborn, 2020). This fact is related to the theory that in most early-stage companies there is only one person within the founder team responsible for almost all networking activities (Neergard, 2005). Even his co-founder Benno Ommerborn addressed this point and emphasized the importance of the division of roles. He has leveraged his network to work with top data scientists on more than one occasion and highlighted the value of the founders' networks for heliopas.ai (Ommerborn, 2020).

6.2.3.6 Funding

The two co-founders of heliopas.ai decided early on to bootstrap the company for as long as possible. They based their strategic decision on their wish of not diluting the focus of the founder's vision and keeping the company shares and complete management control. Hence, heliopas.ai had to decline potential investors on the one side and instead focused on obtaining government and research grants to finance growth and product development on the other side. At the end of 2020, heliopas.ai had obtained a total of almost €350,000 in funding and prize money (Wolff, 2020). To this sum, the following financing options contributed: EXIST Business Start-up Grant, ESA-BIC Grant, Copernicus Incubation Grant, a grant from the German Center for Aviation and Astronautics (DLR), Sparkasse, GROW student founding contest, as well as the CyperChampions competition. For the near future, the founders are planning to consider an investment round, depending on the right chronologically fit and their belief of a necessity.

6.2.3.7 Challenges and Crises

As discussed in the literature, company growth necessitates the adaptation of processes, structures, and functions to new situations, which may lead to problems and crises over time (Greiner, 1998). However, these struggles can also be triggered by external forces.

Since the first idea resulted from the Founder's Hack hackathon, heliopas.ai has faced some problems and challenges as well. The following subchapter provides a more detailed look at those critical situations regarding the team and the product focus.

Founder Team and Employees

The founding team is integral to the success or failure of a start-up within the early stage. Identifying a third team member to join the founders in the EXIST Grant proved to be a troublesome process. Although the two co-founders initially saw the necessity to employ a person with the skillset of a COO (Wolff, 2020), a further data scientist joined the team. Unwilling to commit to the annual grant of EXIST, this arrangement only lasted for some months. Besides the lack of a sharp picture of the concrete business model, Benno Ommerborn and Ingmar Wolff have been pressed for time to find and convince their ideal candidate. As a consequence, they did not reflect on their decision, and a complicated working relationship between the co-founders and chosen one began. Although the employee joined with supposed experience as a project manager, he delivered suboptimal and unproductive results (Ommerborn, 2020). Breaking engagements and previous agreements multiple times, the founders decided to terminate the experiment after a short period of four months (Wolff, 2020). Subsequently, resources could not be used efficiently during a crucial time for the development of the project and a new hiring process had to begin. The tense situation partially relaxed, when Julian Seidel joined the team spontaneously. However, an overlap of competencies with Ingmar Wolff and the condition of the contract only being temporary for the duration of EXIST may not have been an ideal constellation.

In preparation for a successful product launch and a decent adaptation among the target market, the staff of heliopas.ai grew substantially in March and April 2020 (Wolff, 2020). Simultaneously, with the restructuring of the organization and internal processes, the team was split into technical and business units (KIT Gründerschmiede, 2020). As a negative side effect, these organizational changes resulted in a lack of communication and exchange of information between the teams. During a period of integrating pilot customer feedback quickly, this circumstance led to inefficient working processes. In the end, this culminated in tensions and some discontent within the team (Seidel, 2020). The additional resources were surpassed by an even higher increase in the complexity of managing the employees. Keeping everybody in the loop of daily decisions was

extremely challenging, as more than half of the team members were working part-time as interns or student freelancers. Furthermore, new hires may not feel as purely passionate about the vision and product as the initial team, resulting in discontent between team members (Seidel, 2020). To address this issue, the founders proposed a team-building workshop, which improved personal relationships. Rethinking some of the organizational changes was beneficial to improving the collaboration between the business and the technical team sustainably.

Just as heliopas.ai was making good progress in the context of customer feedback and improving the app's usability a few weeks after launch, another crisis came up. A high percentage variance of the soil moisture values in WaterFox compared to the reality on the fields showed that the models were not reliable enough yet. While this technical issue was not unexpected for Benno Ommerborn, who simply could not further the research in recent months, Ingmar Wolff was fully unaware of this research gap. It became obvious that a misunderstanding in communication between the founders had existed for close to a year (Ommerborn, 2020; Seidel, 2020). Being unsure about the exact reasons for the miscommunication helped the two founders to understand the need for structural reporting processes. In the end, this was beneficial for the overall communication with the whole team. Meanwhile, an apologizing email to all users of WaterFox and additional free trial periods were able to mitigate most of the damage on the customer front.

Focus and Premature Scaling

As mentioned in the subsection ‘history’ most of the first two years Benno Ommerborn and Ingmar Wolff spent working together on evaluating different markets and business models. Thereby, heliopas.ai underwent several pivots before its final legal foundation and settled primarily on WaterFox. New technology-based ventures which pivot once or twice have a 3.6x higher user growth, are 52 percent less likely to scale prematurely, and raise 2.5x more capital than start-ups that change their business model none or more than two times (Marmer et al., 2011). Ever since focusing on the WaterFox application, heliopas.ai has performed further small adaptions. This change includes the Geisenheim irrigation model approach, which users can toggle in the settings instead of satellite data. Ingmar Wolff regrets not talking to potential customers in-depth earlier, which he considers the most important learning of their journey thus far. One of his co-founders agrees with this statement by reflecting that there should have been more resources on

listening to customers' problems initially, instead of having a ‘solution searching for a non-existing problem’ (Seidel, 2020). Furthermore, Benno Ommerborn lists his takeaway from restarting heliopas.ai several times: not trying to scale too early and instead focusing on achieving product-market fit first. Spending three weeks integrating the payment processing platform Paddle when not one customer had even indicated a concrete willingness to pay is a perfect example for him (Ommerborn, 2020). Taking adequate time to gather feedback and improving the product should have been the priority. Customer feedback was that the app was not offering farmers enough value compared to the story they told in their marketing channels (Wolff, 2020).

Before launching the first version, the founders wanted to throw the app on the market and see some traction (Wolff, 2020). Three months later, the EXIST Grant would have expired, putting financial pressure on the founders. Therefore, they focused their strategy on making money with a semi-finished product, even though it may have missed some steps in between (Seidel, 2020). An analysis of more than 3,200 high-growth firms identified that it requires two to three times more effort to validate their market than the founders expect (Marmer et al., 2011). This underestimation may create pressure to scale prematurely, which could certainly be the case with heliopas.ai. Both founders emphasized the opportunity to learn from these challenges heliopas.ai has been facing so far. Solving critical situations within their company not only improved their leadership skills but made them more sensitive toward changes in social processes within the team. Furthermore, they understood that a smaller team size could be more effective in their current situation (Wolff, 2020). After considering feedback from the fox family, data from business experiments, and intensive discussions in the team, the founders realized the necessity to rely on customer feedback and fasten the development cycles of the app (KIT Gründerschmiede, 2020). Hence, they implemented the agile software development methodology SCRUM in their development processes, and updates with new features have been published every two weeks since (Seidel, 2020).

6.2.4 Cross-Case Conclusions

Drawing cross-case conclusions based on methods of synthesis ‘facilitates the comparison of commonalities and differences in the events, activities, and processes’ (Cruzes et al., 2015). Knowledge mobilization as the synthesized outcome of two or more case studies occurs when accumulating, comparing, and contrasting those cases (Khan &

VanWynsberghe, 2008). Thereby, all the single cases need to be treated equally to avoid any bias of one case dominating the entire array of cases (Yin, 2014). Through the cross-case analysis of two new technology-based firms, the impact of the EE framework conditions on their evolutionary dynamics can be derived. Additionally, conclusions on the well-functioning of the EE can be drawn, and thus, an in-depth understanding of the local entrepreneurial processes increased (Cowell et al., 2018; Tsvetkova et al., 2019).

Trust

In none of the interviews, the topic of mistrust was mentioned once. This fact leads to the reasoning that the general level of trust in the EE of Karlsruhe is no barrier to the resilient growth of the ecosystem. The growing startup community had a major impact on the local entrepreneurial culture from which new businesses could benefit and success stories were created. In both cases it was a challenge to build a strong brand that increase trust and reliability towards customers and partners, counteracting the weakness of having no track record. Thereby, local networks guarantee a leap of faith toward other actors in the entrepreneurial ecosystem.

However, as both companies were struggling within the founding team at a certain point, it became obvious that the loss of internal trust can lead to failure. Therefore, it is important to facilitate an open discussion culture to clarify personal goal statements and emerging changes such as the distribution of roles in the team. When the basis of trust decreases, a change in the team composition could become inevitable. For both companies, this difficult decision paid out well in conclusion.

University

The first similarity which can be observed is that the local university had a major influence on both cases. First of all, the excellent courses of study at the KIT have been the decisive motive for all of the founders to move to the region. Being able to attract young talents is highly relevant for the growth of an EE (Spigel & Vinodrai, 2021). Furthermore, university entrepreneurship education programs played an essential role. During seminars and workshops, the original ideas could be further developed into prototypes. Student thesis could be used to work on technological development, enabling the founders to spend significant time on their projects. Further advantages were the access to machines and software licenses as well as the possibility to use offices for free. Thereby, the teams received plenty of support from their professors, supervisors, and

businessmen, demonstrating the functioning of mentorship. The founders were lucky to receive aid from the university in the application for government grants such as the EXIST start-up scholarship. Additionally, financial support to conduct market research was granted and connections to university partners could be exploited to set up contacts with customers.

Internationalization

Findings from the previous study indicate that internationalization has a positive effect on local entrepreneurial activities (Henn et al., 2022a). In this field, both cases differ in their fundamental orientation. Whereas RESTUBE followed the vision of an early internationalization strategy to 'conquer the world' from the beginning, heliopas.ai focused its activities on the German market. Participating in the German Accelerator Program has been highly supportive of RESTUBE to access the US market through established networks. Even if the US campaign did not work out well, the mindset of the founders was sensitized to the importance of having a global business model. Following an internationalization strategy, a distribution network was established with partners in more than 20 countries from Mexico to Japan, and a producing supplier was identified in Vietnam.

The decision to address only German-speaking customers in the DACH region was based on language barriers, and an expected high effort for the translation of the app into English and other languages. Instead of focusing on countries with high market potential, the German Market was selected as a test region. Hereby, the advice of mentors and support institutions would have been helpful to develop a global business model in the early stage, to avoid building a product only for one specific market. Although future expansion strategies into single markets have already been in planning, this indirect route is highly resource-intensive, slowing down the scaling process.

Mentoring

Both cases demonstrate that the availability of mentors and dealmakers is critical to enhancing the resilient growth of new ventures. In the product development stage, RESTUBE benefited from the personal mentorship of Mo Meidar, a former owner of one of the world's largest machine tool companies. In the discovery phase, both companies were supported by mentors from the university to further develop the ideas into prototypes.

In the ecosystem of Karlsruhe, mentoring through start-up consultants related to assistance in all aspects concerning the daily business of an early-stage start-up was offered, often used by entrepreneurs from all stages. Following the 'Lean Startup' approach, it is crucial to receive feedback from mentors to test the hypothesis. In addition, face-to-face coaching with large enterprises from the region was helpful to work on company culture and setting up contacts with customers.

Financial Capital

The availability of risk capital in a region affects the growth of new ventures positively (Spigel & Harrison, 2018; Velt et al., 2018). However, none of the case companies got an investment from a local VC or even a business angel. This leads to the suggestion that the EE of Karlsruhe may have a lack of financial capital, which can be a barrier for startups to receive funding, not being able to unleash their full growth potential. As heliopas.ai decided to bootstrap the company and declined to search for venture capital, there may be a deficiency of awareness of risk capital in the region. Alternatively, the companies financed their growth in the early stage through public grants. Not being able to raise risk capital from local investors, young companies need to find creative solutions. Due to its growing reach and media presence, RESTUBE could face the financial challenge and receive venture capital from different areas around Germany and the US. In addition, crowdfunding campaigns on Seedmatch and Kickstarter have been conducted which turned out as an important component of the scaling process. Applying for multiple competitions was a strategy for heliopas.ai to receive not only awards but also smart money such as an Amazon Cloud credit in the amount of €90,000.

Availability of Talents

The existence of talent in an EE is considered one of the critical resources (Stam & van de Ven, 2021). As research institutions, universities, and the strong IT industry attract human capital to move to the EE of Karlsruhe, skilled labor is available locally. Being in a competitive situation with other startups and established companies, there is a permanent ongoing fight for talent and it is not easy to recruit the right employees. Computer scientists are aware of this situation and have high salary expectations, which is a disadvantage for startups without a high level of financial capital. In addition, data scientists are rather interested in technical aspects such as data science and neural networks than having any entrepreneurial mindset. Nonetheless, finding a co-founder

with complementary skills worked out well for helioipas.ai through the functioning business networks. In contrast to experts from the IT sector, there is a growing number of specialists with knowledge about design thinking supporting young companies to build customer-centric solutions.

For both case companies, it was a vital strategy to hire cheap but highly qualified working students. Although these processes worked out very well, the result was a growing challenge due to the high fluctuation of student employees and the staff had to be rebuilt permanently. Thereby, a major advantage has been the close connection to the local universities. Having no issues with hiring talents, both companies grew rapidly, leading to miscommunication and dissatisfaction within the teams. Facing these organizational challenges, forced the founders to restructure and reduce the number of employees.

Networks

Local networks are highlighted as important for the resilience growth of EEs, especially in the early phases (Scott et al., 2021). Networks with high connectivity have a strong impact on social-cultural factors such as trust (Shwetzer et al., 2019). Being highly connected to the local EE network, played a key role in the growth of heliopas.ai, enabling multiple opportunities randomly but constantly. As customers are limited in the beginning, networks provide access to special groups of dedicated early adopters that are willing to test prototypes. For RESTUBE some of the events of the entrepreneurial community became irrelevant at some point and attending those played a minor role from then on. As having a unique product, events with a strong focus on only IT and digital startups added no value for them anymore. Hence, related to their specific products and industries, both companies used national and international networks to build personal relationships with customers, organizations, and suppliers. Whereas RESTUBE set up contacts with the global water sports industry, athletes, associations, or event organizers, heliopas.ai identified agricultural advisors and irrigation associations. Those networks have been responsible for the creation of additional business opportunities. Of particular importance have been conferences and fairs to set up direct contacts with companies and other important actors in their industry. Besides the sales activities, the networks were valuable to receive feedback from experts at the senior management level.

Support infrastructure

Support organization and its functioning are essential for the resilient growth of new ventures in a local context (Theodoraki & Catanzaro, 2022). As both cases highlight, supportive programs and start-up consultancy are especially important in the ideation process and early stage. Through support from the university environment, RESTUBE and heliopas.ai could master critical challenges. It can not be excluded that both startups would not have survived the time of exploration until the development of the final product without mentoring and coaching on a variety of topics. During the application process for public grants, valuable support from the university, mentors, and other individuals from the EE lead to the receiving of funding. In tough times, the team of RESTUBE was coached for three months that have been characterized by reflection and optimization.

Both cases illustrate that the support infrastructure needs to provide more services to identify a global business model and assistance in the internationalization process. Therefore, local support actors need to be connected to global acting institutions. As a prime example, the cooperation between actors in Karlsruhe and the German Accelerator worked out well and RESTUBE received deep insights about the US market and contacts to an established network. One weakness of the Karlsruhe ecosystems may be the integration of established companies into the EE networks as those enterprises are not fully engaged in the local community so far. This relevance became apparent as heliopas.ai was able to identify a business model with higher market potential through personal contact with insurers and reinsurers.

Furthermore, the support infrastructure in Karlsruhe provides onramps and access points to the EEs. Through regular meetings such as guest talks, networking events, startup weekends, and hackathons, barriers to participation are reduced, enabling everyone to be part of the community. As entrepreneurs in Germany face bloated bureaucracy and high administrative burdens, more support in these areas would be vitally important.

Access to markets

Enabling access to markets for local startups is considered a major advantage of EEs (Zahra, 2021). This is especially important for smaller ecosystems or emerging countries with lower market potential (Spigel et al., 2020). Both startup cases illustrate that reaching global markets from Karlsruhe is not a large restriction. As the city of Karlsruhe is located in the center of Europe, connections to national and foreign markets such as France and

Switzerland are well-developed. Furthermore, the digital infrastructure of Karlsruhe provides access to global markets easily. Whereas heliopas.ai offered its application over digital platforms such as the Google Play Store, RESTUBE utilized a self-operated online shop to sell its products all around the world. These operations demonstrate that either physical products and hardware but also digital products and services can be distributed without high barriers.

In traditional markets with conservative customers, creative solutions are needed to overcome potential market barriers. In the case of heliopas.ai., providing consulting services was key to building a trustworthy brand before entering the agricultural market with the final product. Besides creating a revenue stream, consulting projects can be door openers toward customer acquisition. Another way to access markets is to establish a network of national and international distribution partners. Thereby, the support through the network and personal contacts were very helpful for RESTUBE to identify the right markets and understand the needs of particular customers while also acting cost-effectively. To test the effectiveness of single distribution channels, multiple experiments can be used to calculate e.g. Customer Acquisition Cost (CAC). In traditional B2B markets, classical approaches like a word-of-mouth strategy and personal referrals among customers may work out to scale in those markets.

6.2.5 Discussion and Limitations

Although following a rigorous process, there are several limitations of the conducted cross-case analysis. First, the study is limited to only two analyzed cases. Therefore, a suggestion for future research is to increase the number of cases to improve the validity and generalizability of the implications. Second, the analysis was conducted at one location as an investigation area. However, to understand the influence of different cultures on the resilient growth of new ventures, it would be needful to build a cross-national analysis (Belitski & Büyükbalci, 2021). Third, one further limitation is that the selected cases are only successful ones. This weakness might potentially lead to a bias, and cases from companies that failed should be included in the investigation (Spigel & Harrison, 2018). Additionally, none of the cases is related to women or senior entrepreneurship. However, to get a holistic understanding of the impact of EE conditions, all types of entrepreneurship should be integrated into the cross-case analysis. As the narrative synthesis has been performed by the author only, it cannot be ruled out

that the judgments are based on his experiences and beliefs on the topic (Cruzes et al., 2015). However, following a rigorous and transparent proceeding is mandatory for conducting high-quality case study research (Yin, 2014).

7 Quantitative Analysis

7.1 Introduction

As the prevalence of high-growth firms is strongly related to the well-functioning of the local EE, it is essential to understand the relative influence of existing elements (Vedula & Kim, 2019; Stam & van de Ven, 2021). Although EE literature has grown tremendously, it remains an open question on how to evaluate an EE, its health, and its resilience (Muñoz et al., 2020; Rocha et al., 2021). The discussion of whether EEs can be quantified and compared via metrics has become the subject of a highly controversial debate (Credit et al., 2018). However, conducting a quantitative evaluation is required to describe the status of an EE and to monitor the effects of individual actions on the EE dynamics (Cho et al., 2022). Empirical data enable researchers, politicians, and decision-makers to differentiate between productive and unproductive entrepreneurship (Audretsch et al., 2021). As single ecosystem elements are highly interdependent, the need for a systems perspective based on a clear analytical framework has been revealed (Alvedalen & Boschma, 2017; Stam & van de Ven, 2021). Consequently, empirical research in the field of EE is underrepresented so far (Sternberg, 2022; Wurth et al., 2022). This lack of an adequate diagnosis approach is considered a critical reason why policymakers often fail in building supportive framework conditions, not learning from previous mistakes (Leendertse et al., 2022).

Over the last few years, there have been multiple attempts to measure the performance and functioning of EEs (Credit et al., 2018; O´Connor & Audretsch, 2022). Thereby, indicators to evaluate the vibrancy of an EE were proposed as density, fluidity, connectivity, and diversity (Stangler & Bell-Masterson, 2015). In particular, density and connectivity are identified as the most impactful to the growth of ecosystems (Taich et al., 2016; Nylund & Cohen, 2017). Coherence and diversity were revealed as critical forces in measurement metrics for EE resilience (Roundy et al., 2017). Further research included network density, multiplexity, modularity, and network centralization to understand the complex social constructs within EEs (Neumeyer et al., 2019). Recently, multiple studies presented frameworks and metrics to define a measurement tool (Liguori et al., 2019; Sternberg et al., 2019; Stam & van de Ven, 2021; Johnson et al., 2022; Perugini, 2022). However, these approaches are not accurate enough to be used as comparable EE metrics (Leendertse et al., 2022). As their applicability is not given in any

geographical context, limiting the generalizability to a large extent (Ligouri et al., 2019; O´Connor & Audretsch, 2022).

7.1.1 Data Challenges and Issues

Approaching the topic of regional EEs and resilient growth empirically, it becomes apparent that data collection and aggregation from multiple sources is challenging in many respects (Szerb et al., 2019; Spigel et al., 2020; Wurth et al., 2022). This issue can be traced back to the fact that there is no requirement for most entrepreneurial ventures to report financial data (Lux et al., 2020). In particular in-depth analyses lack statistically ensured datasets and have difficulties in combining data at all relevant levels and dimensions (Johnson et al., 2022). In recent years, startup activities have increasingly been mapped globally via freely accessible online services, such as 'CrunchBase', 'Dealroom', or 'Startup Genome' (Hannigan et al., 2021; Leendertse et al., 2022). Since the origin of individual data entries is not traceable and therefore also not easily verifiable, data on these platforms provide superficial insights but do not meet the criteria of profound scientific approaches (Wurth et al., 2022). Whereas in some countries such as the Netherlands public accessible data about startup activities exist and can be used for analysis (Stam & van de Ven, 2021), critical discussions illustrate issues with data quality and comparability in the field of entrepreneurship (Sternberg et al., 2019; Muñoz et al., 2020). A comparison of data sources is detecting the limited usage of those metrics (Shwetzer et al., 2019). This issue can be traced back to the fact that no generally accepted definition of what a startup is has been established (Carayannis et al., 2018; Malecki, 2018).

Especially in Germany, statistics on firm foundations are discussed highly critically as being inconclusive and meaningless to conclude on productive entrepreneurship (Struck, 1999; Bonk, 2003). Overall, it appears that a sufficient number of data sources can be used to quantify start-up activities in Germany. These data are either process-produced or sample-based (Hagen et al., 2012). The first category gathers information from publicly mandated reporting processes, e.g. business registration statistics, or is based on research for commercial usage (Sternberg et al., 2015). These include the statistics of the Institut für Mittelstandsforschung Bonn (IfM) and the Mannheimer Unternehmenspanel (MUP). Sample-based datasets instead are reports such as the Global Entrepreneurship Monitor

(GEM), the KfW-Gründungsmonitor, the Microcensus of the Federal Statistical Office of Germany (MZ), the Socio-Economic Panel (SOEP), and the Flash Eurobarometer.

Only on closer examination of the published figures, a distorted and inconsistent picture emerges. For instance, high uncertainty is caused by the use of different definitions and a missing delimitation between the single types of business foundations, resulting in widely divergent startup figures (Bonk, 2003; Spigel et al., 2020). Another point of criticism is that it is not yet possible to document and monitor the impact of concrete actions on the development of single startups (Roundy et al., 2017; Velt et al., 2018). However, this information would be required to analyze not only the success factors but also the possible causes for their abandonment and the impact of the EE on their evolutionary dynamics (Cho et al., 2022). In this case, the Global Entrepreneurship Monitor (GEM) is a partial exception. In addition to the comparison between countries worldwide, the GEM data enables the depiction of different startup stages as a process (Sternberg et al., 2021).

As illustrated, it can be summarized that the existing data material has clear limitations concerning its use as foundation statistics and therefore, are vulnerable to misinterpretations (Brown & Mason 2017; Bruns et al., 2017). On this basis, it is difficult to conduct scientifically sound analyses, forcing researchers to identify and adapt to related indicators and proxies (Stam & van de Ven, 2021; Komlósi et al., 2022). In particular, as company-related data and their chronological sequence are virtually non-existent, only minor conclusions can be drawn about the effectiveness of measures stimulating high-growth firms and local economies such as the EXIST Business Start-up Grant (Kulicke, 2014; Cho et al., 2022).

To sum it up, the existing data material does not meet the requirements of an empirically robust study for analyzing the resilient growth of EEs (Rocha et al., 2021). Future research needs to enhance the exploration and communication of quantitative entrepreneurship (Wennberg & Anderson, 2020). Novel approaches are needed to further develop the EE conceptualization, requiring high quality, validity, and reliability of data (Iacobucci & Perugini, 2021, O`Connor & Audretsch, 2022). As entrepreneurship does not occur in isolation (Shane, 2003), traditional metrics from economics, social outcomes, and welfare may be diluted by other external influences (Bruns et al., 2017; Autio et al., 2018; Ligouri et al., 2019). Recently, empirical studies faced these weaknesses and attempted to measure the functioning of EEs and their resilience by using indicators as proxies instead

(Brown & Mason, 2017). Introducing a new set of measurement criteria and collecting data from start-ups through a questionnaire is considered a promising solution to solve the data quality issue (Liguori et al., 2019). Although understanding the dynamics of start-ups is of paramount importance (Roundy et al., 2017), these descriptive insights are highly valuable to visualize the present state of an EE. As research on EEs and resilient growth requires a longitudinal perspective (Mack & Mayer, 2016; Korber & McNaughton, 2018; Fernandes & Ferreira, 2022), survey-based approaches should be conducted periodically (Sternberg et al., 2019).

7.1.2 The Startup Survey Approach

Multiple attempts to measure and define EEs have evolved recently (Schäfer, 2021; Johnson et al., 2022; Perugini, 2022). However, some of these approaches are using only ecosystem metrics rather than analyzing data from startups (Leendertse et al., 2022). The limitation of currently available data is critical, requiring new kinds of data as well as new data analysis techniques (Credit et al., 2018). Furthermore, future research needs to take a more holistic approach to analyze the interrelationships between entrepreneurship and resilience from a multi-level and longitudinal perspective (Korber & McNaughton, 2018; Scott et al., 2021). Additionally, longitudinal datasets would provide a framework to further develop the evaluation of EEs from a statical to a dynamical level (Leendertse et al., 2022).

The firm performance of entrepreneurial firms is linked to the framework conditions of an EE (Rocha & Audretsch, 2022). Having these in-depth data as outcome parameters facilitates concluding the well-functioning of an EE (Roundy et al., 2017; Spigel & Harrison, 2018; Belitski et al., 2021). More recently, studies have provided evidence of a beneficial effect on entrepreneurial activities (Perugini, 2022). Positive effects of the environmental factors on psychological capital, social capital, and entrepreneurial education within an EE have been observed (Lux et al., 2020). Hence, more ‘bottom-up’ approaches are required that are using data from entrepreneurs and startups to acquire data about the quality of the local EE (Sternberg, 2022). Those proxies can be used to measure EE dynamics (Brown & Mason, 2017). The self-collection of data through a survey of a representative sample of startups is strengthening the understanding of which drivers and barriers foster or hinder the development of EEs (Hernández & González, 2017). As general economic data may be diluted by other external influences (Bruns et

al., 2017), the objective of such an index is to approximate the overall quality of an EE (Leendertse et al., 2022). The firm performance of a startup can be used as a predictor to measure an EE and to derive improvement potential toward higher resilient growth (Lux et al., 2020; Iacobucci & Perugini, 2021). Single characteristics of new technology ventures have been identified as success factors for survival (Song et al., 2008). Thereby, these success factors and the resulting firm performance are correlated to the traits of the surrounding EE (Bouncken & Kraus, 2022; O´Connor & Audretsch, 2022). Overall, the firm performance can be measured by numerous figures including revenue, inventory turnover, return on equity, profit margin, sales growth, liquidity ratio, new patents, and stock prices (Lux et al., 2020). However, indices rely on the availability of economic data, ignoring the specificities of a smaller spatial scale (Brown & Mason, 2017; Perugini, 2022). As most entrepreneurial ventures are not required to report financial data, the study had to be built on the willingness of business owners to provide data voluntarily through the questionnaire survey (Lux et al., 2020). Hence, the firm performance indicator used in the subsequent analysis is defined as a combination of the indicators (1) number of employees, (2) turnover, (3) investment, (4) average annual growth, and (5) the years of survival. Thereby, the performance can be evaluated by innovativeness, productivity, and employment as outcome variables (Acs et al., 2017). Further measurement aspects to include should the creation of jobs, commercialization of new ideas and technologies, and realization of greater market efficiency through competition (Nicotra et al., 2018). According to Lux et al. (2020) the capturing of firm performance can also be done by including (1) the quality of products, services, or programs; (2) the development of new products, services, or programs; (3) satisfaction of customers or clients; (4) marketing penetration; (5) growth in sales; (6) profitability; and (7) market share. Other studies are focusing on qualitative elements such as entrepreneurial narratives, social norms, and entrepreneurial culture (Roundy & Bayer, 2019). Through the measurement of those indicators, conclusions can be drawn about different growth paths (Schäfer, 2021). Similar questionnaire-based studies are using annual growth, turnover, size, and age for the characterization of firm performance (Freitas & Kitson, 2018).

7.2 Hypotheses Development

A quantitative approach is applied when hypotheses need to be tested for confirmation or disconfirmation (Newman et al., 1998). Based on the theoretical framework developed through the findings from the systematic literature review (Henn et al., 2023) and the

insights from the qualitative study about drivers and barriers of EEs in Latin America (Henn et al., 2022a), the following hypotheses are proposed.

Trust

The importance of trust for the evolutionary dynamics of an ecosystem has been identified in various studies (Iansiti & Levien, 2004). For the well-functioning of entrepreneurial processes, the factor of trust is significantly impacting on productive entrepreneurship and the economic outcome (Muldoon et al., 2018; Nicotra et al., 2018). Having a high level of trust between entrepreneurs and local communities is increasing the interactions between all stakeholders, leading to additional opportunities (Munoz et al., 2020; Scott et al., 2021). Thereby, regional entrepreneurial culture and shared norms of behavior are fostering the building of trust within an EE (Thomas & Autio, 2014; Leendertse et al., 2022). A lack of trust is seen as a major challenge for ecosystems in developing countries and a barrier to resilient growth (Quinones et al., 2021; Henn et al., 2022a). Support programs and other community management institutions need to foster trust-building processes (Theodoraki et al., 2018; Belitski et al., 2021).

H_{1a} *Having a high trust in the entrepreneurial ecosystem positively affects the firm performance of startups.*

H_{1b} *Having a high trust in the entrepreneurial ecosystem positively affects access to the entrepreneurial ecosystem*

H_{1c} *Participating in events of the entrepreneurial community positively affects the trust of startups in the entrepreneurial ecosystem.*

H_{1d} *Entrepreneurial culture positively affects the trust of startups in the entrepreneurial ecosystem*

Networks

Recent studies identified networks as crucial for the evolution of effective and thriving local EEs (Scott et al., 2021). EEs with large and well-connected networks tend to be more resilient to shocks (Walsh, 2019). Furthermore, high connectivity among local stakeholders impacts the growth of new ventures and the outcome of the EE (Fernandes & Ferreira, 2022). Strong ties of networks are positively affecting entrepreneurial recycling and re-emerging, having a high impact on regional adaptability and resilience (Walsh 2019; Spigel & Vinodrai, 2021; Wurth et al., 2022). A low level of connectivity is a barrier negatively influencing the birth and growth of new ventures and may reduce EE resilience toward the stage of decline (Hernández & González, 2017; Spigel & Harrison, 2018). Overall, high collaboration is increasing the entrepreneurial resilience

of individuals, ventures, and communities (Fernandes & Franco, 2022), highlighting the intersection between social capital and entrepreneurship (Kim & Aldrich, 2005).

H_{2a}	*Having strong networks in the entrepreneurial ecosystem positively affects the firm performance of startups*
H_{2b}	*Establishing a personal network positively affects the trust of startups in the entrepreneurial ecosystem*
H_{2c}	*Participating in events of the entrepreneurial community positively affects the establishment of a personal network*
H_{2d}	*Establishing a personal network positively affects the exchange with mentors*
H_{2e}	*Establishing a personal network positively affects access to the entrepreneurial ecosystem*

Mentors and Dealmakers

The objective of mentors and dealmakers is to assist entrepreneurial teams in improving their business skills and building localized social capital (Spigel, 2017; Credit et al., 2018). Thereby, young founders can benefit from the long-standing of those businessmen (Lux et al., 2020). Additionally, these agents enhance a vibrant entrepreneurial community, lowering the entry barriers for new projects to join the ecosystem (Stam & Welter, 2020). Dealmakers and mentorship are of high relevance to enable collaborations and connecting the dots within an EE, positively influencing the effectiveness of processes (Shwetzer et al., 2019; Belitski & Büyükbalci, 2021). Acting as intermediaries, both actors are efficiently unleashing potential, especially relevant to following an early internationalization strategy (Theodoraki & Catanzaro, 2022). Relying on the networks of mentors and dealmakers, new ventures can establish high-value relationships with the local business environment to more effectively leverage their resources to improve firm performance (Lux et al., 2020). Furthermore, as the process of entrepreneurial recycling positively influences knowledge transfer and labor mobility after a shock, dealmakers, business advisors, and mentors need to be involved in the EE to a high degree (Brown & Mason, 2017; Spigel & Vinodrai, 2021).

H_{3a}	*Exchanging with mentors positively affects the firm performance of startups.*
H_{3b}	*Relying on the support of dealmakers positively affects the firm performance of startups.*
H_{3c}	*Exchanging with mentors positively affects the trust of startups in the entrepreneurial ecosystem.*
H_{3d}	*Relying on the support of dealmakers positively affects the trust of startups in the entrepreneurial ecosystem.*

H_{3e} *Exchanging with mentors positively affects the internationalization strategies of startups.*

Internationalization

The impact of transnational entrepreneurship on the evolutionary dynamics of EEs became highly relevant in recent discussions (von Bloh et al., 2020; Henn et al., 2022a). Linkages across borders are supportive to overcome existing barriers, leading to a regional advantage for local economies (Schäfer, 2021; Zahra, 2021). The international orientation of high-growth firms stimulates the evolutionary momentum of early-stage EEs, leading to the establishment of a resilient stage (Harima et al., 2021). Thereby, the internationalization mindset of entrepreneurs has to be enhanced already in the early stage (Costa et al., 2022). In addition, the support infrastructure needs to adapt its services and networks to the transnational activities of entrepreneurs, facilitating the expansion of new ventures into global markets (Theodoraki & Catanzaro, 2022). Transcending physical boundaries through international entrepreneurship is beneficial for the transformation into knowledge-based economies (Neck et al., 2004). Following an internationalization strategy, high-growth firms are increasing the growth of resilient EEs (Ryan et al., 2021; Zucchella, 2021).

H_{4a} *Focusing early on internationalization strategies positively affects the firm performance of startups.*
H_{4b} *Focusing early on internationalization strategies positively affects the scalability of the business model.*
H_{4c} *Participating in events of the entrepreneurial community positively affects the internationalization strategies of startups.*
H_{4d} *Relying on the support of dealmakers positively affects the internationalization strategies of startups.*
H_{4e} *Focusing early on internationalization strategies positively affects access to markets.*

Digitalization

For the growth of EEs in an interconnected world, the role of digitalization has been highlighted recently (Bouncken & Krauss, 2022). The impact of digital technologies on how new business creation is proceed has grown significantly nowadays (Elia et al., 2020). Furthermore, these technologies enabled the rise of born-global companies, leveraging their growth processes through an internationalization path (Vadana et al., 2021). Overall, digital entrepreneurship is potentially a promising solution to overcome the obstacles of smaller EEs with high barriers such as limited market potential and

administrative regulations (Quinones et al., 2021; Henn et al., 2022a). Access to global markets through digital networks and platforms can compensate for the vulnerabilities of physical networks (Hernández & González, 2017). In addition, digitalization is fostering the creation of new business opportunities in global markets (Autio et al., 2018; Laudien et al., 2018). Through the high scalability born digitals are characteristic for building early and then rapid international growth (Monaghan et al., 2020). The dynamics of digital entrepreneurship enable new ventures to access external actors and resources (Beliaeva et al., 2019; Xu & Dobson, 2019). In doing so, transnational entrepreneurs are supportive to overcome resource scarcity on a regional level (Harima et al., 2021).

H_{5a} *Having a digital business model positively affects the firm performance of startups*
H_{5b} *Having a digital business model positively affects the scalability of the business model*
H_{5c} *Having a digital business model positively affects access to markets*
H_{5d} *Having a digital business model positively affects the internationalization strategies of startups*

Connections to Universities

Universities and research institutions play a critical role in local economic growth (Bramwell & Wolfe, 2008; Audretsch, 2014). Entrepreneurship education and the entrepreneurial university are widely recognized as drivers and contributors to EEs (Shwetzer et al., 2019). Recent studies have identified that universities are likely to be the focal point of an EE (Miller & Acs, 2017; Motoyama & Knowlton, 2017). Thereby, universities have an important function in attracting young talents to the region and shaping their entrepreneurial intention (Trivedi, 2016; Wright et al., 2017). Delivering entrepreneurship education with a more practice-based approach enables students and researchers to enhance academic entrepreneurship through the foundation of university spin-off ventures (Belitski & Heron, 2017; Sciarelli et al., 2021). Concerning productive entrepreneurship and high-growth firms, the majority of entrepreneurs tend to have at least one university degree (Audretsch et al., 2021). Overall, strong relationships between universities and the industry impact the resilience of local EEs (Bacon & Williams, 2022).

H_{6a} *Having strong connectivity to the local university positively affects the firm performance of startups.*
H_{6b} *Having strong connectivity to the local university positively affects the exchange with mentors*
H_{6c} *Having strong connectivity to the local university positively affects the hiring of skilled employees*

H_{6d} *Having strong connectivity to the local university positively affects access to the entrepreneurial ecosystem*

Entrepreneurial Culture

For the creation of strong sustainable EEs, the importance of regional entrepreneurial culture has been highlighted recently (Bischoff, 2021). Hence, culture is a key element in common EE frameworks (Donaldson, 2021). Entrepreneurship culture is the degree to which entrepreneurship is valued in a region (Stam & van de Ven, 2021). Thereby, the role of culture and norms on local entrepreneurial activity is depending on several civil society indicators (Audretsch et al., 2021). New adaptive capabilities are needed to shape the regional culture and the mindset of the local society toward an entrepreneurial orientation (Venkataraman, 2004; McNaughton & Gray, 2017). Entrepreneurial behaviors catalyze the environment toward an increasing emergence of high-growth firms as an outcome indicator (Donaldson, 2021). In particular, cultural settings combined with talents and adequate support services enhance entrepreneurial output (O´Connor & Audretsch, 2022).

H_{7a} *Having an entrepreneurial culture within the region positively affects the firm performance of startups*

H_{7b} *Having an entrepreneurial culture within the region positively affects the raised equity capital of startups*

H_{7c} *Having an entrepreneurial culture within the region positively affects the focus on productive entrepreneurship*

As the outcome of entrepreneurship is not predictable, the support of young companies is of paramount importance (Theodoraki & Catanzaro, 2022). Having a functioning support network at a local level can enhance productive entrepreneurship, avoiding a high number of unproductive entrepreneurship and informal entrepreneurial activities (Audretsch et al., 2021). The existence of multiple support organizations and services enhances competition, improving the quality of the support infrastructure in total (Theodoraki et al., 2018). However, if there is no close link between the support infrastructure and high-growth firms, resources tend to leave for other places (Harima et al., 2021). Concerning the evolutionary path of EEs, support infrastructure has to be tailored to the growing needs of stakeholders to permanently set new impulses for reinvigoration (Mack & Mayer, 2016; Bischoff, 2021). By testing the hypothesis summarized in Table 4 and deriving valuable insights, this study aims to increase the understanding of how local support infrastructure can enhance productive entrepreneurship.

Table 4. *List of the hypothesis derived from the previous studies*

Category	***H_n***	***Hypotheses***
Trust	H_{1a}	*Having a high trust in the entrepreneurial ecosystem positively affects the firm performance of startups*
	H_{1b}	*Having a high trust in the entrepreneurial ecosystem positively affects access to the entrepreneurial ecosystem*
	H_{1c}	*Participating in events of the entrepreneurial community positively affects the trust of startups in the entrepreneurial ecosystem*
	H_{1d}	*Entrepreneurial culture positively affects the trust of startups in the entrepreneurial ecosystem*
Networks	H_{2a}	*Having strong networks in the entrepreneurial ecosystem positively affects the firm performance of startups*
	H_{2b}	*Establishing a personal network positively affects the trust of startups in the entrepreneurial ecosystem*
	H_{2c}	*Participating in events of the entrepreneurial community positively affects the establishment of a personal network*
	H_{2d}	*Establishing a personal network positively affects the exchange with mentors*
	H_{2e}	*Establishing a personal network positively affects access to the entrepreneurial ecosystem*
Mentors & Dealmakers	H_{3a}	*Exchanging with mentors positively affects the firm performance of startups*
	H_{3b}	*Relying on the support of dealmakers positively affects the firm performance of startups*
	H_{3c}	*Exchanging with mentors positively affects the trust of startups in the entrepreneurial ecosystem*
	H_{3d}	*Relying on the support of dealmakers positively affects the trust of startups in the entrepreneurial ecosystem*
	H_{3e}	*Exchanging with mentors positively affects the raised equity capital of startups*
	H_{3f}	*Exchanging with mentors and dealmakers positively affects the internationalization strategies of startups*
International	H_{4a}	*Focusing early on internationalization strategies positively affects the firm performance of startups*
	H_{4b}	*Focusing early on internationalization strategies positively affects the scalability of the business model*
	H_{4c}	*Participating in events of the entrepreneurial community positively affects the internationalization strategies of startups*
	H_{4d}	*Focusing early on internationalization strategies positively affects the hiring of skilled employees*
	H_{4e}	*Focusing early on internationalization strategies positively affects access to markets*
Digitalization	H_{5a}	*Having a digital business model positively affects the firm performance of startups*
	H_{5b}	*Having a digital business model positively affects the scalability of the business model*
	H_{5c}	*Having a digital business model positively affects access to markets*
	H_{5d}	*Having a digital business model positively affects the internationalization strategies of startups*
University	H_{6a}	*Having strong connectivity to the local university positively affects the firm performance of startups*
	H_{6b}	*Having strong connectivity to the local university positively affects the exchange with mentors*

	H_{6c}	*Having strong connectivity to the local university positively affects the hiring of skilled employees*
	H_{6d}	*Having strong connectivity to the local university positively affects access to the entrepreneurial ecosystem*
Culture	H_{7a}	*Having an entrepreneurial culture within the region positively affects the firm performance of startups*
	H_{7b}	*Having an entrepreneurial culture within the region positively affects the raised equity capital of startups*
	H_{7c}	*Having an entrepreneurial culture within the region positively affects the focus on productive entrepreneurship*

7.3 Methodology

Empirical research is an approach to testing objective theories and validating or falsifying hypotheses by examining the relationship among variables (Newman et al., 1998; Creswell & Creswell, 2017). For quantifying the impact of independent and dependent variables, quantitative research provides objective measurement techniques (Punch, 2013; Bougie & Sekaran, 2019). To this end, data can usually be derived from different sources (Johnson & Christensen, 2012). As data in the field of EE is largely opaque, forcing researchers to identify and adapt to related indigenous indicators and collect them (Liguori et al., 2019; Stam & van de Ven, 2021).

Using a questionnaire as a standardized survey instrument is an efficient mechanism for systematic data collection (Krosnick, 2018). The process of quantitative analysis followed the recommendations of designing and using a research questionnaire (Rowley, 2014). This process included the development of (1) the objective and framework, (2) the determination of items and wording of questions, (3) the design of response options and rating scales, and (4) the design of the questionnaire and arrangement of questions. Thereby, relying on upon already applied and validated questionnaire items and constructs, whenever possible, is the preferable option (MacKenzie et al., 2011; Song et al., 2015). Potential items have been identified in similar studies such as Cowell et al. (2018), Freitas & Kitson (2018), Velt et al. (2018), Colombelli et al. (2019), Liguori et al. (2019), Lux et al. (2020), and Audretsch et al. (2021). In case appropriate questionnaire items are non-existent in the literature, new survey questions need to be derived for those parts (Bischoff, 2021). To cover all relevant parts, further items were generated, avoiding open-ended questions (Slattery et al., 2011; Rowley, 2014). Relying on a five- or seven-point Likert scale based on individual perceptions of the participants guaranteed the clarity of responses, preventing any misinterpretations of open formulations (Likert,

1974; Brace, 2018). In addition, Likert scales were recognized as an effective and easily understandable approach in quantitative research, especially suitable for online surveys (Bishop & Herron, 2015; Subedi, 2016). Another advantage is that Likert scales allow for dealing with a large quantity of data, beneficial for data coding and data analysis (Li, 2013). To follow a powerful parametric statistical treatment, the ranges used in this study were selected from 'strongly disagree' to 'strongly agree' (Jamieson, 2004; Cohen et al., 2011; Bishop & Herron, 2015). Additionally, survey structures based on the Likert scaling support construct measurement and validation procedures and enable adapting easily after the pre-testing phase (MacKenzie et al., 2011; Li, 2013).

7.3.1 Design of the Questionnaire

As mentioned above, the basis for this quantitative analysis was built on the previous version of the Harmonized Instrument Initiative (HII) survey, which has been developed within a joint research project of the TU Berlin, TU Munich, and the Karlsruhe Institute of Technology (Deubel, 2012). The main objective was to create a standardized data collection tool for tracking the evolution of technology-based ventures so that it is enabled to compare the statistics from different places. The questionnaire design consisted of six sections, including 45 single questions to collect data from startups about their characteristics, activities, and strategies. As it is intended to conduct the HII survey periodically, the objective of the project is to create a longitudinal database of startups from one EE (Henn et al., 2015). Having data over a horizon of several years is a key requirement for understanding how EEs develop, evolve, and may increase their resilience (Spigel & Harrison, 2018). During the last years, the survey was conducted in the TechnologyRegion of Karlsruhe, receiving 65 returns in 2015 and 97 in 2017. The scientific conceptualization of the project and the first descriptive findings were presented at the *'Gforum'* Conference 2015 in Kassel, Germany (Henn et al., 2015). By analyzing the findings from those years, weaknesses were identified, leading to the further development of the questionnaire tool. Additionally, a previous quantitative study about the support infrastructure for knowledge-based startups in the region of Karlsruhe has been evaluated (Rabe, 2005). Furthermore, specific questions from similar studies about startup activities such as the 'Deutscher Startup Monitor' (Kollmann et al., 2021) and the 'KfW Gründungsmonitor' (Metzger, 2021) were integrated into the questionnaire design. In doing so, it was possible to contextualize data from the EE of Karlsruhe to general

data, increasing the validity of the findings (Ligouri et al., 2019). However, the absence of comparable indicators has been identified as a major weakness in EE research (Sternberg et al., 2019, Stam and van de Ven, 2021), limiting its generalizability (Carayannis et al., 2018). The final questionnaire design (see Appendix A2) was presented to the scientific community at the RADMA Conference 2022 in Trento, Italy (Henn et al., 2022b). In total, the survey instrument consists of 39 single questions, arranged into seven main categories to cover all relevant aspects to analyze the status quo of an EE descriptively and to test the hypotheses outlined in Chapter 7.2. Subsequently, the questionnaire was transferred into a digital version using the platform 'soscisurvey'. This web application was chosen because of its orientation toward scientific use cases, its integration with statistical software solutions, and its fulfillment of the data security regulations of Germany (DSGVO). To avoid any language barriers concerning the target group (Lynn, et. 2008), the questionnaire has been translated into German as well, and therefore, presented in both languages.

7.3.2 Pre-Test

Subsequently to completing the questionnaire design, the capability and usability of the survey instrument have been reviewed by conducting different types of pretests. Thereby, the combination of traditional and newer methods improved the data quality of a 'modern survey approach' (Geisen & Murphy, 2020). As multiple scientific studies emphasized the importance of pretesting to determine the quality and effectiveness of a questionnaire design (Bowden et al., 2002; Krosnick, 2018), its role in empirical research is critical (Sudman & Bradburn, 1982). This formal evaluation is a prerequisite before carrying out the main survey, no matter how closely the questionnaire construction is oriented on recommendations based on best practice examples (Krosnick, 2018). However, a pretest is not only a single task, but also a set of procedures to ensure the quality of the survey instrument (Buschle et al., 2022). By following an 'optimal mix' of pretesting methods, five approaches can be applied to reduce and even avoid any potential bias (Geisen & Murphy, 2020). These methodologies include pilot testing, expert reviews, cognitive interviewing, usability testing, and online pretesting. In doing so, the four main aspects of reliability and validity, linguistic and content-related comprehensibility of questions, the avoidance of duplications, and specific data-gathering problems could be reviewed (Atteslander, 2008). In addition, all facets of the questionnaire need to be checked

including question content, wording, sequence, form and layout, question difficulty, and given instructions (Grover & Vriens, 2006). As a growing awareness of 'flaws' in conventional pretesting led to changes, further procedures and indicators should be considered such as response latency, expert panel, behavior coding, re-interview, and reconciliation method (Morton et al., 2008).

Overall, the original version of the HII survey has been already of high quality as its questionnaire design has been evaluated thoroughly at the time of its development (Deubel, 2012). In addition, the HII questionnaire has been applied in practice, which has proved its usability (TU Berlin, 2014; Henn et al., 2015; Fajga, 2020). For the pretest of this study, the online version of the advanced questionnaire design was utilized. Thereby, the process followed a multi-step approach, using both qualitative and quantitative pretesting techniques. The process included informal methods, expert reviews, cognitive interviews, and a field test under real-life conditions with a limited number of participants (Campanelli et al., 2008). In the beginning, informal tests were appropriate to check the general design and layout of the questionnaire (Brancato et al., 2006; Geisen & Murphy, 2020). Therefore, several meetings with scientific staff members from the EnTechnon institute and graduate students from the Karlsruhe Institute of Technology were conducted and the comments were transcripted in a protocol. Using guiding questions was beneficial to evaluate the content validity and the completeness of elements (Rammstedt, 2004; Ikart, 2019). As a next step, the questionnaire design was sent to experts in the field of EEs with a research, university, or startup consultant background. Consequently, the artifact was reviewed from a methodological, scientific, and industrial perspective to receive feedback about its scientific merit (Campanelli et al., 2008). Subsequently, cognitive interviews were applied using the Three-Step Test-Interview (TSTI) framework (Noël & Prizeman, 2005; Hak et al., 2008). This instrument is based on declared pretests in which respondents are informed about the circumstances and the request to search for potential weaknesses (Babonea & Voicu, 2011). Therefore, a special function of the online survey tool was used, enabling the participants to write down comments after every single question. In total, five observation-based sessions were conducted with actual entrepreneurs by utilizing the technique "think-aloud". Thereby, the participants completed the questionnaire for their company and spoke out loud if there was any ambiguity. Their behavior was recorded precisely, followed by a feedback session to get a report on the thoughts of the participant afterward (Hak et al., 2008). As

a final step, a sample of 20 respondents was selected from the list of potential startups to further identify and eliminate potential problems in the real scenario (Grover & Vriens, 2006). The pretest group consisted of founders with similar characteristics to the actual target group (Diamantopoulos et al., 1994). For these real-life pre-tests, the participants filled out the questionnaire in the same manner as the actual survey, not being informed about the pretest situation. In doing so, the objective was to determine the 'flow' of the survey, whether the underlying patterns work, how much time was needed to fill out the questionnaire, and the termination rate (Babonea & Voicu, 2011).

In conclusion, major improvements were made through (1) a reduction of length by decreasing the number of questions, (2) re-wording several questions due to a lack of clarity and understanding, (3) adjusting and adding response options, (4) specifying the descriptions of the different survey sections, (5) re-adjusting of the section descriptions, (6) adapting the types of questions and the formal layout and (6) inserting definitions for better understanding. The final version of the questionnaire design used for the data sampling and collection phase is provided in Appendix A2.

7.3.3 Data Collection

As the existing data about startups and EEs are not fulfilling the requirements of in-depth quantitative analyses, data have to be collected that was not available elsewhere (Freitas & Kitson, 2018; Sternberg et al., 2019; Szerb et al., 2019; Audretsch et al., 2021; Bischoff, 2021). To ensure the validity and reliability of the quantitative research approach, targeted questionnaire participants had to be selected. As the quantitative analysis took place in the regional EE of Karlsruhe and no detailed list of potential startups existed so far, a database had to be created by scraping manually. Due to the insufficient data situation, even local administrations were not aware of the ongoing entrepreneurial activities. Hence, three strategies for building a comprehensive database have been pursued, beginning already in 2014.

First, existing lists of startups have been transformed and useful information extracted. These lists contained mainly new technology-based firms and young companies out of the university context identified through consulting services and scholarship programs such as KEIM and EXIST (Kulicke, 2015). Secondly, through conducting a structured search process for existing companies using Google Search, business platforms, i.e. Linkedin, and websites from the local entrepreneurial community, ie. startupska.de.

Furthermore, concrete websites of institutions and organizations related to the local EE of Karlsruhe have been monitored. These included for instance publicly accessible data on the websites from the CyberForum, the Center for Interdisciplinary Entrepreneurship (CIE), the energy accelerator AXEL, the student initiatives PionierGarage, and Enactus, and the [x]Lab from the University of Applied Sciences. Additionally, direct contacts to the WiFoe Karlsruhe and the DHBW studies 'Unternehmertum' as well as the trawling of newspaper articles and blog archives led to further entries in the database. In addition, locations in which young companies are likely to have their office space have been considered, namely the 'Alter Schlachthof' including the Perfect Future and the FUX building, the Technologiefabrik Karlsruhe, RaumFabrik Durlach. Thirdly, appearing new projects and young firms that joined the ecosystem through events, competitions, or educational programs were recorded straight away. For all the entries all relevant information, if available, was directly included in the sheet with data points about the founding team, contact details, website, trade register excerpt, and so on. In doing so, a database with approximately 1,000 startups from the last 20 years as entries was created, building the fundamental basis for the following data-collecting processes.

To select the companies to invite to participate the database needed to be adjusted. Due to the short lifecycle of new ideas and a high death rate in young companies, more than 500 companies were not existing anymore. Furthermore, companies older than 10 years and firms that were not fulfilling the definition of a startup, e.g. companies only focused on website building or consulting services, were excluded. In total, 380 founders have been contacted in the first round, sending a reminder after two weeks. By following this strict process and only inviting pre-selected companies, the responses could be controlled and guaranteed, leading to the high quality and reliability of the responses (Toepoel & Schonlau, 2017). Furthermore, a high response rate of 25 percent could be achieved due to personal invitations and a functioning network. A public call would lead to an uncontrollable situation where the responses are not controllable anymore. It can not be secured if those respondents are startups or not which may dilute the data quality. The focus on a regional ecosystem and the personal contact with the founders there increases the quality of the data or makes it possible to obtain them in the first place. The spatial proximity to the study area helps to assess and interpret the data correctly. Although certain limitations will arise in the course of the study, of which one should be aware, a clear "research opportunity" can be seen here. Overall, the survey was conducted over a

30 consecutive days period in April and May 2022. Thereby, the comparison between early and late respondents revealed no substantive differences across all study variables, supporting the representativeness of the sample (Dalecki et al., 1993; Lux et al., 2020).

7.3.4 Data Preparation and Data Analysis

The online questionnaire tool 'soscisurvey' enables a direct export of the collected data in several file formats. Regarding the documentation for the data preparation, the data set was automatically transformed to the format of the statistical analysis program SPSS Statistics. Thereby, the software tool defined variables correctly by using the corresponding question as a basis. Subsequently, the software SPSS was used for conducting the descriptive data analysis as well as the correlation analysis. However, before being able to analyze the raw survey data, initial steps to prepare the data properly have to be conducted (Raaijmakers, 1999). Therefore, the process of data preparation included identifying the scale of measurement, handling missing survey data, and discovering inconsistent as well as careless responses (Huang et al., 2012; Meade & Craig, 2012; Akbulut, 2015).

In the first step, all open questions of the questionnaire had to be transformed into a scale of measurement (Rowley, 2014; Dawaele, 2018). This includes the amount of equity capital the companies raised and which of the international markets are the most significant ones. As data without any absence of values is a requirement for most statistical techniques, sophisticated methods of dealing with missing data had to be applied (Raaijmakers, 1999; Brosius, 2013). Although single non-responses are not diluting the reliability of the descriptive analysis part, the completeness of data is a prerequisite of the correlation analysis (Krosnick, 2018).

To deal with the data issues, two techniques of treating missing data have been taken into account, namely deletion and imputation (Little, 1998; Toepoel & Schonlau, 2017). Therefore, in the first step, five of the responses were excluded from the sample as not fulfilling the minimum percentage of answered questions. In the second step, five additional responses were deleted as not answering the necessary parts for testing the hypotheses. In contrast to deletion, the process of imputation replaces missing values by the mean of the particular variable or by forecasting through the regression of other explanatory variables (Toepoel & Schonlau, 2017). As this study has a limited reference

quantity, through imputation it has been possible to keep the number of responses at a high level (Black & Babin, 2019).

From the 104 database entries, a total number of 93 participants worked through the questionnaire up to the last page, representing a processing quota of 89.4 percent. Thereby, the responding entrepreneurs completing the survey have used both language versions, but mainly German (89) instead of English (4). As Table 5 shows the average duration to fill out the questionnaire has been 562.09 seconds, which is just below the promised ten minutes of processing time. This show that the pre-test did great preparatory work, explaining the very low dropout rate.

Table 5. *Processing time of the respondents*

	N	Min	Max	Mean	Std. Dev.
Processing time (except outliers)	93	242	895	562.09	154.844

Although the study has to deal with missing values, the data density can be considered at a high level. Table 6. shows that the highest amount of missing values within one single questionnaire has been 34 percent. On average, only 3.78 percent of the fields were not filled out, providing a valid database for the following analysis.

Table 6. *Missing values*

	N	Min	Max	Mean	Std. Dev.
Missing values (expect outliers)	93	0	34	3.78	5.060

By applying the *'missing completely at random'* (MCAR) test of Little (1988), it could not be refuted that any patterns or relationships were underlying the missing values. Thereby, the Little MCAR analysis conducted with SPSS provided the following test results: Sig. = 0.235, DF = 74, and $\chi_2 = 82.439$). As the ρ-value was $p < 0.05$ the null hypothesis that the missing values are random could not be accepted. To prepare the data comparably and transparently for the subsequent descriptive and correlation analysis, the sample was checked and outliers that have a high percentage of missing values were excluded. In a further step, all responding companies that were not fulfilling the startup definition of being still younger than 10 years have been removed additionally. By following this strict process, the sample had to be reduced to a final number of 84 respondents. Nevertheless, this data sample provided a good data basis, slightly above the

65 responding companies of a comparative study about the EE of Mannheim, Germany (Gilde et al., 2020).

7.4 Descriptive Analysis

The evaluation part begins with conducting a descriptive analysis of the collected data enables the investigator to outline the findings of the data and make conclusions on the fundamental research objectives (Thompson, 2009). The analysis includes a graphical illustration question-by-question based on frequency distributions and percentages. Among others, frequency tables and mean values are used to represent the evaluation methods as well as to illustrate the distribution independently from the particular measurement level (Schnell et al., 2013). In addition to the tables, graphics (bar charts and pie charts) are used to display the data result in an adequate and clear presentation, easy and uncomplicated to understand from the reader´s perspective (Kopp & Lois, 2014). Furthermore, if possible and reasonable, the data is aggregated using the key clusters, patterns, and characteristics. In doing so, the outcome of the survey is presented using descriptive, inferential, and correlation analysis. Finally, tables, figures, and diagrams are discussed subsequently regarding the insights about EE resilience and its theoretical conceptualization from the previous studies.

7.4.1 General Information

In Part A of the questionnaire general information about the startup has been collected. Thereby, Figure 15 shows that the sample of respondents in all surveys consists mostly of younger companies with a strong decrease concerning aging. In the survey of 2022, over half of the startups have been founded in 2020 and after, meaning that they have been younger than two years. Consequently, the average firm age in the sample is 2.7 years. Overall, the numbers are comparable to the descriptive statistic of similar relevant studies such as the ‘Deutscher Startup Monitor’ (DSM) (Kollmann et al., 2021) and thus, this data distribution can be considered representative of general entrepreneurial activities in Germany. Furthermore, these figures show that in the EE of Karlsruhe new companies emerge permanently, leading to the conclusion that the processes of searching and identifying new business opportunities and translating those ideas into practice are functioning. The fact that new technology ventures (NTVs) have only a limited survival rate, because of abandoning or acquisition, lies in the nature of things (Song et al., 2008).

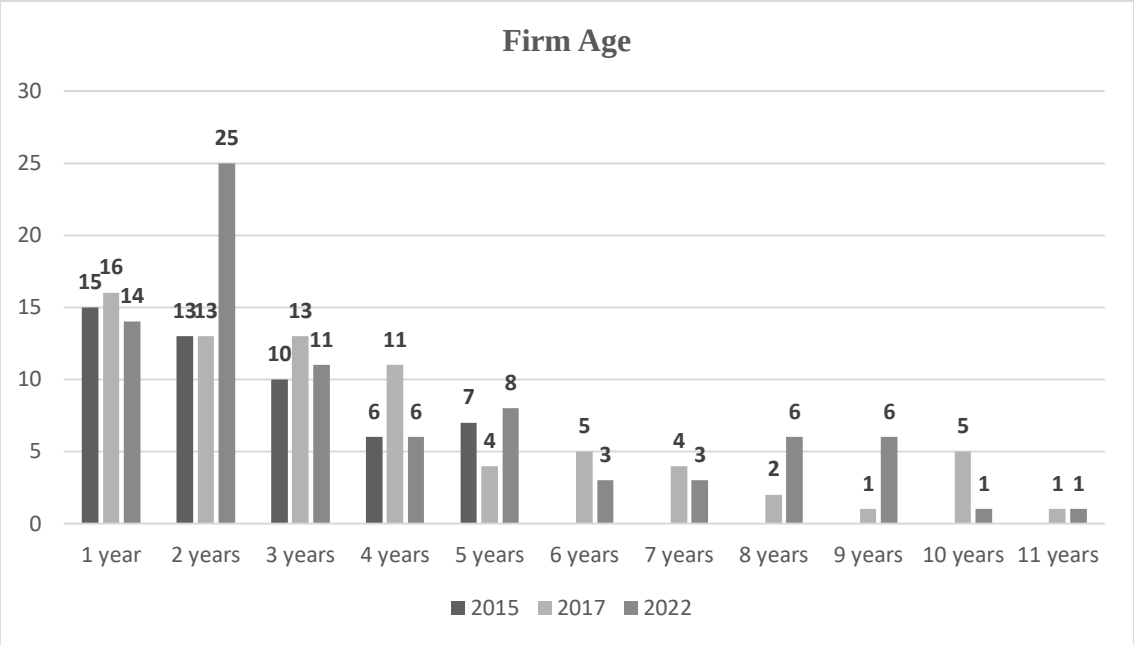

Figure 15. *Firm age of the startups*

Equally to the average firm age of the startups, the distribution of the development phases demonstrates the predominant existence of younger firms. The majority of the responding companies (65.9%) classified themselves into the project, pre-seed, and seed stages. However, the data shows that the growth stage (32.9%) is the largest individual category. According to the DSM, the number of German startups in the early stages is higher (74.1%) than in the sample (Kollmann et al., 2021). This fact demonstrates that a not-inconsiderable amount of startups in the EE of Karlsruhe are following a high-growth strategy, facilitating productive entrepreneurship in the region.

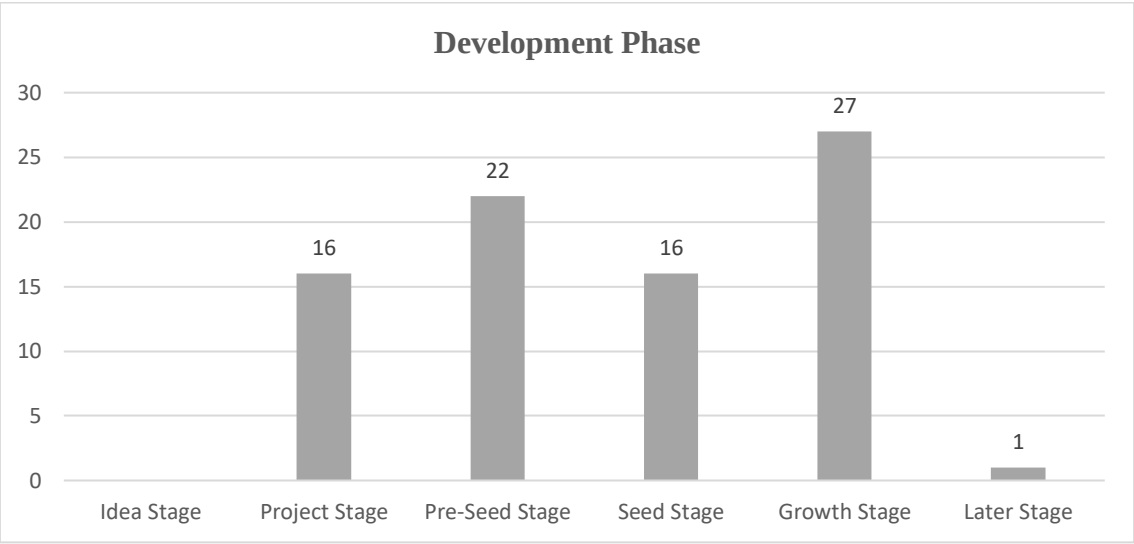

Figure 16. *Development phases of the startups*

The vast majority of the responding startups in 2022 are registered as private limited companies. Thereby, the favorite options for founders are the legal status of a 'GmbH' and the smaller version 'UG' with in total of 72.6%. As these choices of company registration indicate a certain level of seriousness and ambition, the commitment of entrepreneurs in Karlsruhe can be highlighted. Furthermore, this stands in contrast to the numbers in Berlin where only one-third of the new ventures are registered as private limited companies (TU Berlin, 2014). Thereby, the larger percentage of freelancers (43%) can be traced back to the focus of entrepreneurial activities in the fields of media, art, culture, and design. Overall, having a larger number of ambitious firms in the EE of Karlsruhe can be seen as a tendency toward high-growth and productive entrepreneurship.

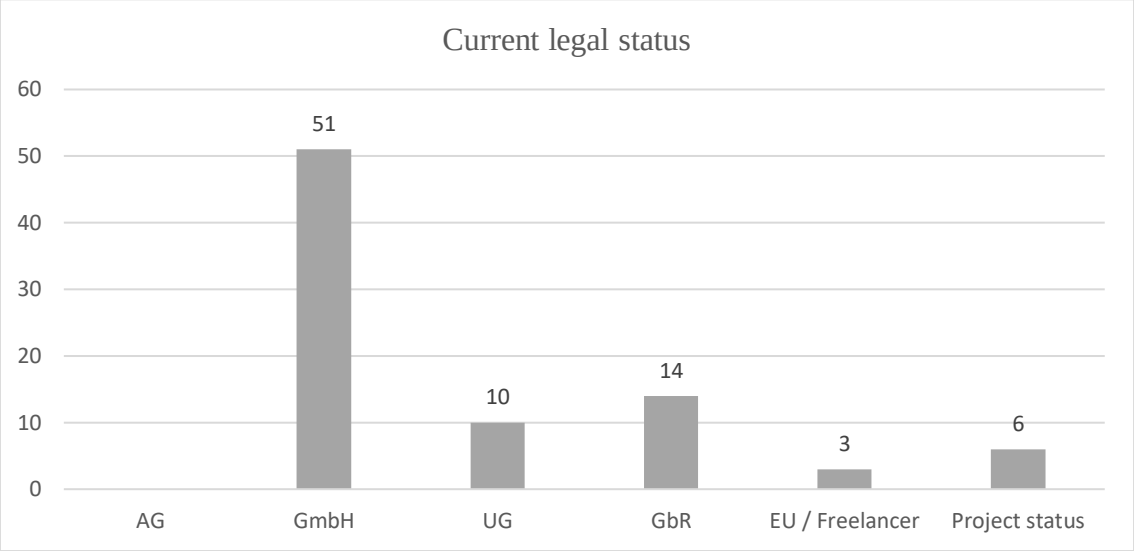

Figure 17. *The current legal status of the startups*

The importance of information and communications technology (ICT) for the EE of Karlsruhe is pointed out in Table 7. As approximately half of the responding startups (51.2%) are strongly assigned to the IT sector, this industry field can be pointed out as a focal point of the local EE, highly relevant for the well-functioning and further development toward a higher resilience. Overall, this accords with the general trend in the German startup landscape in recent years as most young companies are meanwhile related to the sectors of IT and software (Bitkom, 2021; Startup Detector, 2021). Although the '*DSM'* ranked ICT as the largest industry sector likewise, the percentage of 30.5% is still lower than in the EE of Karlsruhe (51.2%) (Kollmann et al., 2021). This fact confirms the assumption of the outstanding relevance of IT for the local entrepreneurial processes. Furthermore, the fields of electrical engineering (13.1%), consulting (11.9%), mechanical

engineering (10.7%), and marketing/media (10.7%) are contributing to the emergence of startups. The high number of technology-based firms is supporting the image of Karlsruhe as being a hub for DeepTech, differentiating the EE from other startup locations around Germany (Henn & Terzidis, 2019). In comparison, the software and ICT sector in Berlin is not as predominant (18%), being on the same level as the field of media, art, and culture (Fajga, 2020).

Table 7. *Industry distribution of the startups*

	N	Percent of Cases
IT / Internet / Web 2.0	43	51.2%
Others, namely	14	16.7%
Electrical Engineering / Telecommunications	11	13.1%
Consulting	10	11.9%
Research	10	11.9%
Marketing / Media	9	10.7%
Mechanical Engineering / Vehicle Manufacturing	9	10.7%
Trade Sector	7	8.3%
Construction / Architecture / Planning	6	7.1%
Environmental Technology / Water	6	7.1%
Medical Technology	6	7.1%
Social / Health Sector	6	7.1%
Art / Culture	5	6.0%
Chemical / Pharmaceuticals	5	6.0%
Education	4	4.8%
Energy Sector	4	4.8%
Biotechnology	2	2.4%

A close relationship with local universities and its impact on entrepreneurial activities. can be a potential driver for the emergence and high growth of tech startups (Motoyama & Knowlton, 2017; Wright et al., 2017). According to the *Deutscher Startup Monitor*, the Karlsruhe Institute of Technology (KIT) is a highly founder-friendly university, ranked in the Top 5 in Germany for several years (Kollmann et al., 2021). In cities with excellent universities and research institutions, such as Heidelberg or Karlsruhe, the startup density is above average (startupdetector, 2021). Although the responding entrepreneurs rate the connectivity to the local universities on average as slightly positive, a considerable number of companies in Karlsruhe have only a very low relationship with those institutions (see Figure 18). For EE diversity, it is of high importance that more sources for the creation of startups exist, not only depending on spin-offs from the university context. Nevertheless, in general, universities and research institutions are fundamental

drivers for entrepreneurial activities and the attraction of talent to the region (Miller & Acs, 2017).

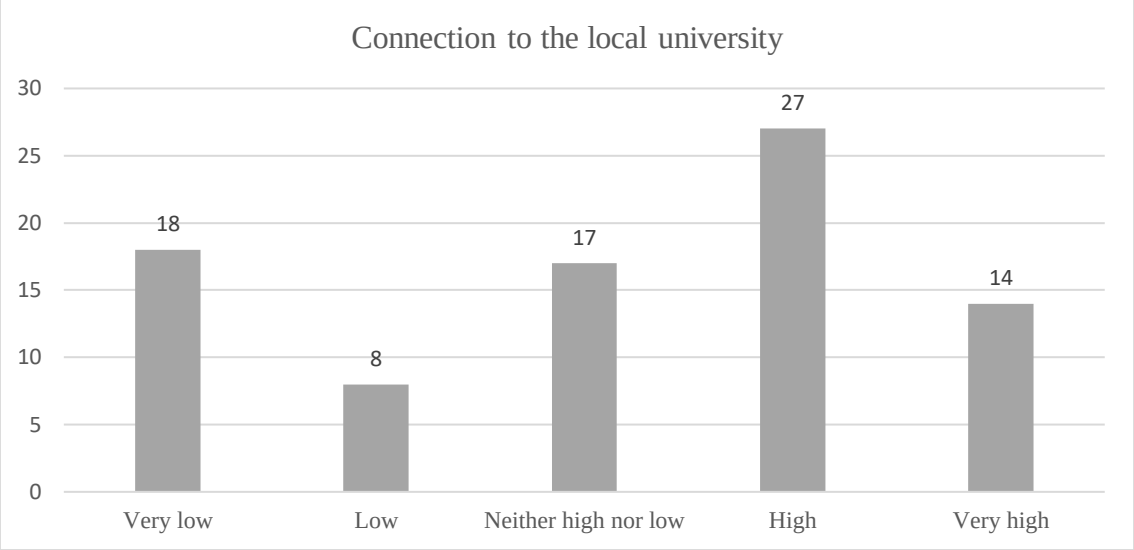

Figure 18. *Connectivity to the local university*

As Figure 19 shows the vast majority of the responding companies have not reached a significant amount of annual turnover. Additionally, less than half of the startups (42.9%) have already achieved operating profits in one of the previous years. These numbers are confirming the previous findings that the responding startups are mainly still in the early stage, generating less than 250,000€ in revenue per year. Only less than 15 percent of the firms have surpassed the barrier of 500,000€. In the EE of Berlin, a quarter of the local startups achieved a revenue stream above this limit (Fajga, 2020). However, the distribution curve of Karlsruhe is largely comparable with other EEs (startupdetector, 2021).

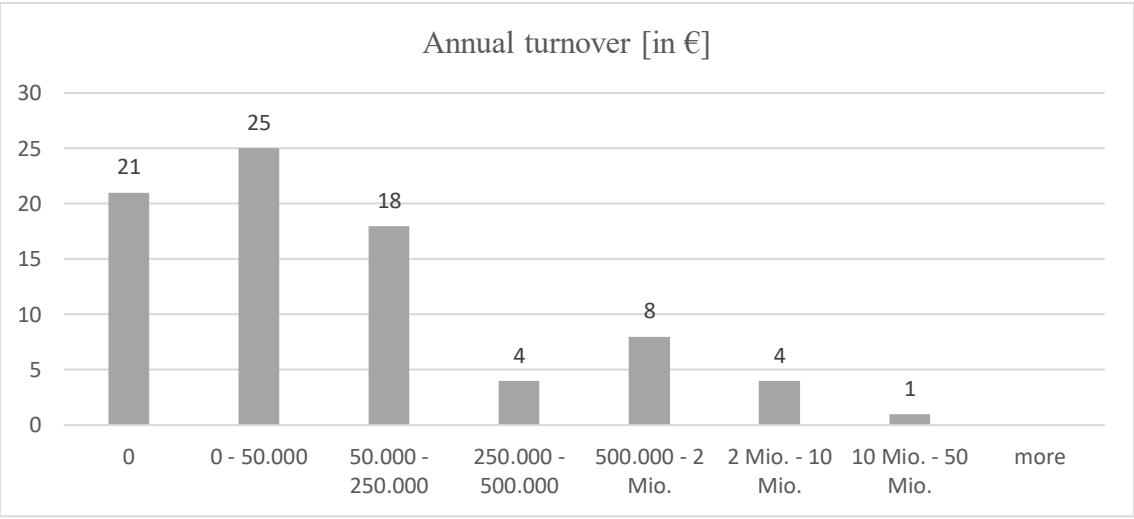

Figure 19. *Annual turnover of the startups in the last year*

Furthermore, Figure 20 indicates that the majority of the responding companies are following a conservative growth strategy. A remarkable number of twenty-two firms (are planning with a zero-growth rate, not applying a business model that is built on scaling not having started to do so. This fact reveals that only a few of the new ventures in the sample show significant growth potential and can be considered high-growth firms. As the majority of startups are in the early stage, it is a challenge to work on the proof-of-concept before addressing the scaling potential.

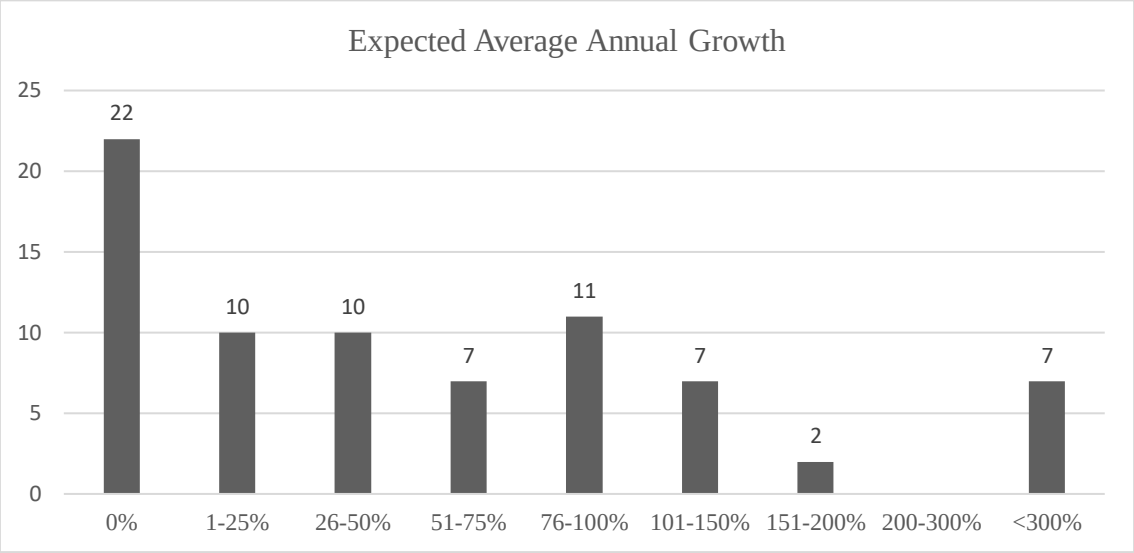

Figure 20. *Average Annual Growth*

The numbers of both Figures 21 and Figure 22 show that in the EE of Karlsruhe the applied business models are focused mainly on business-to-business (B2B) and the providing of services. Nevertheless, the longitudinal data analysis points out that the distribution may shift slightly towards product-based business models over the last years. Whereas in 2017 the startups made 72.1% of the revenues based on services, the number decreased to a percentage of 56.6% in 2022. One reason for this development may be the Covid-19 pandemic and its restrictions. Throughout it has been complicated to carry out services and more and more startups tended toward selling just products. As established companies were acting more risk-aware during the crisis and cutting their budget, the overall sum of business-to-business sales decreased likewise (Kollmann et al., 2021). Although the total number of new ventures with a focus on B2B is still at a very high level, it has been observed all around Germany recently that new ventures are trending to aim directly at customers (startupdetector, 2021). In comparison to these data, the *'DSM'* pointed out the dominant role of the B2B sector in the German startup landscape with

two-thirds (68.7%) of the overall revenues (Kollmann et al., 2021). In general, the focus of business models based on B2B and services can be summarized as key characteristics of the EE of Karlsruhe. Related to the economic power of the region (Henn & Terzidis, 2019).

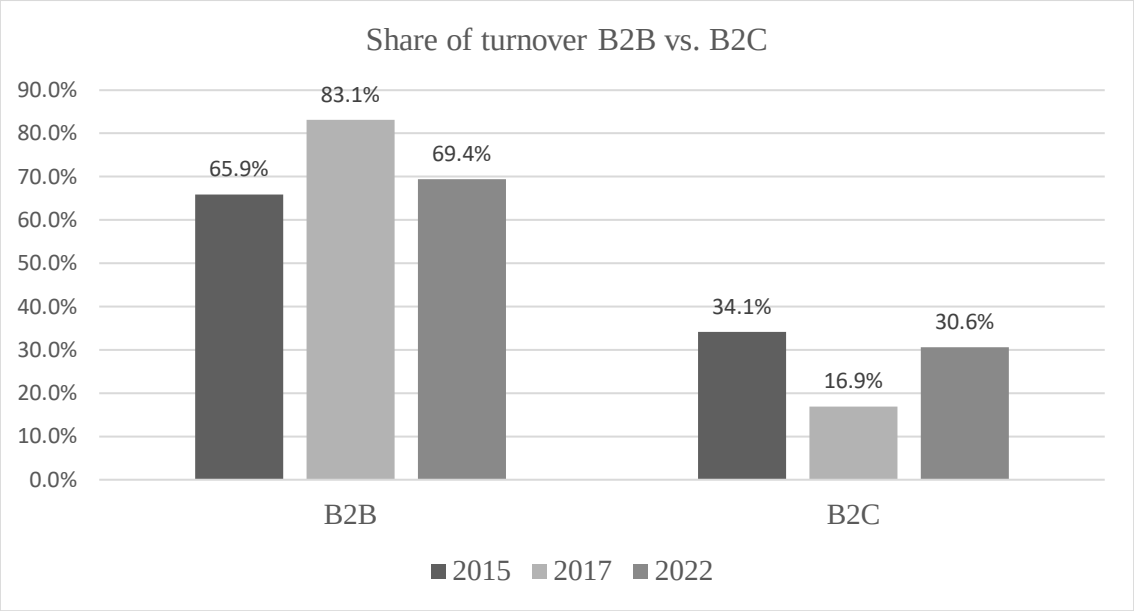

Figure 21. *Distribution of the turnover between B2B and B2C*

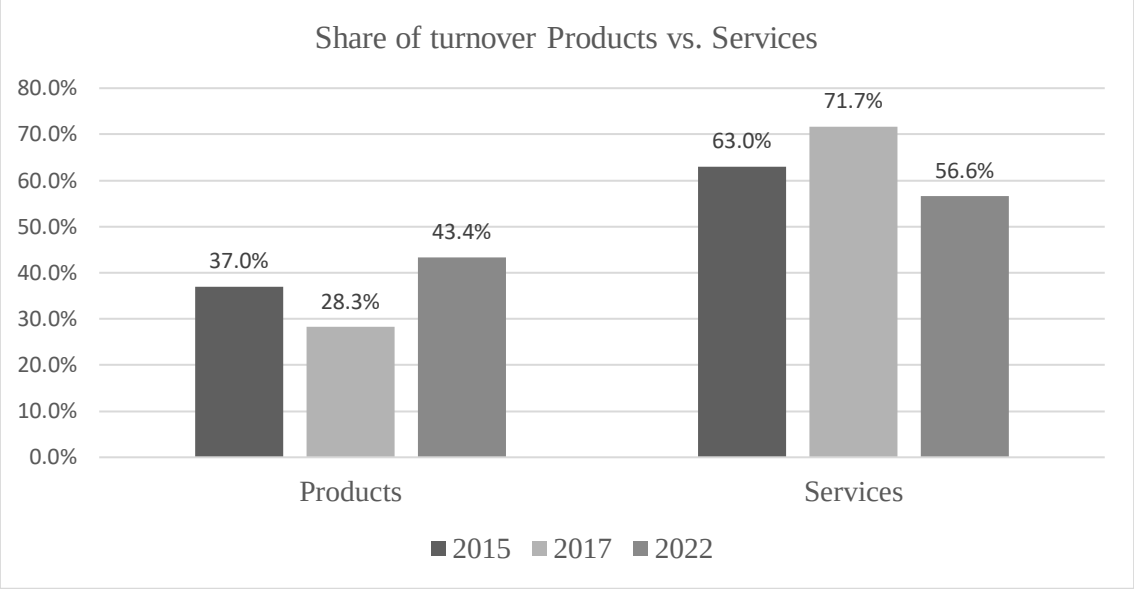

Figure 22. *Distribution of the turnover between products and services*

7.4.2 Founders and Team

In the next section, the data about the founders and team are presented in detail. Thereby, Figure 23 illustrates that the majority of the responding startups have been established by a founding team consisting of two or three persons. Comparatively, the *Deutscher Startup Monitor* reported an average number of 2.5 founders in its sample (Kollmann et al., 2021). In Berlin, the average size of a founding team is with an amount of 3.4 persons somewhat higher (Fajga, 2020). Having a founding team of between two and four members has been identified as a success factor in entrepreneurship literature (Zahra et al., 2003; Song et al., 2008). As in the EE of Karlsruhe, single founders and startups with five and more persons in the founding team play only a marginal role, the situation is satisfactory.

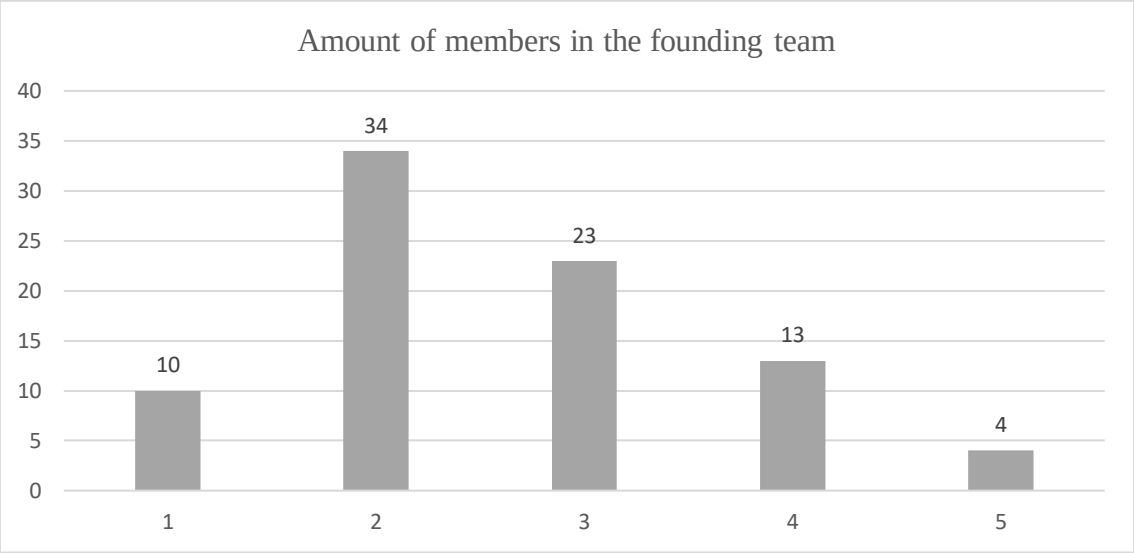

Figure 23. *Total number of members in the founding team*

Nevertheless, having a closer look at the average team composition reveals that female entrepreneurs are highly underrepresented in the data sample. Figure 24 points out that in only around one-quarter of the responding startups at least one woman is part of the founding team. Although in recent years the overall share of female entrepreneurs has increased to a percentage of 38.0% in Germany (Metzger, 2021), only 17.7% of the high-growth firms in startup ecosystems have female founders included (Kollmann et al., 2021). This inequality is confirmed by further studies, pointing out that in only a smaller percentage of startups (20.2%) at least one woman is working in the management team (startupdetector, 2021). Although in general these low numbers in technology-based EEs are influenced by multiple challenges for women entrepreneurship (Hirschfeld et al., 2020), the data of Karlsruhe reveals a surprisingly above-average percentage of 25%.

Overall, the distribution of female entrepreneurship is characterized by major regional and sectoral differences. In the case of Berlin, female entrepreneurs are part of the founding team in nearly half of the startups, which is certainly related to the focus on media, art, and culture (Fajga, 2020). Further sectors with a larger percentage of female leaders are eCommerce, services, environmental technology, and human resources as well as education (startupdetector, 2021).

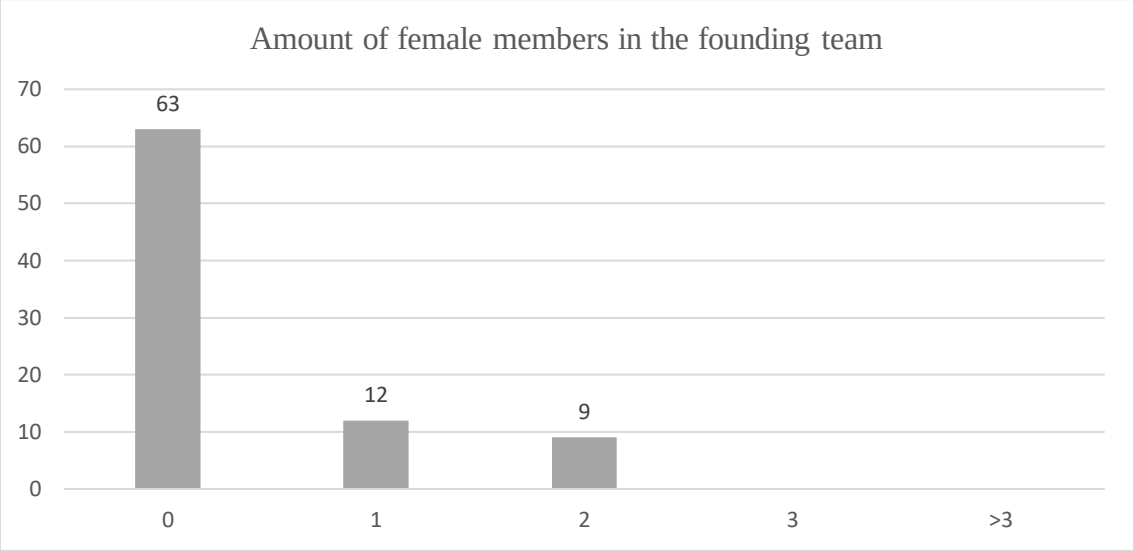

Figure 24. *Total number of female members of the founding team*

In the EE of Karlsruhe, most of the high-growth firms are founded by entrepreneurs with an academic background in economics and business engineering (52.4%), and computer science (35.7%), illustrated in Table 8. Both study programs at the KIT as well as at the HSKA are well-recognized and a source of highly skilled talents (Henn & Terzidis, 2019). Thereby, entrepreneurship courses have been systematically integrated into education programs, sensitizing students and researchers to entrepreneurship as a possible preferable career option (Frank & Schröder, 2020). Furthermore, the founders in Karlsruhe are also related to the studies of electrical (9.0%) and mechanical engineering (9.7%). Whereas a large number of founders in Germany graduated in business or economics studies (41.6%), in Karlsruhe the percentages for engineering and computer science graduates starting a business are above average. This data distribution highlights the characteristic of the EE of Karlsruhe as being a successful destination for STEM entrepreneurship.

Table 8. *Course of studies of the founding team*

Studies	N	Percent of Cases
Economics and Business Engineering	44	52.4%
Informatics	30	35.7%
Others, namely	20	23.8%
Mechanical Engineering	14	16.7%
Electrical Engineering and Information Technology	13	15.5%
Physics	5	6.0%
Humanities and Social Sciences	4	4.8%
Architecture	3	3.6%
Civil Engineering, Geo- and Environmental Sciences	3	3.6%
Chemical and Process Engineering	3	3.6%
Mathematics	3	3.6%
Chemistry and Biosciences	2	2.4%

In general, the distribution of the fields of studies in the sample shows that the EE of Karlsruhe can rely on a great talent pool and a functioning university ecosystem with an impactful support infrastructure (Kollmann et al., 2021). Having a closer look at a more differentiated comparison in the local context confirms that medium-sized cities with strong universities, such as Karlsruhe, Heidelberg, and Dresden, are having a considerable startup density that is highlighted as well above the average (startupdetector, 2021).

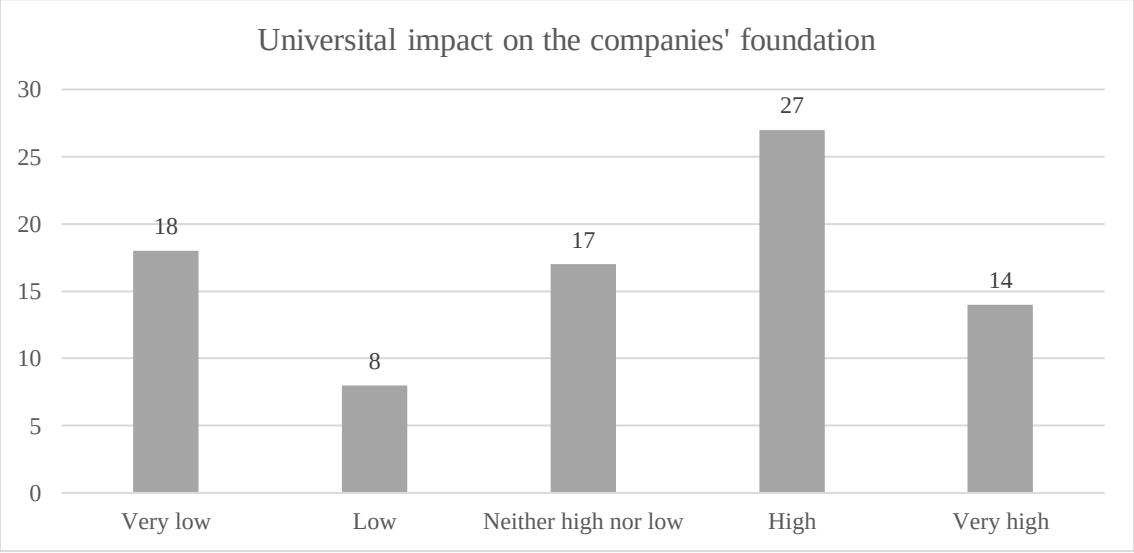

Figure 25. *Influence of the local university on the companies' foundation*

Although the creation of more than half of the new ventures (54.7%) has been influenced highly and very highly by the local universities, quite some companies (34.7%) are not related to those institutions at all (see Figure 25). The existence of diverse types of firms

than university spin-offs may lead to the conclusion that in the EE of Karlsruhe additional sources exist, diversifying the emergence of startups.

Table 9 presents the analysis of the average available experience within the founding teams. Thereby, the data reveal a high level of project experience (Mean=3.60) and working experience (Mean=3.43). Furthermore, the particular ratings of the industry, management, and entrepreneurial experience are neutral. Based on these tendencies, the data may assume that the strength of the curricula program at the university is the focus on project-based and practical experience. Additionally, entrepreneurs are not starting a business directly after their studies, but after some years of working for established companies. Having these experiences in the founding team can be a vital success factor for survival (Song et al., 2008).

Table 9. *Average experience available within your team at the date of foundation*

	N	Minimum	Maximum	Mean	Std. Dev.
Working Experience	84	1	5	3.43	1.079
Industry Experience	84	1	5	3.02	1.326
Project Experience	84	1	5	3.60	1.054
Management Experience	84	1	5	2.99	1.167
Entrepreneurial Experience	84	1	5	2.96	1.187

Interestingly, in more than half of the responding startups (53.6%) at least one of the co-founders has started a business before. Overall, this percentage is above average in comparison to Germany-wide (44.4%) as well as from Berlin (50.7%) and Munich (46.3%) (Kollmann et al., 2021). On the one side, this share highlights that entrepreneurial recycling in the EE of Karlsruhe is working quite well. Consequently, entrepreneurs are tending not to leave the ecosystem after abandoning previous projects. In doing so, local entrepreneurs keep on learning entrepreneurial competencies instead of giving up after the first shot. This behavior leads to the existence of serial founders which is highly beneficial for the entrepreneurial processes within an EE as well as for building personal resilience (Korber & McNaughton, 2018; Malecki, 2018, Vedula & Kim, 2019). On the other side, concerning the large number of entrepreneurs who have been part of a business previously, the overall entrepreneurial experience is rated quite low (Mean=2.96) in the survey.

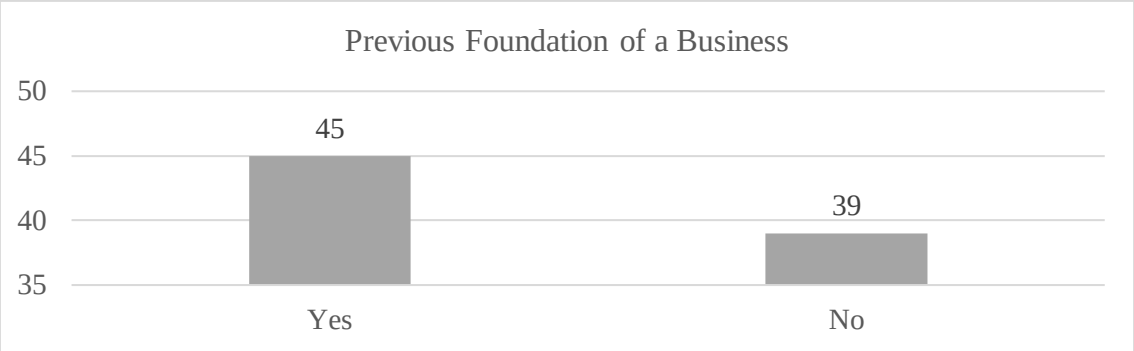

Figure 26. *Founders started a business previously*

As Figure 27 shows, the startup landscape in the EE of Karlsruhe mainly consists of small companies with 1-5 employees (65%). This distribution confirms the tendencies of previous items that the majority of startups are still in the early stages. Furthermore, these numbers are also influenced by the integration of young startups in the project stage. Although these teams have not been legally founded as a company, including them in the study is highly important to create a holistic image of the local entrepreneurial activities. Moreover, the responding numbers reveal that only a severely limited number of six percent has reached the "magic number" of above 20 employees. For the distribution within an EE, this data sample can be designated as standard, supported by equivalent findings from the EE of Berlin (Fajga, 2020). Although small-sized companies are predominately the EE of Karlsruhe, an overwhelming total of 653 full-time jobs have been created through the 83 respondent companies. Overall, the number of 7.87 jobs created per company is slightly below the average of the data from the '*DSM'* (Kollmann et al., 2021).

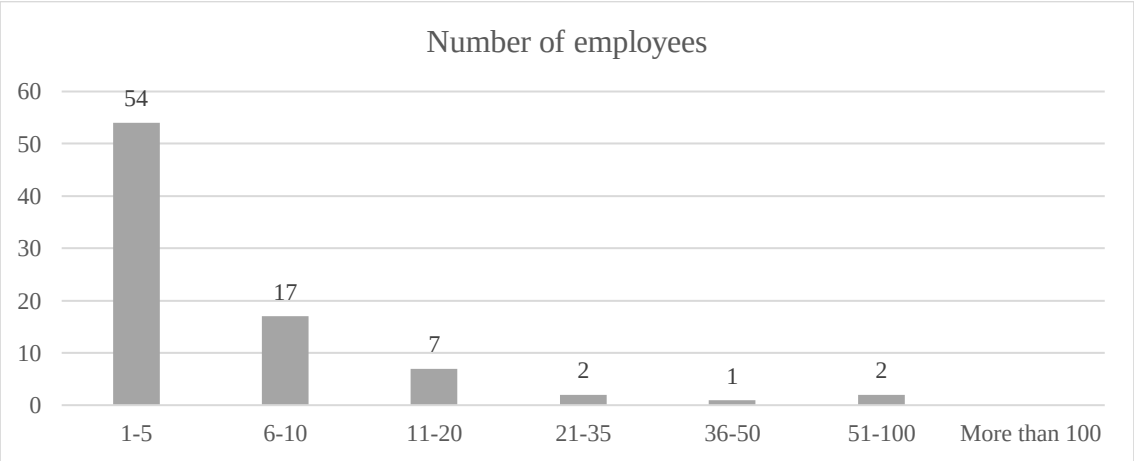

Figure 27. *Current number of employees in full-time equivalents (including the founders, excluding freelancers) in the survey of 2022*

Figure 28 points out that the responding startups from the EE of Karlsruhe assume a positive prospect. Thereby, the vast majority of the startups (78.6%) plan to hire new employees within the next year and only two of the firms forecast to reduce jobs. On average, the companies see the necessity to employ 4.12 skilled workforce. Compared to Germany-wide studies, these numbers illustrate a more conservative growth rate and a risk-averse scaling approach. According to the '*DSM'*, a larger percentage of 91.6% of new ventures are planning to hire on average 8.7 new employees (Kollmann et al., 2021). Thus, the startup landscape in Germany tends to build its future strategic planning on a good and solid future perspective. Overall, the situation for startups in the EE of Karlsruhe is noticeably positive and the scaling of businesses may lead to prospering economic growth.

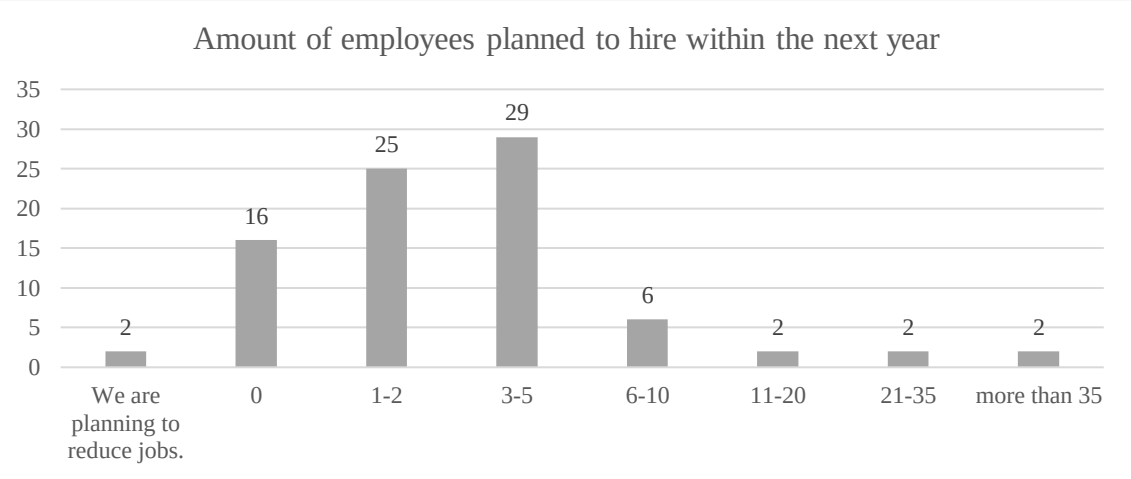

Figure 28. *Amount of employees planned to hire within the next year*

The numbers from Table 10 show that only a few of the responding companies have included an external member on the management board. The possibility to balance weaknesses and missing skills that are existing in the founder team is often overlooked. Especially young firms in the early stage are struggling as they are not able to attract skilled talents, or may not have the resources to do so. However, at a later stage, scaling companies tend to make use of this vital strategy. Those high-growth firms are mainly searching for experts in the field of general management, finance, marketing, and business development. The already existence of a technological knowledge base in the EE of Karlsruhe needs to be highlighted, related to the technology-based background of most of the founding teams.

Table 10. *External board members*

	N	Percent of Cases
No external members	71	84.5%
General Management (CEO)	5	6.0%
Research & Development (CTO)	1	1.2%
Marketing and Sales (CMO)	4	4.8%
Finance (CFO)	6	7.1%
Business Development (CBDO)	4	4.8%

7.4.3 Financing

As Figure 29 shows, in the survey of 2022 nearly one-third (31.3%) of the responding startups have raised external equity capital. Furthermore, the longitudinal perspective indicates a continuously growing number of investments in new ventures from the EE of Karlsruhe (2015: 17.2%; 2017: 23.2%). Although the total amount of VC in the EE of Berlin is many times higher, the share of companies with an investment is only around 23 percent and thus, lower than in Karlsruhe (Fajga, 2020). In the EE of Karlsruhe, the equity capital has mainly been raised by startups active in the fields of ICT.

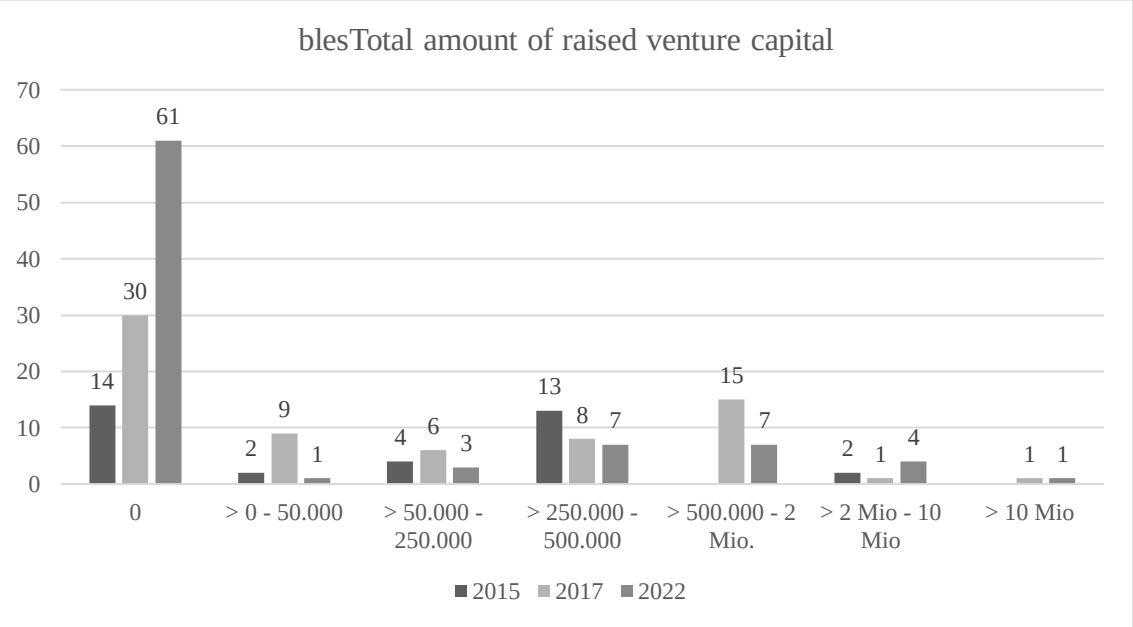

Figure 29. *Total amount of raised venture capital*

Overall, these insights are comparable to Germany-wide investment trends. Although high-growth firms in the field of eCommerce were funded to a large extent in recent years, health and software continued to be the most attractive sectors for venture capitalists (startupdetector, 2021). Due to the high uncertainty during the Covid-19 pandemic,

especially in the beginning, it has been difficult and challenging for new ventures to obtain external equity capital in Q2 and Q3 of 2020 (startupdetector, 2021). However, since the beginning of 2021, the total investment activity has recovered again to a normal level. Especially the total amount of VC invested in the later rounds increased significantly (Dealroom, 2021; Heidenfelder, 2021).

A closer examination of Table 11 reveals that business angels have invested in a quarter of the local startups and therefore, are the main source of investment for startups from the EE of Karlsruhe. The importance of business angel investments for a startup community can be supplemented by comparable data from the EE of Berlin and throughout Germany (Fajga, 2020; startupdetector, 2021). Furthermore, for the responding startups, private venture capital is the second leading source of external equity capital (14.3%). Being able to rely on a higher density of local VCs as well as easier access to global investors, the total numbers in the EE of Berlin are many times higher (38%) in this category (Fajga, 2020). However, high-growth firms from the EE of Karlsruhe that have raised VC also have acquired BA investments before. Further options, such as family, friends, and fools, crowdfunding, corporate venture capital, and incubator funding have only played a minor role so far, not being used by the local new ventures.

Table 11. *Sources of external capital*

	N	Percent of cases
Business Angel Investment	21	25.0%
Private Venture Capital	10	14.3%
Public Venture Capitalist	7	8.3%
Family, Friends, and Fools	4	4.8%
Crowdfunding	4	4.8%
Corporate Venture Capital	3	3.6%
Incubator Funding	1	1.2%

Analyzing the intention of responding companies that have not been able to acquire external capital yet and the reasons behind it, Figure 30 presents a different picture of the access to financial capital in the EE of Karlsruhe. Interestingly, only a limited number of six companies that have been searching for equity capital could not raise equity capital. Consequently, the startups which have not raised external equity capital so far (54.2%) are mainly not interested at all in doing so, as their growth strategy is based either on bootstrapping or revenue-based. These findings lead to the conclusion that in EE of

Karlsruhe the possibility to receive the required funding through access to financial resources is given. Whereas business angels are a fundamental source for early-stage, venture capital is likely more important at a later stage to scale the business. Thus, the low percentage of raised VC investment in the sample is related to the majority of younger firms in EE of Karlsruhe.

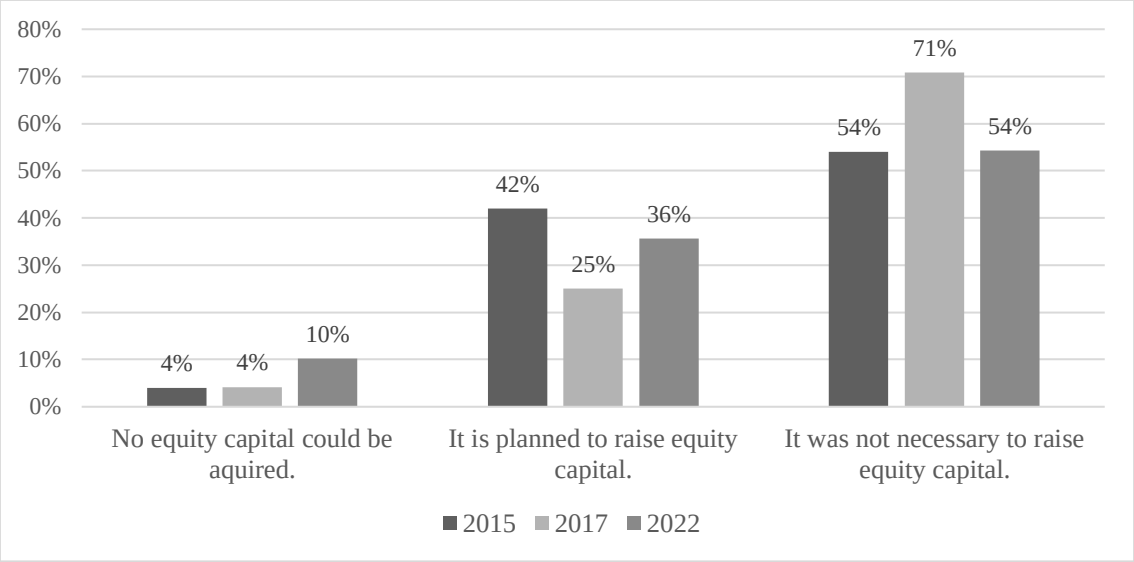

Figure 30. *Reasons for not raising equity capital*

The investment distribution shows that there is a peak in the middle sector of 250,000€ up to 2 million €, indicating the availability of seed investments as a first round. Overall, the responding startups collected an impressive sum of in total 43,515,000€. Similarly, the data from the EE of Berlin confirms that most companies' investments are in the middle range of received equity capital (Fajga, 2020).

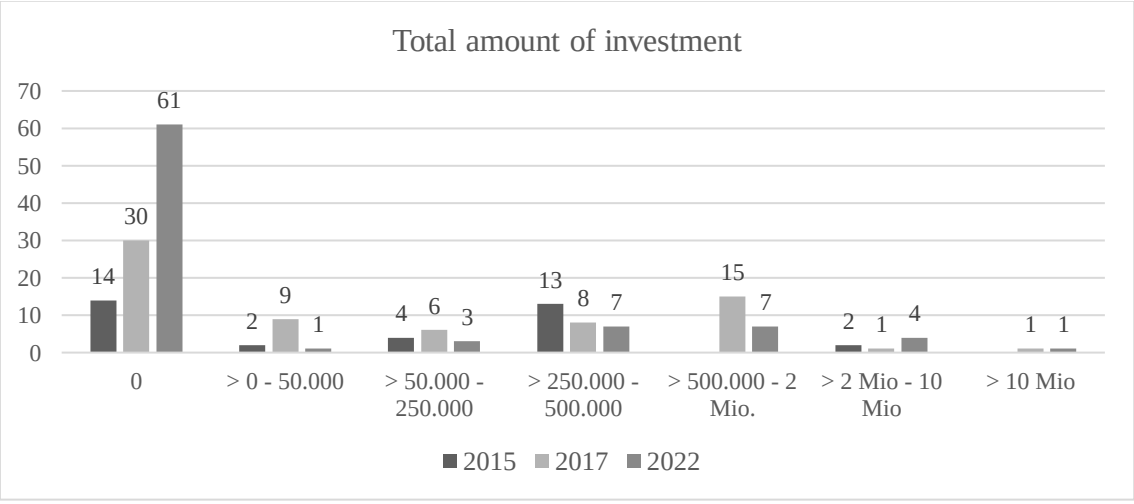

Figure 31. *Total amount of investment*

Additionally, Figure 32 shows that the remaining shares of the particular founding teams are positively linked to received investment capital. This can be an indication that the startups are following a comprehensible and sustainable investment strategy, not limiting the structuring of subsequent investment rounds. Overall, the company shares are still owned to a large extent by the founders and only two of the firms in the survey of 2022 are in a minority-hold situation.

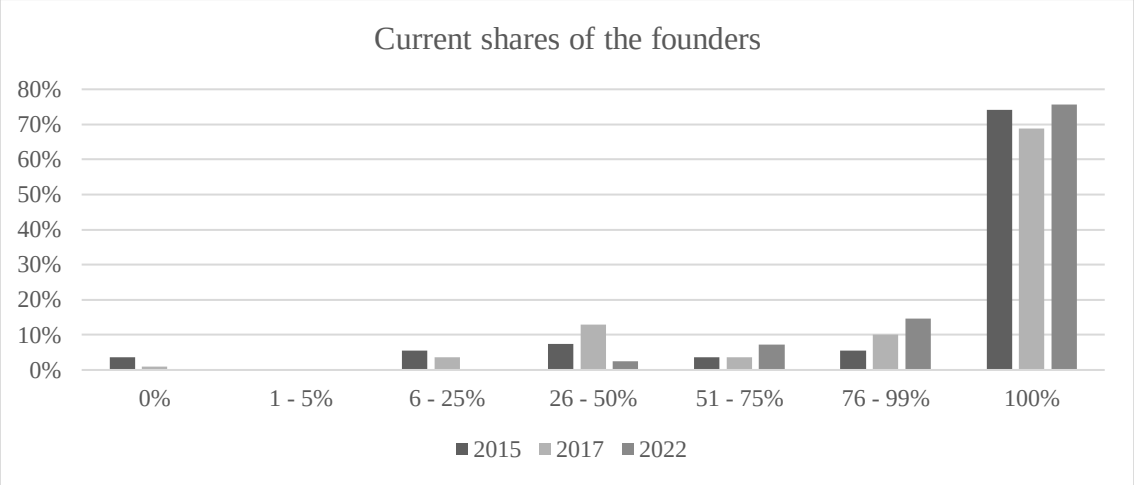

Figure 32. *Current shares of the founders*

Although the total number of regional and national public funding programs has emerged over the last years, Figure 33 shows that only less than half of the responding teams in the EE of Karlsruhe (44.6%) made successful use of these possibilities. These figures are very similar to the 43.2 percent illustrated by data from Germany-wide studies (Kollmann et al., 2021).

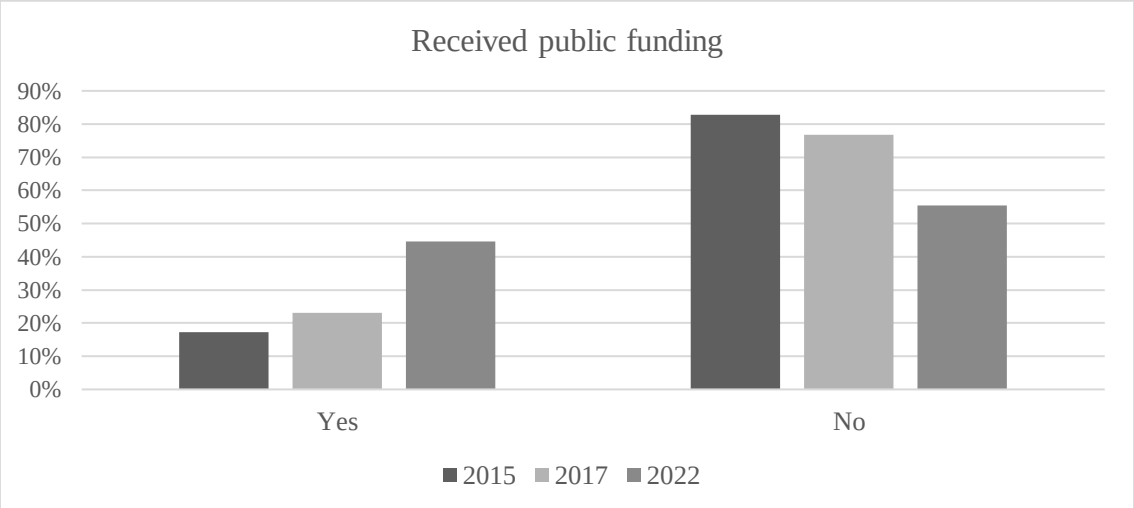

Figure 33. *Received public funding*

Following a public funding strategy as a support to overcome the initial phase, young firms have collected grants from multiple sources (see Table 12). Thereby, the most received public funding scholarships have been the well-established EXIST scholarship (18) for business ideas out of the university context and the regional Startup BW pre-seed grant (12) to leverage the gathered venture capital. Additionally, in the EE of Karlsruhe, the 'EXI Gründungsgutschein' has been used multiple times. These numbers indicate that startups tend to use regional support programs instead of national or international ones, confirmed by comparable data from other locations. For instance, in the EE of Berlin, the EXIST scholarship is the primary public funding, followed by specific regional programs such as the 'Coaching Bonus (IBB)' or the 'Berliner Startup Stipendium (SenWEB, EU, ESF)' (Fajga, 2020). Although most of the support programs aim to reach a broad range of young companies, a considerable number of the responding firms have not applied for those grants or received them. Potential barriers may be the missing transparency and publicity of those scholars or the high administrative effort to apply, leading to an unattractive application process.

Table 12. *Public funding sources*

	N	Percent of Cases
EXIST-Gründerstipendium	18	25.7%
Startup BW Pre-Seed	12	17.1%
Other programs	11	15.7%
EXI Gründungsgutschein	10	14.3%
EXIST-Forschungstransfer	4	5.7%
Junge Innovatoren	4	5.7%
Others regional programs	4	5.7%
Helmholtz Enterprise	3	4.3%
KfW-Gründerkredit	2	2.9%
KfW-Gründercoaching	1	1.4%
Fraunhofer Venture Program	1	1.4%

7.4.4 Business Model, Technology, and Market Strategy

Figure 34 shows that the creation of new ventures and the intention of the founders have been based in the majority of cases (58.5%) on a problem that has been identified. In doing so, an initial idea for a product or service has been transformed into a concrete business model. In contrast, only a few of the responding companies (12.2%) have followed a guided, structured process to search actively for entrepreneurial opportunities

with high market potential. As the high-growth firms in the EE of Karlsruhe tend to be strongly connected to the local university, a considerably high number of the founding teams (29.3%) based their new venture creation on innovative technologies that have been further developed into a product or service.

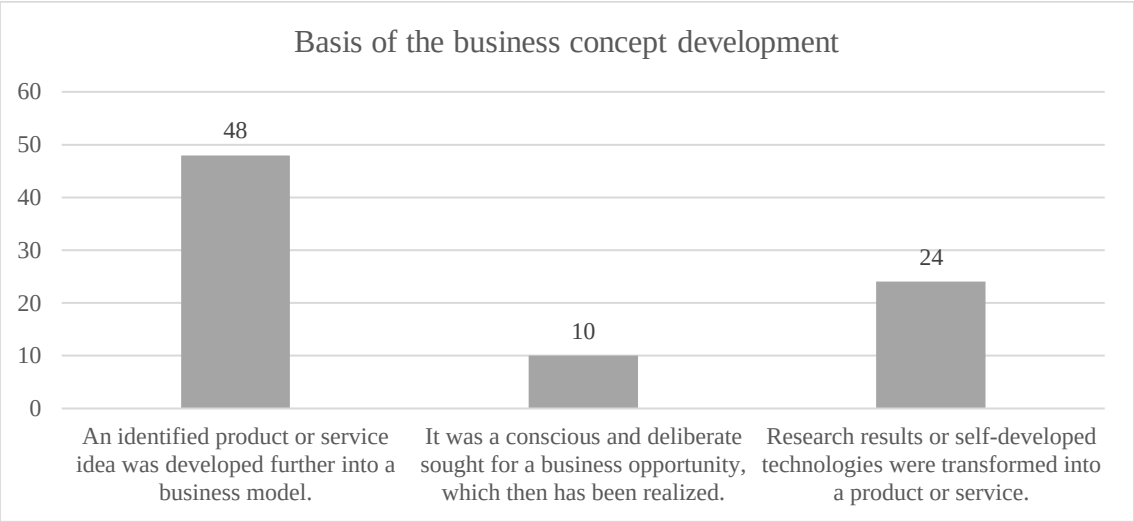

Figure 34. *Basis of the business concept development in the survey 2022*

As a consequence of the technology base, Figure 35 shows that underlying patents have played a core role in the foundation of some of the new ventures (13.1%). Especially for deep-tech startups out of the university context, following a patent-based strategy can be a solid business concept with a supportive protective function. In comparison to those figures, only five percent of the new ventures in the EE of Berlin own patents (TU Berlin, 2014), underlying the characteristic of the EE of Karlsruhe as being a hub for deep tech.

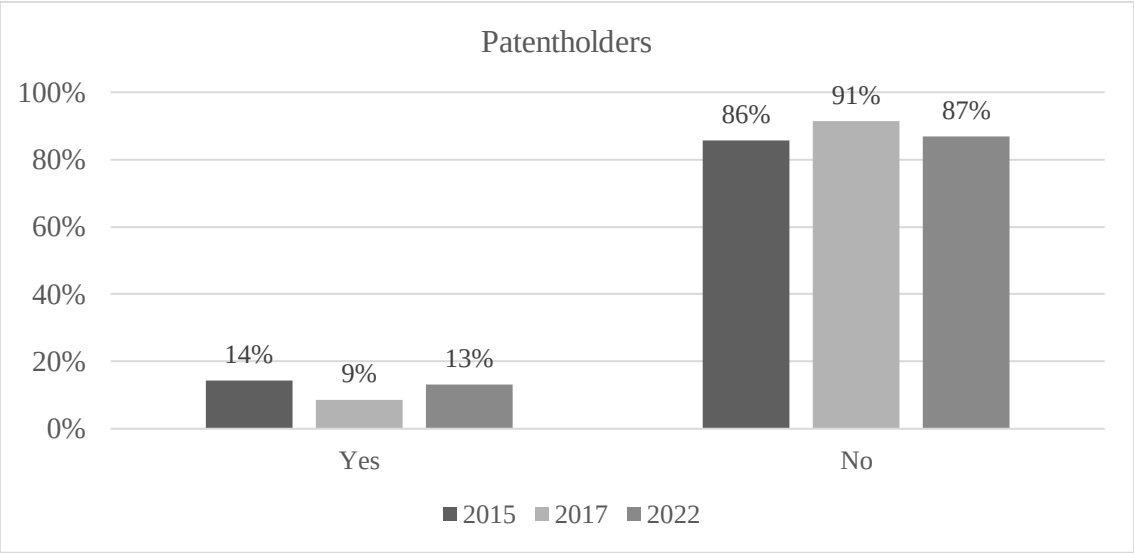

Figure 35. *Number of startups holding at least one patent*

As half of the responding startups implement digital business models and another 35.7% percent hybrid ones, the numbers from Figure 36 confirm the focus of the EE of Karlsruhe on IT and digitalization. Being pioneers in promoting essential future-oriented key technologies, these digital and data-driven startups are highly important for ecosystem development (Kollmann et al., 2021). Related to the permanently ongoing structural change toward a digital and service-based economy, the share of analog business models (14.3%) has decreased to a low level over the last decades.

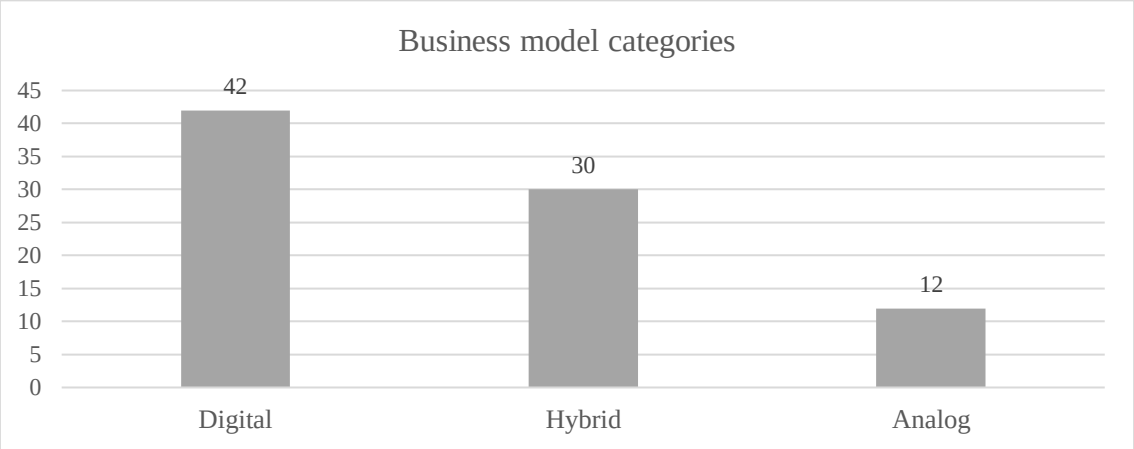

Figure 36. *Business model categories*

Furthermore, Figure 37 shows that over two-thirds of the responding startups (71.4%) rate the level of digitalization concerning their business models as high or very high. Those data highlight that young companies from the EE of Karlsruhe are aware of future trends and focus their entrepreneurial activities and business models on digital transformation. For the further development of regional economies, this fact is particularly important as mainly digital companies show significant growth and scaling potential recently (startupdetector, 2021).

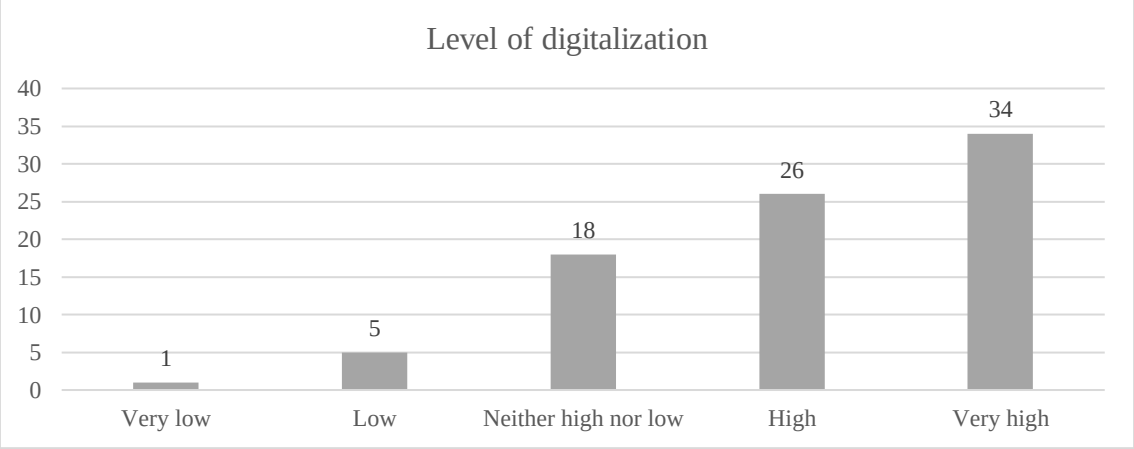

Figure 37. *Level of digitalization of the applied business model*

In the EE of Karlsruhe, the percentage of startups rating the scalability of their business models as high or very high is outstanding. Overall, only a limited number of nine companies consider their scalability as on a very low or low level. These facts are important as for following an ambitious growth strategy scalability has to be given. As productive entrepreneurship is linked to the value creation of high-growth firms (Wurth et al., 2022), the EE of Karlsruhe highly benefits from the awareness of local startups to build potentially scalable business models from the beginning.

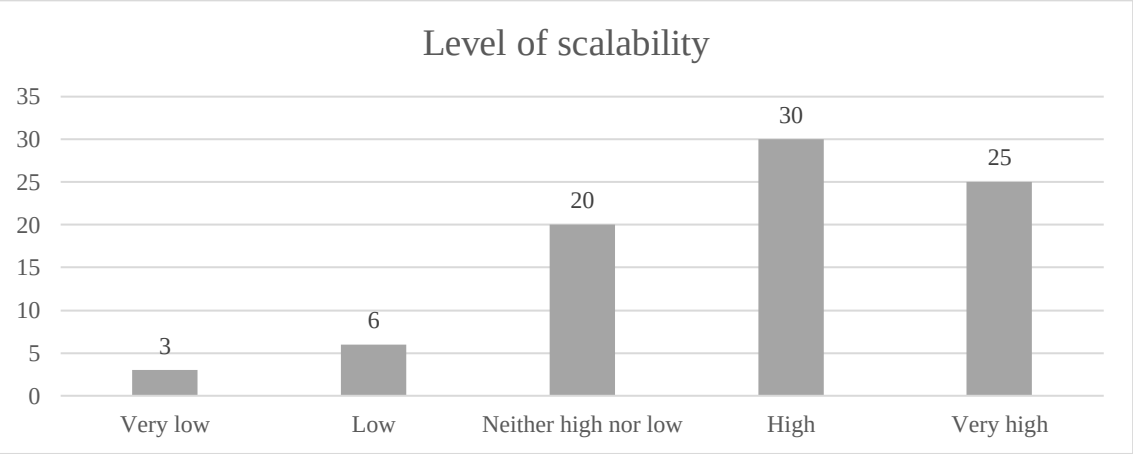

Figure 38. *Level of scalability of the applied business models*

Analyzing the business models listed in Table 13, no definite tendency is observable. A broad field of diverse business models is applied, particularly adapted to individual products or services as well as to the fields of industry. Thereby, the predominant ones are subscriptions (39%), software-as-a-service (36.6%), and software development (35.4%). All of these are related to digital products and services (Kollmann et al., 2021).

Table 13. *Applied business models*

	N	Percent of Cases
Subscription	32	39.0%
SaaS (Software-as-a-Service)	30	36.6%
Software Development	29	35.4%
Direct Selling	25	30.5%
Platform / Marketplace	23	28.0%
Technology Development and Production	23	28.0%
Licensing	16	19.5%
Freemium	15	18.3%
E-Commerce	14	17.1%
Analog Services	12	14.6%
Pay-per-use	9	11.0%
Solution Provider	8	9.8%
Stationary Trade	7	8.5%

Although the previous numbers indicate a positive basic attitude of the entrepreneurs in the EE of Karlsruhe so far, the residential new ventures have to deal with obstacles as well. Thereby, three-fourths of the respondings startups in the survey of 2022 consider the biggest challenge in the field of sales and customer acquisition (see Table 14). Struggling with the commercialization of new and innovative products is a fundamental problem for technology entrepreneurs (Gans & Stern, 2003). According to the *'DSM'*, this fact applies to the majority of new ventures in Germany (65.3%) (Kollmann et al., 2021). Overall, the risk-averse sentiment of potential customers as a consequence of the Covid crisis and the high uncertainty is likely to increase these difficulties (Leppaaho & Ritala, 2022). Furthermore, the categories of product development (39.5%) and human capital (39.5%) have been listed as additional challenges. Whereas the topic of product development has been designated a major obstacle for German startups as well (47.6%), the recruiting of human capital is considered the smallest challenge (Kollmann et al., 2021). These numbers lead to the assumption that hiring the required skilled workforce may be a bottleneck for the growth of young firms in the EE of Karlsruhe. Furthermore, the percentages of cash flow and liquidity (30.9%) as well as the raising of capital (29.6%) are comparable to the data from Germany-wide studies (28.2% and 36.1%). To conclude, the field of purchasing and procurement is not a problem at all, only considered a major challenge by the minority of the local startups (14.8%).

Table 14. *Current major challenges for the companies*

	N	Percent of cases
Sales and Customer Acquisition	59	72.8%
Product Development	32	39.5%
Human Capital	32	39.5%
Cashflow / Liquidity	25	30.9%
Raising of Capital	24	29.6%
Purchasing and Procurement	12	14.8%

Analyzing the market distribution of the responding startups longitudinally, Figure 39 points out that national and international markets are most important for startups in the EE of Karlsruhe related to the share of the companies' turnovers. Interestingly, local and regional markets play a minor role and thus, have only a limited impact on the total sales numbers. It can thus be concluded that the EE of Karlsruhe is well-connected, enabling local startups to reach global markets without high constraints or any barriers. Facilitating high-growth firms with a scaleable business model to sell their products or services to

national and international customers is a key characteristic of a well-functioning EE (Henn et al., 2022a).

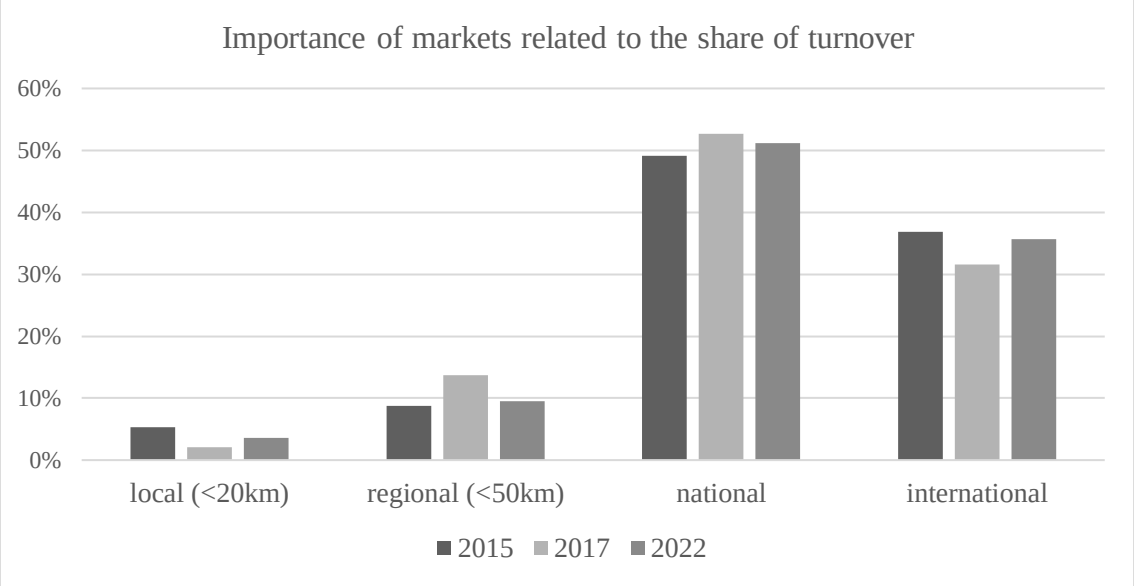

Figure 39. *Importance of markets related to the share of turnover*

Furthermore, Figure 40 shows that the share of turnover achieved in international markets tends towards a low percentage. In total, around one-third of the responding companies are selling their products and services only nationally. For two-thirds, the importance of international sales is less than one-quarter of their turnovers. Nevertheless, a minority of startups (22.2%) achieved to generate more revenues internationally than on the national level. In addition, it is remarkable that six new ventures from the EE of Karlsruhe focus their sales activities completely outside of the German market.

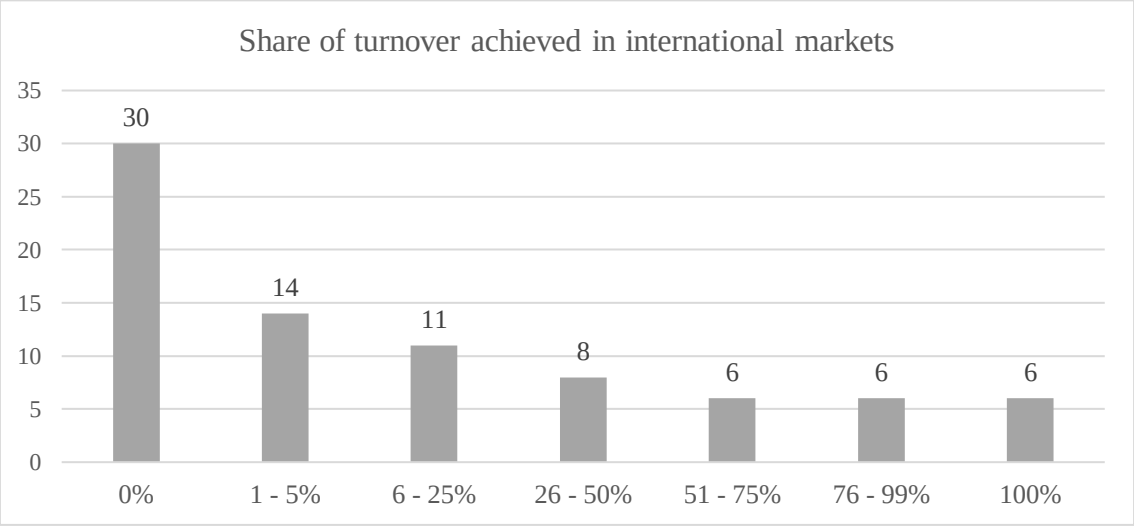

Figure 40. *Share of turnover achieved in international markets*

In contrast, Figure 41 shows that the responding startups rated the importance of international markets within their business models as of higher relevance (Mean=3.72). Thereby, two-thirds of the startups indicated the impact as high or very high. Internationalization strategies play a subordinate role for only a minority of 16.9 percent of new ventures in the EE of Karlsruhe. However, the current activities in transnational entrepreneurship do not meet the specified strategic importance of the responding entrepreneurs. Consequently, the difference between the perceived truth (high importance for the business models) and the actual activities (share of turnover in international markets) is a conundrum. Especially, startups in the early stage tend to include internationalization aspects in their strategic business model development but do not offer their products and services from the beginning globally.

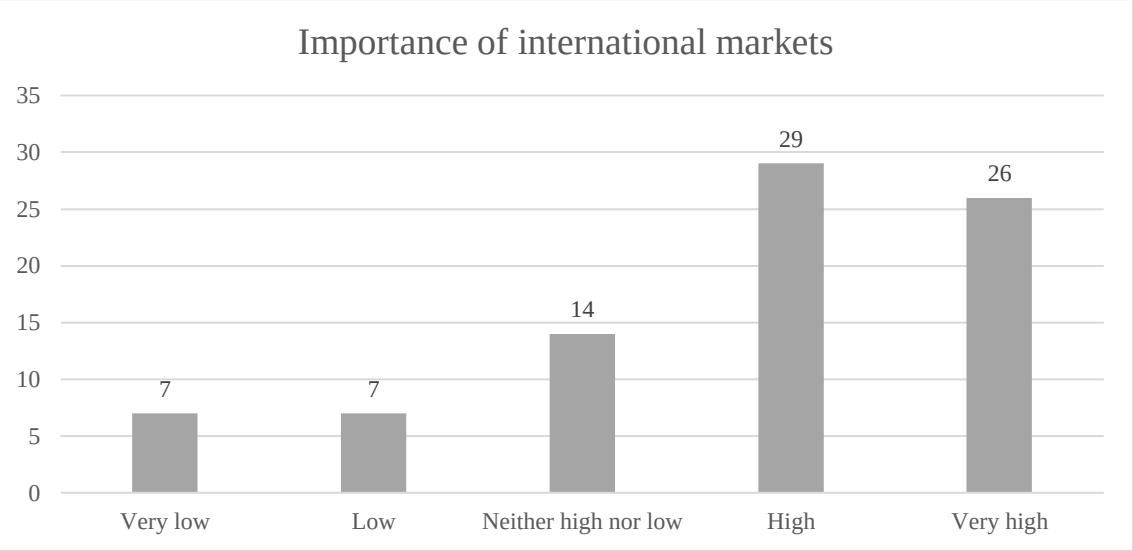

Figure 41. *Importance of international markets*

Overall, the startups from the EE of Karlsruhe consider the German-speaking countries in the DACH region, the European Union, and North America as the most significant international markets for their businesses. Emerging economies such as Latin American and African countries are not likely to be in the scope and thus, these target markets are highly underrepresented in internationalization strategies of the high-growth firms so far. The data from the EE of Berlin (DACH 64%, Europe 61%, North America 30%, and Asia 23%) confirm the current trend of the international orientation of the German startup landscape (Fajga, 2020). Furthermore, these tendencies are comparable to the findings from the *'DSM'* report, listing the following numbers: EU 89%, North America 30.4%, Asia 18.8%, South America 7.1%, Australia and Oceania 6.7%, and Africa 6.1%

(Kollmann et al., 2021). In the EE of Berlin, only 18 percent of the responding companies answered this question, pointing out the market strength of the city and the resulting lower relevance of internationalization for the majority of local startups (Fajga, 2020). To conclude, the survey data reveal that high-growth firms tend to focus on large markets with established connections to residential actors, not identifying the rising potential of developing and emerging economies yet. The well-functioning of transnational networks, transparent regulations, and general trustworthiness would be framework conditions that are supportive to foster the expansion in those markets (von Bloh et al., 2020; Harima et al., 2021).

7.4.5 Connections to the Local Entrepreneurial Ecosystem

In the next section of the survey, the participating entrepreneurs were questioned about their connections to the local EE by indicating to what extent they respectively agree with the following statements. Thereby, the responses were measured on the Likert scale from 1 - Strongly Disagree to 7 - Strongly Agree. In contrast to the previous parts of the questionnaire, this section concentrates on the perspective of individual entrepreneurs on their local EE, covering all relevant fields of interest. In doing so, this study addresses the suggested requirement to measure an EE "by the perception of the people living in the respective region" (Sternberg et al., 2019).

Table 25 summarizes the agreements of the responding startups from the EE of Karlsruhe to the individual statements related to their behavior in the local EE in detail. In doing so, well-functioning and non-functioning connections can be highlighted. Overall, the data positively indicate a high level of trust among the EE actors (Mean=5.20) as well as the non-existence of high barriers to joining the ecosystem easily (Mean=5.15). Furthermore, new ventures tend to establish personal networks within the entrepreneurial community (Mean=4.65) by meeting with other entrepreneurs regularly (Mean=4.64) and making use of valuable exchanges with mentors (Mean=4.62). In contrast, the overall participation of startups in local events is lower (Mean=4.33), showing the highest standard deviation of 1.962. Therefore, it can be concluded that some companies join events quite often and whereas others hardly ever. The promotion of entrepreneurship in general and entrepreneurship-friendly legislation by the local government (Mean=4.22) is evaluated as neither particularly good nor bad. Applied business models are indicated as average (Mean=4.25) related to having access to essential markets without any constraints.

Furthermore, business model internationalization in the early stage shows a slight positive tendency (Mean=4.27). As shortcomings in the EE of Karlsruhe, the inferential analysis points out that the support of dealmakers to establish contacts with customers is missing (Mean=2.70) and that it is a critical issue to hire skilled talents, if necessary, at any time (Mean=3.59). Furthermore, the responding entrepreneurs tend to consider bureaucracy as an obstacle to entrepreneurial processes (Mean=4.84), negatively influencing the growth of the company. Similar to the point of participation in events, the standard deviation of 1.900 is quite high. It thus can be concluded that whereas the administrative burden is critical for some entrepreneurs, others do not see any troubles.

Table 15. *Connections to the local entrepreneurial ecosystems*

Statements	N	Min	Max	Mean	Std. Dev.
"The actors in the entrepreneurial ecosystem are trustworthy and you can talk openly about business ideas, strategies, and challenges"	80	1	7	5.20	1.436
"At least one person of the founding team participates in events of the entrepreneurial community frequently"	81	1	7	4.33	1.962
"The exchange with mentors is valuable and leads to opportunities we have not been aware of before"	81	1	7	4.62	1.625
"We meet with other entrepreneurs and startups regularly to discuss current challenges"	81	1	7	4.64	1.770
"From the beginning, we actively established a personal network within the entrepreneurial community"	81	1	7	4.65	1.755
"There are no barriers to access the local entrepreneurial ecosystem easily"	81	1	7	5.15	1.550
"The local government actively seeks to create and promote entrepreneurship-friendly legislation"	81	1	7	4.22	1.405
„Internationalization strategies have been integrated into business model development early on"	80	1	7	4.27	1.622
"Through the support of dealmakers, contacts with customers could be established and the number of sales increased"	80	1	6	2.70	1.634
"Bureaucracy has been an issue that wasted resources and negatively influenced company growth"	81	1	7	4.84	1.900
"With our business model, access to markets could be achieved without any constraints"	81	1	7	4.25	1.670
"In the local entrepreneurial ecosystem, it is possible to hire the required skilled employees at any time"	81	1	6	3.59	1.439

Overall, the responding startups indicated the EE of Karlsruhe with a positive tendency. The entrepreneurial community is perceived as trustworthy and onramps enable new founders to join easily. Both characteristics are key to a well-functioning EE, significantly impacting regional economic performance (Muldoon et al., 2018; Spigel & Harrison, 2018). An intense competition between young firms and established companies for skilled talents increases salaries to a high level, making it difficult for early-stage start-ups with high revenues or seed investment to compete (Sternberg et al., 2019).

7.4.6 Evaluation of the Entrepreneurial Ecosystem

In the final section of the questionnaire, the participating entrepreneurs were requested to evaluate diverse elements in the EE of Karlsruhe. Similar to the previous section, the responses have been measured on the Likert scale from 1 - Strongly Disagree to 7 - Strongly Agree. The applied approach as well as the accurate statements and the design of the evaluation have been adapted from the study of Audretsch et al. (2021). In this article, EEs were investigated at the city level across emerging markets in Eastern Europe, aiming to examine how to facilitate productive entrepreneurship as well as to reduce unproductive entrepreneurship. Relying on a total sample of 1,652 survey participants out of sixteen cities from nine countries, the data material provides a valuable reference quantity, increasing the representativeness of the findings of the study in the EE of Karlsruhe. The numbers of the questionnaire are presented in the following Table 16.

Table 16. *Evaluation of the local entrepreneurial ecosystems (based on Audretsch et al., 2021)*

Statements	N	Min	Max	Mean	Std. Dev.	Mean Audretsch
"There is a strong focus on growth-oriented and productive entrepreneurship activity in my region"	81	1	7	4.57	1.224	4.70
"There is a sufficient formal network to support entrepreneurship in my region	80	1	7	5.03	1.302	3.82
There is a sufficient number of government entrepreneurship support programs in my region"	81	1	7	4.79	1.339	3.80
"There is a strong entrepreneurship culture and orientation in my region and I personally know entrepreneurs who started a business in the previous years"	81	2	7	5.47	1.295	4.16
"There is a sufficient informal network to entrepreneurship in my region"	81	1	7	5.23	1.197	4.39
"There is a high status of entrepreneurs in my region as well as a sufficient support of independent mass media to entrepreneurship in my region"	81	1	7	4.43	1.294	3.85
"There is sufficient private equity capital (business angels, venture capital, crowdfunding) in my region to support entrepreneurship"	79	1	7	3.80	1.343	3.48
"There is a strong awareness for sustainability in my city (healthy lifestyle, veganism, energy efficiency, sustainability, corporate social responsibility) in my city"	81	2	7	4.77	1.207	3.66

The analysis of the data sample reveals a tendency of the EE of Karlsruhe as slightly rated above average in most of the individual categories, indicating the existence of a functioning local EE. Thereby, the categories of entrepreneurial culture and orientation (+1.31), formal networks (+1.21), and governmental support programs (+0.99) are the largest upsides compared to the data from the sixteen cities analyzed in the study of Audretsch et al. (2021). Furthermore, the entrepreneurs from Karlsruhe valued the local entrepreneurial culture (Mean=5.47) with the best rating, followed by informal networks (Mean=5.23) and the support of entrepreneurship by formal networks (Mean=5.03). The overall status of entrepreneurs in the region as well as the support of independent mass media are rated as sufficient (+0.58). Surprisingly, the focus on productive

entrepreneurship (-0.13) is the only category that has been evaluated as worse than the average numbers from the reference quantity. Although the availability of venture capital is indicated as the lowest rating (Mean=3.80), it is still rated higher than the reference numbers (Mean=3.48) of the study by Audretsch et al. (2021). Nevertheless, these findings should raise concerns as access to financial resources within an EE is critical and its non-availability might limit the growth potential of start-ups (Cantner et al., 2021). To sum it up, the categories of focus on growth-oriented and productive entrepreneurship as well as the existence of sufficient private equity capital have been identified as potential shortcomings. In general, the empirical data outline the EE of Karlsruhe as higher developed than the average ecosystem in Eastern Europe, confirming the substantial basis of the local framework conditions. Consequently, a tendency in facilitating a permanently ongoing structural change driven by functioning entrepreneurial activities could be observed (Henn & Terzidis, 2019).

7.4.7 Discussion

Based on the descriptive analysis, this chapter summarizes the characteristics of the EE of Karlsruhe, discusses its strengths as well as potential shortcomings, and subsequently derives suggestions for improvements to further EE development. Additionally, critics based on the perspective of entrepreneurs from older studies such as Rabe (2005) and Henning et al. (2006) are contextualized. In doing so, it is possible to check if the deficits identified in the past have been solved through targeted actions and programs or if those vulnerabilities still exist.

Overall, the findings confirm the tendency of recent Germany-wide rankings highlighting the positive development of Karlsruhe and its well-functioning EE (Frank & Schröder, 2020; Gilde et al., 2020; Kollmann et al., 2021). The descriptive analysis of this study reveals that the region can rely on a vital entrepreneurial community, based on a high number of young companies searching for new ideas, and discovering entrepreneurial opportunities continuously. This fact can be seen as one particular strength of the EE of Karlsruhe. However, as a consequence, a significant number of founding teams are still in the project and pre-seed stage, and thus, the local support infrastructure and related programs need to specifically target startups before being founded legally as well.

Furthermore, the descriptive findings indicate a strong focus on the IT sector, combined with B2B customers, and service-oriented business models as the core characteristics of

the EE of Karlsruhe. In particular, the concentration of startup activities in the field of information technologies and artificial intelligence is highly relevant to current entrepreneurial processes (Henn & Terzidis, 2019). This specific nature can be traced to the emergence of excellent research institutions in this field, which have influenced the historical development of the regional economic structure from that date onwards. Nevertheless, new technology-based firms additionally address major future trends such as mobility and energy solutions. This proper balancing between a certain focus and diversity is powerful as it increases the resilience of local EEs (Roundy et al., 2017; Spigel & Harrison, 2018). Overall, the vast majority of the high-growth firms can be categorized as technology-based, highlighting the perception of Karlsruhe as a hub for *'DeepTech'*.

The responding entrepreneurs indicated the level of digitalization as highly important for the development of their products and services and describe their applied business models as mainly digital or at least hybrid. Thus, a further EE characteristic of Karlsruhe is the relevance of digital entrepreneurship, which has been identified as a comparative advantage and is increasing regional competitiveness long-term (Quinones et al., 2021). Moreover, the empirics reveal that the excellent universities in Karlsruhe are focal points with a high impact on the quality of entrepreneurial activities and their outcome. Although some companies have only lower connectivity to the university environment, a vast number of startups benefit significantly from being strongly linked to those institutions. As a large number of entrepreneurs have a background in either computer science or industrial engineering and management, the EE of Karlsruhe is favored fundamentally by the local universities and their excellent reputation, attracting young talents to the region. In particular, both of the studies stand out for well-preparing young talents with required entrepreneurial competencies (Belgardt et al., 2021). Nevertheless, educators should promote entrepreneurship across all fields of study to unleash substantial resources additionally, exploiting the power of heterogeneity in founding teams as a success factor (Song et al., 2008; Sciarelli et al., 2021).

A further key characteristic of the EE of Karlsruhe is the distribution of the industrial landscape that is built on a high percentage of small-sized companies (Henn & Terzidis, 2019). The descriptive analysis shows that the majority of startups currently consist of less than five full-time employees including the founders, related to the early stage of the responding companies and that the entrepreneurs tend to bootstrap until the product-

market fit is reached. Although IT companies tend to occupy niches with lower market potential at first, local entrepreneurs are confident in hiring qualified employees within the next year. For the resilience of the EE of Karlsruhe and the permanently ongoing processes of adapting to new trends and addressing niches, those small-sized but therefore agile companies have a positive impact (Spigel & Vinodrai, 2021).

Based on the evaluation of the descriptive analysis, this study reveals the strengths of the EE of Karlsruhe, positively impacting the development of the local ecosystem. First of all, the responding entrepreneurs indicate general trust on a high level, which has been identified as fundamental for the well-functioning of local entrepreneurial activities (Muldoon et al., 2018). In addition, existing formal and informal networks in the EE of Karlsruhe to support entrepreneurship within the region have been detected as adequate to increase the level of interactions between all EE stakeholders (Scott et al., 2021). Being able to rely on networks with high connectivity strongly impacts "the functioning, configuration, evolution, growth, performance, and resilience of EEs" (Fernandes & Ferreira, 2022).

Another positive aspect that is worth to be mentioned is the well-functioning of entrepreneurial recycling within the region. As more than half of the startups rely on the previous founding experience of at least one of the founders, the study demonstrates that resources are likely to stay in the ecosystem, not leaving to work for established companies. Preventing the outflow of those fundamental capabilities is highly supportive of enhancing the resilient growth of EEs (Roundy et al., 2017). Furthermore, it is remarkable that founding teams have made numerous project experiences before even have started to build their business. This expertise is beneficial for the improvement of required entrepreneurial competencies, positively affecting the success rate (Okudan & Rzasa, 2006).

Besides the mentioned positive aspects, the availability and access to financial capital in the EE of Karlsruhe are ambiguous. On the one hand, in contrast to the early 2000s, there seems to be an active business angel scene investing in early-stage startups. On the other hand, the total amount of VC capital raised by high-growth firms remains below its potential. Nevertheless, the percentage of companies that have raised external equity capital has grown continuously over the last years and only a few companies were not able to acquire capital. However, there is still a high number of new ventures that are not

interested in raising VC at this point, and therefore, decided to follow a bootstrapping approach. Overall, the data show a tension between the mindset of entrepreneurs not searching for risk capital and the perspective of classical investors not being interested in the applied business models. This is a contradiction as the majority of startups rate the scalability of their business models in the survey as of high relevance. As a consequence, an expansion of support offers and targeted mentorship may sensitize the startups to a growth strategy based on external venture capital, and educate the entrepreneurs about its opportunities, and risks. As financial capital is a crucial resource for the scaling of high-growth firms, EE leaders should take action to attract VC companies from other ecosystems, aiming to increase the number of investments in local startups. As not even half of startups have received public grants, more promotion has to be done to increase the visibility of these financial opportunities, and the support by the local institutions in the application processes should be improved. Finally, alternative sources in the early stage such as crowdfunding play only a minor role in the EE of Karlsruhe but should be considered to cover financial needs until product-market fit has been reached.

According to the respondents of the survey, a further positive characteristic of the EE of Karlsruhe is that the ecosystem is well-located, providing access to relevant markets. As national and international markets have been mentioned as the most important related to the share of turnover, it can be concluded that those markets can be reached without high restrictions. Besides sales markets, the responding startups rated the connectivity to supplier markets as given so that purchasing and procurement are not seen as a major challenge currently. Although a broad range of entrepreneurs indicates international markets as of high relevance for their business models and revenue streams, the overall integration of internationalization strategies in the early stage remains expandable.

Besides the presented strengths, the survey data provide clear evidence for multiple shortcomings of the EE of Karlsruhe and its framework conditions. According to three-quarters of the respondents, the main challenge for new ventures is currently sales and customer acquisition. In the EE of Karlsruhe, only a few companies have surpassed the threshold of half a million Euros in revenues per year and the average annual turnover remains in the lower sections. This fact is consistent with the general tendency as especially technology-based startups tend to focus on prototyping instead of translating their ideas into a value proposition for customers initially (Gans & Stern, 2003).

Dealmakers as an essential EE element can be supportive to counteract these obstacles by connecting the dots and enabling collaborations with established companies as potential customers (Spigel, 2017; Shwetzer et al., 2019). However, the founders' rating reveals that dealmakers in the EE of Karlsruhe are not existing in sufficient quantity or are inoperable, and consequently, not having a positive impact on sales figures. In particular for the B2B- and service-based business models in the EE of Karlsruhe early cooperation between new ventures and established companies can be critical for the growth and survival of startups. Due to these vulnerabilities, startups tend to have a slower growth rate than is potentially feasible (Brown & Mason, 2014; Pittz et al., 2021). Therefore, the support ecosystem should intensify dealmaking activities and promote the merits of high-growth strategies to enhance productive entrepreneurship in the region. Regarding digital entrepreneurship, avoiding barriers that are slowing down companies´ growth rates is highly important, as startups need to compete with enterprises all around the world and fast acceleration can be a key comparative advantage (Nambisan et al., 2019). As the rated scalability and the growth-related figures are not matching, the data sample tells another story. Hence, education programs should integrate courses on how to build a fast-growing company, and targeted support for this kind of entrepreneurship need to be designed.

A further shortcoming of the EE of Karlsruhe is the complexity of hiring skilled human capital at any time. Although there is a large pool of talent and experts available in the region, the labor market is highly competitive with negative consequences for young firms. As this tense situation is leading to high salaries and increased employee fluctuation, startups are in a difficult position to recruit a qualified workforce whenever needed. This situation has created a somewhat unsatisfactory position for local startups, which may be harming their growth potential. One way to deal with obstacles and address the issue of missing knowledge could be to integrate external experts into the management of the company or even replace positions at a certain point in time (Conti & Graham, 2020). However, the survey data shows that the majority of responding startups have not made use of this possibility and therefore, should include those options in future planning and decision-making. Another shortcoming related to human capital and resources is that female entrepreneurship is highly underrepresented in the region so far. As the descriptive figures outline only 25 percent of the startups have at least one woman included in the founding team. Although this current imbalance in entrepreneurial activities and resulting

the gender gap are consequential to the STEM orientation of the university (Kuschel et al., 2020), more effort has to be made in promoting entrepreneurship amongst women actively. Furthermore, to address this inequality more specialized programs have to be developed in the near term to promote the career path of being an entrepreneur to female talents. For the resilient growth of EEs, it is indispensable to attract women to join the local EE as an essential additional resource.

To sum it up, the framework conditions of the EE of Karlsruhe are favorable, concerning the underlying geographical and economical context. By and large, entrepreneurs are positively influenced by the well-functioning of the EE and its individual elements, not hindering the successful growth of local startups. Concerning EE resilience, particularly worthy of emphasis is the proper balance between a concrete focus and diversity. Addressing future megatrends such as AI, sustainable mobility solutions, and environmental technologies through intensive research activities promotes a permanent ongoing search for new business opportunities. Through this focus on cutting-edge technology, a continuous structural change is happening, leading to enhanced productive entrepreneurship. Remarkably, technology-based startups are likely to become leading companies in their particular niche. Therefore, EE leaders should maintain to focus on quality rather than on quantity.

Nonetheless, as the intensive discussion of the survey data in this chapter has shown there is still plenty of room for improvement. Whereas the support of projects and early-stage startups is sufficiently available, more emphasis should be given to high-growth entrepreneurship. Therefore, improving the entrepreneurial mindset to become more ambitious is not only applying to startups but also all EE actors and institutions. Furthermore, support programs should be targeted to special groups of entrepreneurs so that resources are unlocked eminently, exploiting the full potential of the EE of Karlsruhe.

7.5 Bivariate Correlation Analysis

After evaluating the survey data descriptively, highlighting the characteristics of the EE of Karlsruhe, and deriving suggestions for improvement toward higher resilient growth, the following section focus on inferential statistics. Thereby, the study is using bivariate correlation analysis to test the hypotheses developed in Section 7.2, aiming to verify empirically the significant relationship between individual EE elements and the firm performance of local startups. These correlation analyses aimed to measure the degree of

the linear relationships between the independent and the dependent variables (Raab-Steiner & Benesch, 2021).

Before conducting hypothesis tests, it is a stringent requirement to check the data sample as a prerequisite to the parametric procedures (Field, 2013). Furthermore, based on the type of data scales (nominal, ordinal, metric), different correlation tests need to be taken into consideration (Cliff, 1996; Denis, 2019). Therefore, Table 17 indicates which of the tests is likely to be preferable in which situation. However, depending on the concrete conditions of the particular study and the composition of the data sample, the selection might differ (Diekmann, 2014).

Table 17. *Correlation test selection (Rößler & Ungerer, 2019, own illustration)*

	Metric	**Ordinal**	**Nominal**
Metric	Pearson	-	-
Ordinal	Kendalls Tau	Kendalls Tau	-
Nominal	Eta coefficient	Chi^2	Contingency coefficient

Preemptively to the statistical analyses, multiple checks concerning the quality of data and the applied measures had to be performed. Following this process contributed to the scientific rigor and transparency of the empirical survey-based correlation analysis, ensuring the goodness of data and measures (Slattery et al., 2011; Raab-Steiner & Benesch, 2021). Therefore, it has been fundamentally important to examine the generated variables regarding normal distribution (Field, 2013). In general, the normality of individual variables can be tested by either the application of statistical or graphical methodologies (Patel & Read, 1996). As the sample is below 100 respondents (n=84), the recommended Kolmogorov-Smirnov test has been utilized for the conducted study. Thereby the values for skewness and kurtosis had a wide range for each variable, not fulfilling a significance level of $\alpha<0.05\%$. The figures indicate that the kurtosis of the variables has been on an extreme level, and hence, the variables could not be treated as normally distributed within the subsequent statistical analyses. In the second step, the developed instrument was tested if it accurately measured the variables in the way it was meant to. Afterward, exploratory factor analysis (EFA) was used to determine the construct validity of the measures, and a reliability analysis based on Cronbach's alpha to ensure internal consistency (Bougie & Sekaran, 2019). In doing so, the data sample

was systematically analyzed for possible underlying patterns, determining the factor structure and aiming to reduce complexity (Beavers et al., 2013). Finally, the extracted factors were interpreted, named, and compared with the initial theoretical foundation (Costello & Osborne, 2005).

In this study, the firm performance indicators ((1) number of employees, (2) turnover, (3) investment, (4) average annual growth, and (5) the years of survival) as the dependent variables are based on an interval scale. Moreover, the independent variables as the characteristics of the startups are either interval-scaled or Likert-scaled. As both can be categorized to the ordinal scale, Kendall's Tau has been selected for the bivariate correlation analysis (Cliff, 1996). In the case of two ordinal scaled variables the use of Spearman's rank correlation coefficient can be an envisaged methodology (Gauthier, 2011)

However, in particular, in quantitative analysis with a smaller data sample (N=84) and missing normal distribution, Kendall's Tau is favorable (Döring & Bortz, 2016). The bivariate evaluation identified the relationship between two variables (inferential statistics) by testing for a significantly positive correlation (Diekmann, 2014; Denis, 2019). To examine the 2-tailed correlation the significant levels of $\alpha<0.01$ level (**) and $\alpha<0.05$ level (*) have been applied.

Findings of the correlation analysis

To statistically test the hypotheses developed in Section 7.2, several bivariate correlation analyses were conducted, aiming to measure the degree of the linear relationships between the independent and the dependent variables as well as between multiple independent variables. In general, there is a correlation between two variables if a variation of one variable has an impact on the variation of the second variable (Raab-Steiner & Benesch, 2021). In the following section, the data sample has been tested by using the SPSS software. Table 18 presents the correlation analysis of the study variables.

Table 18. Correlation analysis of the study variables

No.	Variables		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	University	Correlation	1,000	0,155	-0,177	0,000	0,130	,222*	0,077	0,049	,264**	-0,119	-0,126	0,117	0,140	0,178	0,166
		Sig.		0,099	0,055	1,000	0,154	0,013	0,399	0,588	0,004	0,186	0,157	0,193	0,114	0,052	0,070
2	Equity Capital	Correlation	0,155	1,000	0,046	0,170	0,048	0,048	-0,046	0,049	,194*	-0,125	-,196*	0,014	-0,023	0,025	-0,184
		Sig.	0,099		0,639	0,077	0,620	0,608	0,635	0,603	0,041	0,186	0,036	0,882	0,803	0,796	0,056
3	Digitalization	Correlation	-0,177	0,046	1,000	,372**	-0,032	-0,010	-0,049	0,110	0,141	-0,058	,251**	0,148	0,075	0,040	-0,077
		Sig.	0,055	0,639		0,000	0,730	0,916	0,604	0,232	0,132	0,531	0,006	0,109	0,408	0,670	0,417
4	Scalability	Correlation	0,000	0,170	,372**	1,000	0,106	0,172	0,091	0,145	0,042	0,084	,234**	,321**	0,154	0,031	-0,020
		Sig.	1,000	0,077	0,000		0,256	0,059	0,329	0,111	0,649	0,359	0,010	0,000	0,088	0,737	0,835
5	Tust	Correlation	0,130	0,048	-0,032	0,106	1,000	,440**	,197*	,190*	,225*	,180*	-0,048	0,013	,347**	0,107	,289**
		Sig.	0,154	0,620	0,730	0,256		0,000	0,030	0,034	0,013	0,046	0,593	0,883	0,000	0,246	0,002
6	Mentors	Correlation	,222*	0,048	-0,010	0,172	,440**	1,000	,274**	,319**	,253**	0,097	0,000	,175*	,425**	0,165	,308**
		Sig.	0,013	0,608	0,916	0,059	0,000		0,002	0,000	0,004	0,270	0,997	0,047	0,000	0,067	0,001
7	Dealmakers	Correlation	0,077	-0,046	-0,049	0,091	,197*	,274**	1,000	,202*	0,075	0,122	0,042	,272**	0,162	0,109	,192*
		Sig.	0,399	0,635	0,604	0,329	0,030	0,002		0,025	0,411	0,177	0,635	0,002	0,068	0,238	0,036
8	Personal network	Correlation	0,049	0,049	0,110	0,145	,190*	,319**	,202*	1,000	,465**	0,052	-0,006	0,098	,353**	,226*	0,151
		Sig.	0,588	0,603	0,232	0,111	0,034	0,000	0,025		0,000	0,558	0,946	0,266	0,000	0,012	0,094
9	Access to the EE	Correlation	,264**	,194*	0,141	0,042	,225*	,253**	0,075	,465**	1,000	0,019	-0,068	0,061	,293**	,309**	0,176
		Sig.	0,004	0,041	0,132	0,649	0,013	0,004	0,411	0,000		0,832	0,441	0,494	0,001	0,001	0,054
10	Skilled employees	Correlation	-0,119	-0,125	-0,058	0,084	,180*	0,097	0,122	0,052	0,019	1,000	0,045	0,028	0,119	0,027	,256**
		Sig.	0,186	0,186	0,531	0,359	0,046	0,270	0,177	0,558	0,832		0,610	0,754	0,172	0,769	0,005
11	Access to markets	Correlation	-0,126	-,196*	,251**	,234**	-0,048	0,000	0,042	-0,006	-0,068	0,045	1,000	,371**	-0,006	-0,002	0,057
		Sig.	0,157	0,036	0,006	0,010	0,593	0,997	0,635	0,946	0,441	0,610		0,000	0,943	0,983	0,524
12	Early international	Correlation	0,117	0,014	0,148	,321**	0,013	,175*	,272**	0,098	0,061	0,028	,371**	1,000	,192*	0,073	-0,014
		Sig.	0,193	0,882	0,109	0,000	0,883	0,047	0,002	0,266	0,494	0,754	0,000		0,028	0,421	0,881
13	Event participation	Correlation	0,140	-0,023	0,075	0,154	,347**	,425**	0,162	,353**	,293**	0,119	-0,006	,192*	1,000	0,089	,227*
		Sig.	0,114	0,803	0,408	0,088	0,000	0,000	0,068	0,000	0,001	0,172	0,943	0,028		0,320	0,011
14	Entrepreneurship culture	Correlation	0,178	0,025	0,040	0,031	0,107	0,165	0,109	,226*	,309**	0,027	-0,002	0,073	0,089	1,000	,245**
		Sig.	0,052	0,796	0,670	0,737	0,246	0,067	0,238	0,012	0,001	0,769	0,983	0,421	0,320		0,008
15	Focus on productive entrepreneurship	Correlation	0,166	-0,184	-0,077	-0,020	,289**	,308**	,192*	0,151	0,176	,256**	0,057	-0,014	,227*	,245**	1,000
		Sig.	0,070	0,056	0,417	0,835	0,002	0,001	0,036	0,094	0,054	0,005	0,524	0,881	0,011	0,008	

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

At first, the main hypotheses H_{1a}, H_{2a}, H_{3a}, H_{4a}, H_{5a}, H_{6a}, and H_{7a} assuming that individual characteristics of the startups and elements of the EE directly affect the firm performance of the startups as the EE outcome were tested. Thereby, both Kendall Tau-b´s correlation, as well as Pearson´s correlation, revealed no statistically significant relationship between the dependent firm performance indicator and one of the individual independent variables. Thus, the hypotheses of H_{1a}, H_{2a}, H_{3a}, H_{4a}, H_{5a}, H_{6a}, and H_{7a} were rejected. Alternatively, the individual parts of the FPI ((1) number of employees, (2) turnover, (3) investment, (4) average annual growth, and (5) the years of survival) were tested against the impendent variables, but also not delivering significant correlation. Consequently, the fundamental idea behind the FPI could not be verified and had to be replaced as the data sample collected through the survey has not delivered the required data density. Therefore, future research is encouraged to re-adapt the approach to a larger reference group. Nevertheless, the subsequent bivariate correlation analysis of the independent variables provided thrilling insights.

Trust

As the element of trust has been identified as essential for the processes in EEs that enhance productive entrepreneurship (Muldoon et al., 2018), it is of high interest how to impact the creation of confidence. Therefore, Hypotheses H_{1c} and H_{1d} proposed that the entrepreneurial culture as well as regular participation in events affects the trust of startups in the EE and its present actors. Kendall Tau-b´s correlation revealed a significant positive association between the level of trust and the entrepreneurial culture (τ b = 0.289**, ρ = 0.002) and participation in events (τ b = 0.347**, ρ = 0.000). Both tests are significant under the 0.01 level. Furthermore, hypothesis H_{1b} can be verified as there is a moderately positive and significant correlation between the level of trust and access to the EE (τ b = 0.225, ρ = 0.013) considering a significance level of α = 0.05. To sum it up, the data support the hypothesis H_{1b}, H_{1c}, and H_{1d} that trust in the EE can be positively affected by concrete entrepreneurial processes, and therefore, EE builders are promoted to enable and foster those trust-building activities (Cunningham et al., 2019; Belitski et al., 2021).

Networks

The existence of formal and informal networks in an EE is likely to increase the level of interactions between diverse stakeholders, supporting the emergence of productive

entrepreneurship in the regional context can (Scott et al., 2021). Therefore, this study proposed that relying on a strong personal network affects the fundamental trust of startups in the EE (H_{2b}), the exchange with mentors (H_{2d}), and the access to the EE (H_{2e}). Applying the Kendall Tau-b test revealed a significant positive relationship between the personal network of startups and the level of trust in the EE (τ b = 0.190*, ρ = 0.034), the exchange with mentors (τ b = 0.319**, ρ = 0.000), and access to the EE (τ b = 0.465**, ρ = 0.000). Furthermore, hypothesis H_{2c} that there is a positive correlation between the personal network of startups and the participation in events is confirmed (τ b = 0.353**, ρ = 0.000) considering a significance level of α = 0.01. Therefore, hypotheses H_{1b}, H_{1c}, H_{1d}, and H_{1e} were supported by the data. Consequently, the EE elements positively influencing the creation of strong networks are highlighted to impact the evolutionary processes, performance, and resilience of EEs (Shwetzer et al., 2019; Fernandes & Ferreira, 2022).

Mentors & Dealmakers

Mentors and dealmakers have been identified as important stakeholders in an EE as they share personal advice and directly connect the dots in the ecosystem, positively influencing the well-functioning of entrepreneurial activities (Spigel & Harrison, 2018; Belitski & Büyükbalci, 2021). Hypothesis H_{3c} and H_{3d} predicted that the exchange with mentors affects the trust in the other EE actors as well as access to the EE. The correlation analysis using the Kendall Tau-b test revealed a positive, significant relationship between working with mentors and trust (τ b = 0.440**, ρ = 0.000) and access to the EE (τ b = 0.253**, ρ = 0.004), both at a significance level of α = 0.01. Moreover, hypothesis H_{3f} that there is a correlation between collaborating with mentors and dealmakers and internationalization strategies is supported for mentors (τ b = 0.175*, ρ = 0.028) as well as dealmakers (τ b = 0.272*, ρ = 0.002). Based on the Kendall tau-b test no statistically significant correlation between mentors and dealmakers and the amount of investment raised was observed, and therefore hypothesis H_{3e} was rejected. To sum it up, the data support hypotheses H_{3b}, H_{3c}, and H_{3f} that mentors and dealmakers can have an impact on the capabilities of startups and the outcome of EEs (Spigel, 2017).

International lens

Internationalization strategies have a major role in overcoming the barriers of EEs by transcending physical boundaries, and hence, impacting resilient growth (Asemokha et

al., 2019; Henn et al., 2022a). Therefore, this empirical investigation proposed that the early international orientation of startups is positively correlated to the scalability of their business models (H_{4b}), the hiring of skilled employees (H_{4d}), and the access to markets (H_{4e}). Whereas the bivariate correlation analysis revealed significant positive associations between internationalization and scalability (τ b = 0.321**, ρ = 0.000) and access to markets (τ b = 0.371**, ρ = 0.000) considering a significance level of α = 0.01, the Kendall Tau-b test provided no statistically significant evidence for the hiring of employees (τ b = 0.28, ρ = 0.754). Moreover, hypothesis H_{4c} that participating in events is related to early internationalization strategies was slightly supported by the data (τ b = 0.192*, ρ = 0.028). Concerning the four hypotheses, the correlation analysis confirmed H_{4b}, $H_{4d,}$ and H_{4e} and rejected H_{4c}, highlighting the fundamental role of an international perspective (Theodoraki & Catanzaro, 2022).

Digitalization

Digital entrepreneurship can be a greater opportunity to reduce the negative influence of missing resources in local EEs, enabling startups to build and benefit from global connections (Quinones et al., 2021; Bouncken & Kraus, 2022). To address this crucial role, the following hypotheses proposed that the level of digitalization of the business model is positive significant correlated to the scalability (H_{5b}), the access to markets (H_{5c}), and international orientation (H_{5d}). Whereas the Kendall tau-b test validated the significant and positive correlation between the level of digitalization and the level of scalability (τ b = 0.372**, ρ = 0.000) and the access to markets (τ b = 0.251**, ρ = 0.006), the data did not indicate any statistically detectable relation to early international strategies (τ b = 0.148, ρ = 0.109). To sum it up, the data support hypotheses H_{5b} and H_{5c} predicting that digitalization can lead to an enhanced scaling process of startups by facilitating access to customer markets outside of the local EE (Torres & Godinho, 2022).

Connections to Universities

Universities and research institutions have an essential role in attracting and educating talents as well as being a collecting pool for innovative ideas and therefore, have been identified as focal points for the resilient growth of EEs (Bacon & Williams, 2022). Accordingly, this study proposed that having close connections to the local university directly affects the exchange with mentors (H_{6b}), the hiring of skilled employees (H_{6c}), and the access to the EE (H_{6d}). The correlation between the proximity to universities and

the exchange with mentors (τ b = 0.222*, ρ = 0.013). Furthermore, the Kendall tau-b test revealed that the correlation concerning the access to the EE (τ b = 0.264**, ρ = 0.004) is positive and significant at a significance level of α = 0.01. However, the assumption that a close relationship with the local universities could not be verified through the data statistically (τ b = -0.119, ρ = 0.186) and therefore, H_{6c} was rejected. In conclusion, the data support H_{6b} and H_{6d}, pointing out the role of the intersections between productive entrepreneurship and universities to enhance regional economic growth (Audretsch et al., 2021).

Culture

The fundamental nature of entrepreneurial culture affects other EE elements to a large extent (Walsh & Windsor, 2019). Therefore, the role of entrepreneurial culture in building sustainable EEs has been identified as crucial (Bischoff, 2021; Donaldson,2021). Therefore, the following hypotheses predicted that there is a positive and significant correlation between the perceived entrepreneurial culture in the EE and the raised equity capital (H_{7b}) and a strong focus on productive entrepreneurship (H_{7c}). According to the Kendall tau-b test, the data did not indicate any statistical correlation between entrepreneurial culture and raised equity capital (τ b = 0.45, ρ = 0.638). Nevertheless, a moderate positive, significant correlation between entrepreneurial culture and the focus on productive entrepreneurship (τ b = 0.192*, ρ = 0.036) could be detected at the significance level of α = 0.05. Consequently, the data support the hypothesis (H_{7c}) that there is a favorable dependence between entrepreneurial culture and productive entrepreneurship, encouraging EE builders to invest in social capital for the resilient growth of EEs (Porras-Paez & Schmutzler, 2019).

Table 19. *Summary evaluation of the hypothesis (A=Accepted; R=Rejected)*

Category	***H_n***	***Hypotheses***	***Accepted / Rejected***
Trust	H_{1a}	*Having a high trust in the entrepreneurial ecosystem positively affects the firm performance of startups*	*R*
	H_{1b}	*Having a high trust in the entrepreneurial ecosystem positively affects access to the entrepreneurial ecosystem*	*A*
	H_{1c}	*Participating in events of the entrepreneurial community positively affects the trust of startups in the entrepreneurial ecosystem*	*A*
	H_{1d}	*Entrepreneurial culture positively affects the trust of startups in the entrepreneurial ecosystem*	*A*
Networks	H_{2a}	*Having strong networks in the entrepreneurial ecosystem positively affects the firm performance of startups*	*R*

	H_{2b}	*Establishing a personal network positively affects the trust of startups in the entrepreneurial ecosystem*	*A*
	H_{2c}	*Participating in events of the entrepreneurial community positively affects the establishment of a personal network*	*A*
	H_{2d}	*Establishing a personal network positively affects the exchange with mentors*	*A*
	H_{2e}	*Establishing a personal network positively affects access to the entrepreneurial ecosystem*	*A*
Mentors & Dealmakers	H_{3a}	*Exchanging with mentors positively affects the firm performance of startups*	*R*
	H_{3b}	*Relying on the support of dealmakers positively affects the firm performance of startups*	*R*
	H_{3c}	*Exchanging with mentors positively affects the trust of startups in the entrepreneurial ecosystem*	*A*
	H_{3d}	*Relying on the support of dealmakers positively affects the trust of startups in the entrepreneurial ecosystem*	*A*
	H_{3e}	*Exchanging with mentors positively affects the raised equity capital of startups*	*R*
	H_{3f}	*Exchanging with mentors positively affects the internationalization strategies of startups*	*A*
International	H_{4a}	*Focusing early on internationalization strategies positively affects the firm performance of startups*	*R*
	H_{4b}	*Focusing early on internationalization strategies positively affects the scalability of the business model*	*A*
	H_{4c}	*Participating in events of the entrepreneurial community positively affects the internationalization strategies of startups*	*A*
	H_{4d}	*Focusing early on internationalization strategies positively affects the hiring of skilled employees*	*A*
	H_{4e}	*Focusing early on internationalization strategies positively affects access to markets*	*A*
Digitalization	H_{5a}	*Having a digital business model positively affects the firm performance of startups*	*R*
	H_{5b}	*Having a digital business model positively affects the scalability of the business model*	*A*
	H_{5c}	*Having a digital business model positively affects access to markets*	*A*
	H_{5d}	*Having a digital business model positively affects the internationalization strategies of startups*	*R*
University	H_{6a}	*Having strong connectivity to the local university positively affects the firm performance of startups*	*R*
	H_{6b}	*Having strong connectivity to the local university positively affects the exchange with mentors*	*A*
	H_{6c}	*Having strong connectivity to the local university positively affects the hiring of skilled employees*	*R*
	H_{6d}	*Having strong connectivity to the local university positively affects access to the entrepreneurial ecosystem*	*A*
Culture	H_{7a}	*Having an entrepreneurial culture within the region positively affects the firm performance of startups*	*R*
	H_{7b}	*Having an entrepreneurial culture within the region positively affects the raised equity capital of startups*	*R*
	H_{7c}	*Having an entrepreneurial culture positively affects the focus on productive entrepreneurship*	*A*

8 Conclusion

8.1 Summary

This dissertation deals with the idiosyncrasy of EEs, the evolutionary dynamics, and the impact of the framework conditions on resilient growth. As highlighted multiple times within the individual studies, the EE phenomenon can be associated with a concept that facilitates economic development at the local or regional level. Enhancing entrepreneurial activities and productive entrepreneurship as the outcome of the ecosystem is supportive of the success of sustainable structural change. By providing a new understanding of the contextualization of entrepreneurship based on resource-based reasoning, policy, and EE builders are enabled to create an environment that fosters the implementation of innovative ideas and technologies by entrepreneurial personalities. Therefore, a set of research questions have been developed, addressing the research gap of an evolutionary perspective on EEs and resilient growth. In doing so, this thesis explored how individual EEs differ in the way actors, factors, and their interactions support, or not, young entrepreneurs, start-ups, scale-ups, and the resilience of all entrepreneurial firms. Thereby, the objective of this thesis has been to enable people to transform their ideas into businesses, creating jobs and reducing poverty around the globe.

Through the implication of diverse methodologies following a mixed-method approach, all of the individual studies present important findings, highlighting the relevance of the EE approach for improving entrepreneurial activities in a local context. By discussing the key insights, relevant aspects, and major contributions, this chapter synthesizes the findings and reflects on those research projects, highlighting how the particular studies contribute to answering the particular research questions. Analyzing the research process chronologically, all achieved research results are taken into account and summarized as follows.

In the first study, a systematic literature review was performed to categorize the emerging EE literature concerning the topic of resilience. As the EE approach has become one of the most interesting research streams in entrepreneurship, international business, and regional economic development scholars, the fundamental principle of application of this methodology was to explore the interconnectivity between those conceptualizations. In doing so, the study provides an in-depth understanding of how EEs can support resilient

growth in every specific geographical context. Thereby, the bibliometric data and the analysis of the selected literature sample acknowledge the importance of EE framework conditions for productive entrepreneurship as the outcome. Following a rigorous process to ensure high quality and transparency, this part of the thesis discussed the existing conceptualizations and empirical findings from previous articles from multiple perspectives and axes (spatial, structural, and systemic). In addition, a critique of EE literature in its current status has been developed. These obstacles have been addressed in the subsequent empirical studies to further contribute to the promotion of EEs as drivers for regional entrepreneurial activities and productive entrepreneurship. More precisely, the literature review identified four dimensions that have been thoroughly discussed one by one: (1) the systemic approaches and EE determinants, (2) the perspective of the evolutionary dynamics, (3) the context characteristics, and (4) the measurement and evaluation of EEs.

In the first part of the study, the analysis confirmed that some core publications (e.g., van de Ven, 1993; Neck et al., 2004; Cohen, 2006; Isenberg, 2010) have been the starting point of the EE approach (Velt et al., 2020). Following the systemic approach, the level of analysis has been adapted from national EEs (Acs et al., 2014) to a local and regional perspective (Iacobucci & Perugini, 2021). Furthermore, the role of geography became the focal point, enabling the identification of location-specific advantages for fostering regional competitiveness long-term (Schäfer, 2021; Ryan et al., 2021). Various follow-up studies focused on presenting lists of determinants that are influencing local entrepreneurial activities instead of using network theory to analyze the interconnections of individual elements (Alvedalen & Boschma, 2017; Scott et al., 2021). However, to increase the resilience of an EE through targeted measures actively, it is essential to be fully aware of all EE elements, and it is different markedness at any specific place (Theodoraki et al., 2022). Hence, the thorough review of the existing EE literature addressed this shortcoming by extracting and summarizing all relevant elements presented.

Secondly, the study identified the evolutionary nature of EEs as a key characteristic in following the pathway toward resilient growth. Thereby, the building of framework conditions that support the creation of resilient EEs pursues a long-term horizon, not just a short-term equilibrium (Theodoraki & Catanzaro, 2022). Although articles have

developed a dynamic perspective based on different phases, including the stages of decline and reemerge, it has barely been investigated how crises and shocks may affect entrepreneurial firms and their sustainable success (Mack & Mayer, 2016; Brown & Mason, 2017). Therefore, the concept behind EE evolution and its impact on the transformation processes of local economies is considered undertheorized (Walsh, 2019: Cho et al., 2022).

In general, resilience is an adaptive conceptualization based on evolutionary dynamics and relies on the ability to deal with continuously shifting external and internal influences (Williams & Vorley, 2014; Roundy et al., 2017). Combining structural aspects and attributes with dynamic processes and the scaling of capabilities provides a process-based view of the transformation of EEs toward the resilient stage (Spigel & Harrison, 2018; Walsh, 2019). Thereby, EE resilience depends on the creation, flow, and transformation of resources and their recycling (Spigel & Vinodrai, 2021). Furthermore, the well-functioning of an EE prevents the outflow of new ventures to other places, and new resources are attracted to participate in the entrepreneurial community (Roundy et al., 2017; Spigel & Harrison, 2018).

The third part of the study discussed patterns of how to build EE resilience as well as characteristics that are influencing the transformation positively. As a “one-size-fits-all” approach does not meet the concrete circumstances at a specific place, a simple reproduction of a combination of determinants from a successful ecosystem is not expedient (Belitski & Büyükbalci, 2021; Bouncken & Kraus, 2022). To deal with the ambiguity to which extent decisive EE elements are pronounced in a geographical context, an understanding of the scope and spatial scale as well as the EE boundaries has to be created (Roundy et al., 2017; Malecki, 2018). Strengthening the local framework conditions to enable resilient growth has to build on multiple dimensions, including micro-, meso- and macro-level perspectives (Theodoraki & Messeghem, 2017; O´Kane et al., 2021). Furthermore, it is essential to be aware of the focal point of the ecosystem and its impact on the structural setting and capability of the EE (Guerrero et al., 2021). Relevant EE drivers could be entrepreneurs, universities and research institutions, policy, and military as well as established companies (Miller & Acs, 2017; Cukier et al., 2020; Belitski et al., 2021; Ryan et al., 2021). Even though an active and engaged actor can be a catalyst for the further development of an EE, especially in the early stage, depending

on one organization may be critical (Spigel & Harrison, 2018). Hence, for the transformation towards a more resilient stage, additional anchor organizations need to emerge to reduce dependence (Spigel & Vinodrai, 2021).

Another EE-level characteristic that is likely to increase the resilience of local EE is to balance the paradoxical tension between diversity and coherence (Roundy et al., 2017). Whereas ecosystems with a higher diversification rate are less sensitive to the fluctuations of resources (Spigel & Harrison, 2018), focusing on a core industry or technology may lead to spillover effects (Brown & Mason, 2017). However, following the evolutionary path, EEs tend to transform into a Marshallian district type that may be vulnerable to adapt to future trends (Walsh, 2019). Having a diverse ecosystem based on different kind of young firms significantly impact the robustness and resistance against unexpected crisis and shocks (Cavallo et al., 2019). Thereby, the continuous process of searching for new business opportunities is supportive of rebalancing the orientation of entrepreneurial activities (Cantner et al., 2021). Overall, the combination of coherence and diversity is co-producing EE resilience (Roundy et al., 2017).

In the final part, the study treated in-depth the shortcoming concerning the measurement and evaluation of EEs as a major criticism of the EE approach currently. Although there have been some attempts to develop a universal EE metric, multiple articles indicated that it is still unsolved how to measure EE performance and outcome and what indicators to include in the calculation (Stam & van de Ven, 2021). However, in practice, all of these approaches have shown major limitations, and none have prevailed. This can be traced back to the lack of a clear analytical framework (Alvedalen & Boschma, 2017). In addition, the existing data are neither fulfilling the required quality criteria nor are they available in any geographical context. Although having those data about the characteristics of new ventures would be of paramount importance to evaluate EE resilence (Roundy et al., 2017), a lack of quantitative modeling and survey-based research is detectable (Maroufkhani et al., 2018; Fernandes & Ferreira, 2022). Therefore, future research is challenged to enhance the collection of data from startups about their characteristics and firm performance (Iacobucci & Perugini, 2021). Within the regional context, those statistics can be used as a proxy for the EE outcome, allowing conclusions to be drawn on the functioning of individual elements and the entire ecosystem (Brown & Mason, 2017; Stam & van de Ven, 2021). As research on the resilient growth of EEs

requires an evolutionary and dynamic perspective, empirical investigations need to be conducted periodically to create longitudinal data (Buratti et al., 2022; Fernandes & Ferreira, 2022). The insights and considerations of this section have formed the valuable basis for the quantitative analysis of the EE Karlsruhe presented in study three.

The second study addressed challenges and barriers in the evolutionary dynamics of EEs toward growing into a more resilient stage. To answer that research question, a qualitative approach based on 35 expert interviews in four countries of the Global South has been conducted, including all relevant types of EE actors. Thereby, the insights from the review of EE literature form the basis for the research project, in particular for the development of the interview guidelines and the applied inductive coding strategy (Gioia et al., 2012). The conceptual design applied a cross-national analysis to address the research gap that previous articles tend to concentrate their investigations on only one ecosystem. Aiming to understand the strategic orientation of EEs in an early stage, developing and emerging countries in Latin America have been selected as investigation areas for this research project. In doing so, the comparative and multiscalar perspective of this study led to a compiled list of feasible starting points and potential solutions how to overcome these obstacles, modifying the theoretical conceptualization of the EE approach.

The empirical analysis revealed multiple insights supporting the evolutionary path of EE resilience. The data showed that all six domains according to Isenberg (2010) are highly relevant for the resilient growth of EEs. The main challenges negatively influencing entrepreneurship in a regional context are a lack of trust (Quinones et al., 2021), fraud, corruption (Freire-Gibb & Gregson, 2019), inherent institutional instabilities (Reyes & Sawyer, 2019), and high regulatory burden (Salinas et al., 2020). Furthermore, a low level of education (Ferreyra et al., 2017), missing entrepreneurial competencies, small markets, and the non-functioning of networks (López & Álvarez, 2018) have been identified as substantial obstacles. Surprisingly, the study highlighted the extraordinary role of women and senior entrepreneurship, demonstrating the potential behind all kinds of entrepreneurial activities.

First of all, the findings indicated that entrepreneurship in Latin America has been mainly driven bottom-up by the entrepreneurial community so far, not by local deciders or EE builders. The established strategy of policy-makers providing support by using the scattergun approach without differentiating between diverse kinds of entrepreneurship

proved to be inefficient (Brown & Mason, 2014). Instead, public policy should mainly focus on building supportive framework conditions and fostering an entrepreneurial culture in the region (Bischoff, 2021). Due to limited financial means, lack of expertise, and slow transformation processes, nascent EEs cannot provide perfect conditions in any domain at any time yet (Mack & Mayer, 2016; Cho et al., 2022). Therefore, the objective should be to enable young firms to access other EEs with sufficient resources. In doing so, the connectivity between EEs globally can reduce the outflow of entrepreneurs and their new ventures and attract new resources additionally (Spigel & Harrison, 2018). The findings of this study revealed that entrepreneurs in Latin America already have an international orientation to compensate for the non-existence of required resources in their particular home EEs. Thereby, internalization strategies could be observed in manifold ways. This includes attendance at global competitions, the search for venture capital and industry partners, the development of global business models, and the exchange with entrepreneurs from different cultural backgrounds, positively influencing the entrepreneurial mindset. For EEs, instead, the role of internationalization is important to attract talent and financial and social capital. Institutions can stimulate awareness by addressing the topic in entrepreneurial education courses, support programs, and public events. For a sustainable impact of internationalization strategies on the resilient growth of EEs, this study highlighted the importance of a well-functioning local support infrastructure and partner organizations that are well-connected in the domestic markets (Theodoraki & Catanzaro, 2022).

In addition, this study found empirical evidence that digital entrepreneurship is supportive of transcending physical boundaries. By providing access to markets around the globe, the barriers for startups from smaller markets and rural areas can be significantly reduced. Furthermore, digital networks are likely to compensate for the lack of functioning physical networks. Building the necessary infrastructure to access global markets through digital entrepreneurship is a major challenge for policymakers. Overall, for EE resilience, these framework conditions are essential as a comparative advantage for regional competitiveness.

The findings of this study pointed out that EE internationalization needs to be actively enhanced already in the early stage to impact the evolutionary path toward resilient growth. Adopting an international perspective from the beginning stands in contrast to

the transformation process, according to Spigel & Harrison (2018), introducing a new debate on the contextualization of entrepreneurship (Stam & Welter, 2020). Therefore, international entrepreneurship (IE) literature should be integrated into future discussions.

In the third part of the thesis, case study research has been used to adapt a regional perspective on the evolution of new technology-based firms. Observing and analyzing the evolution of two startups from the EE of Karlsruhe from the idea stage into an established company in practice, empirical results confirmed the impact of local EE framework conditions on the evolutionary dynamics and resilient growth. Thereby, conducting case study research was beneficial in understanding the complex behavioral patterns of entrepreneurial activities (Creswell & Poth, 2018). Based on the insights of previous studies, the compound relationship between a new venture and the surrounding EE has been described in detail. In particular, the challenges and barriers in the evolutionary dynamics of the EE of Karlsruhe have been linked to the findings and the further modified theory on regional EEs and resilient growth. Therefore, semi-structured expert interviews with the founders delivered comprehensive insights, experience reports, and thought processes directly from the inner circle. With this unique data source, it has been possible to analyze their interactions with the EE elements at any time. In doing so, this study provided an understanding of how the EE of Karlsruhe positively or negatively influences the growth of local startups. Applying an in-company perspective, conclusions on the EE and its well-functioning could be drawn, and thus, the understanding of the significance of local entrepreneurial processes on the resilient growth of EE was further developed. Consequently, the study found evidence that EE resilience and the interdependency between micro- and macro-processes are closely linked (Roundy et al., 2017). As at multiple points in time, entrepreneurial recycling was critical for the survival of both companies, the hypothesis of Spigel & Vinodrai (2021) concerning the role of institutions and social capital at different spatial levels can be supported. Overall, the operational framework developed through the previous studies has been qualitatively validated by the applied primary case study research approach.

In the final study, this thesis followed a quantitative research methodology to address the research questions of how to measure and evaluate EEs in a regional context as well as their resilience. In doing so, this section challenged the fundamental idea that favorable framework conditions impact the firm performance of new ventures as the outcome of

the EE (Rocha & Audretsch, 2022). Based on the insights from the analysis, the aim has been to monitor the EE dynamics and individual characteristics to derive recommendations for actions for EE development toward a higher resilient stage. Consequently, the study addresses the need for more quantitative modeling approaches in the field of EEs (Maroufkhani et al., 2018).

In the beginning, the study adopted a critical perspective on the current data situation by reviewing existing public data sources, measurement approaches, and their shortcomings (O´Connor & Audretsch, 2022; Wurth et al., 2022). As EE research is struggling with challenges such as data availability, quality assurance, transparency, and comparability, the generalizability is limited, and none of the multiple measurement approaches has prevailed (Iacobucci & Perugini, 2021). Furthermore, traditional economic metrics do not fulfill the requirement as in practice EEs are not completely isolated, and those data may be diluted by external influences (Shane, 2003; Ligouri et al., 2019).

Aiming to measure the functioning of EEs and their resilience, this study addressed known vulnerabilities by introducing a survey-based diagnostic tool. Therefore, the survey is designed as a bottom-up approach built on the characteristics of startups in a particular EE as input and output measures. In doing so, quantitative data on firm performance indicators and firm-level perceptions of EE elements and the interactions between them could be created. Thereby, the EE outcome is measured in terms of the success of the startups based on the firm performance indicator, including annual turnover growth, number of employees, amount of raised venture capital, and years of survival. Furthermore, the findings from the previous studies were transformed into question items to test the hypotheses related to the resilient growth of EEs. Based on existing startup questionnaires and developed hypotheses constructs, the survey was designed as a data collection tool, generating comparable EE metrics in any geographical context. As the survey was conducted three times in the EE of Karlsruhe between 2015 and 2022, the empirical investigation created longitudinal data and further developed the EE measurement from a statical to a dynamical approach.

Following an intense data collection process based on a self-created list with around about 1,000 local startups, the obstacles of missing data could be reduced, and a sufficient number of respondents were reached. In total, 104 founders fully answered the questionnaire, whereas 84 have been useable for the evaluation part. Thereby, the

emphasis of the empirical research consisted of two parts. At first, the descriptive part was applied question by question as a diagnostic tool to analyze the EE elements, deriving strengths, weaknesses, and finally, concrete suggestions for improvement. Secondly, the data were used to test the hypothesis by applying an explorative factor analysis.

In particular, the descriptive analysis provided a holistic view of the EE of Karlsruhe and proved the applicability of a survey-based evaluation tool for the further development of EEs towards a more resilient stage. The empirical inquiry enabled the understanding of the characteristics of the region, supportive elements as well critical barriers. On the other side, as not many of the hypotheses concerning the significance of the framework conditions on the firm performance indicator were supported by the underlying data, the part of the analysis has to be reconsidered. However, the study highlighted multiple correlations between individual elements, contributing to an advanced theoretical modification of the EE approach.

In summary, the thesis answered all three research questions one by one. It has been confirmed that the EE approach needed to develop from a country-level perspective to a regional concept. This study advanced the multi-dimensional measures and the evolutionary understanding to describe the complicated relationship between economic growth and entrepreneurship at a specific place. Although entrepreneurship is mainly driven bottom-up, the findings demonstrated that active support by local deciders and policy-makers is required to influence individual EE elements, facilitating growth-oriented and productive entrepreneurship.

8.2 Relevance and Implications

Relevance

Over the last decade, the EE approach has become a strongly emerging phenomenon, attracting overwhelming attention from scholars and policymakers (Wurth et al., 2022). The geographical contextualization of entrepreneurship has become a major subject in contemporary entrepreneurship research (Harima et al., 2021). Nevertheless, theoretical development and the implication in practical strategic planning are still in their infancy (O´Connor & Audretsch, 2022). Therefore, the thesis is of high relevance as it provided multiple studies on how to further develop the understanding of regional entrepreneurial activities and the influence of the local environment. This chapter reflects on the value of

the research project and the findings derived from all conducted studies for both scientific as well as practical circles.

Overall, the concept of EEs is associated with an economic strategy that facilitates regional development based on the creation of a supportive environment fostering high-growth firms (Spigel & Harrison, 2018). Regional competitiveness becomes crucial, as it leads to competitive advantage and secures the survival of EEs when confronted with external, unpredictable shocks (Spigel & Vinodrai, 2021; Cho et al., 2022). Therefore, the objective of this thesis was to create an understanding of how to prepare upfront for more and more frequently upcoming crises by increasing EE resilience. The development of a profound knowledge base and the transformation into a diagnostic tool has been of paramount importance as the structures and dynamics of EEs vary widely across regions, even in the same nation or industry (Alvedalen, 2021).

Besides addressing the shortcomings of the current EE literature, this research project identified a strong potential in a new era of economic development. Providing supportive framework conditions and increasing the entrepreneurial competencies of talents in a particular region can have a major impact on the economic outcome. Therefore, the findings are highly relevant to the further developing regional economies, especially for nascent ecosystems and EE in developing and emerging countries (Guerrero et al., 2021). Moreover, this thesis followed the current discourse on value-based growth and raised awareness to support responsible and sustainable entrepreneurship in the local context, not focusing on monetary success only. In combination with an evolutionary perspective, this approach can have a major impact on productive entrepreneurship and resilient growth, leading to enhanced addressing of societal problems.

Theoretical implications

By addressing the main research questions, this thesis contributed to the current EE literature, tying to the demand of further developing the immature theoretical conceptualization (Fernandes & Ferreira, 2022). Although the growing body of literature indisputably presented valuable insights, the incidence of publications led to a fuzzy image in its entirety (Brown & Mason, 2017; Cao & Shi, 2021). Overall, the findings of this thesis made important theoretical contributions to the EE phenomenon by deepening

the understanding of how EEs and their framework conditions can support the resilient growth of regional economies.

To summarize the emerging EE literature and extract the core aspects related to the holistic view of EE resilience, in the first study a systematic literature review has been conducted. In this format, the bibliometric inquiry provided an overview of the descriptive numbers of publishing years, countries, institutions, journals, and relevant researchers. Furthermore, through the review, the EE approach has been linked to the concept of economic resilience, identifying the intersections and introducing a knowledge base of critical elements influencing the enhancement of EE resilience. The findings of this thesis contribute to the argument that the systemic approach of EEs should follow a local nature rather than a national-level perspective.

Although a comprehensive list of static EE determinants has been compiled, evolutionary dynamics have been identified as remarkably impactful on resilient growth. As the EE evolution is still undertheorized, the thesis reviewed existing life-cycle and process-based dynamic approaches and synthesized the insights into an EE path dependence. As argued before, for the resilient growth of EEs it is of paramount importance to adopt a resource-centric view. This includes not only attracting resources to the ecosystem or preventing resources from leaving but also the impactful recycling of entrepreneurial resources. Beyond that, this dissertation highlighted the activation and integration of existing resources to the local EE, such as women or senior entrepreneurship.

In a second study, a cross-national analysis has been conducted to identify challenges and barriers embedded in the transformation process toward EE resilience. Observing individual EE actors in their natural environment and how entrepreneurs are dealing with obstacles and missing resources, led to the identification of promising bottom-up strategies. In particular, following an international orientation has a significant effect on overcoming growth barriers. Hence, this thesis argues that in contrast to the transformation theory of Spigel & Harrison (2018), internationalization strategies can stimulate the resilient growth already in early-stage EEs. Consequently, this dissertation contributed to a new contextualization of spatial boundaries by merging the EE approach with the international entrepreneurship (IE) literature and transnational dimensions. In combination with the insights from the systematic literature review, this comprehensive

knowledge extended the previous understanding of the further development of EEs to a holistic approach.

As it is a common consensus among researchers that the absence of comparable metrics to measure and evaluate EEs is a major shortcoming, this thesis addressed this issue on multiple levels. Based on the review of the current EE literature and the critical discussion of the weaknesses, a survey-based diagnostic tool has been developed. Thereby, the collection of data from startups about their characteristics and firm performance as a proxy for the EE outcome enables unraveling the complex relationships (Sternberg et al., 2019). Implementing the questionnaire in the analysis of one single EE and thus verifying its applicability, a solid basis for redefining has been generated. Additionally, conducting the survey periodically addresses the evolutionary nature of EEs, facilitating the tracing of the transformation based on longitudinal data to understand the impact of space and time (Cho et al., 2022). As the measurement framework can be applied at any EE across the globe, no matter which geographical context, the vulnerability of comparability is removed.

Practical implications

The role of public policy in supporting entrepreneurship has been criticized across multiple disciplines (Stam, 2015; Knox & Arshed, 2022). For a long time, governmental institutions tended to spread subsidies through a scattergun approach, leading to ineffective programs and sunk costs (Guerrero et al., 2021). Although policymakers have strong interests in fostering entrepreneurial activities within their regional boundaries, those deciders have difficulties in making informed decisions (Hannigan et al., 2021). Due to the missing knowledge about EE emergence and evolution as well as the absence of an adequate diagnosis approach, policymakers tend to just copy policies observed in successful regions instead of developing a strategy tailored to the local conditions (Leendertse et al., 2022; Wurth et al., 2022). Nevertheless, EEs and their evolutionary dynamics toward a more resilient stage require policy interventions to create economic well-being and to be able to respond to future challenges (Brown & Mason, 2017; Feldman et al., 2019).

This dissertation supports policymakers and EE builders in developing a cohesive, strategic direction based on the context-specific structures in their local boundaries.

Providing an in-depth understanding concerning the linkages between the EE approach and economic resilience, political institutions can follow a profound process to build sustainable framework conditions. This knowledge base includes all EE elements that either enhance or hinder entrepreneurial activities and is beneficial to differentiate between productive entrepreneurship and destructive entrepreneurship. For government and local institutions, it is essential to raise awareness about those challenges and barriers toward the resilient growth of local economies to create regional competitive advantages (Tavassoli et al., 2021). Although policymakers are obliged to contribute to more effective place-and evidence-based strategic planning (Buratti et al., 2022), this dissertation highlighted the negative consequences of an overregulated system as it may slow down the growth of startups significantly. Instead, policy should concentrate on eliminating or at least reducing bureaucracy and administrative obstacles as well as on fostering an entrepreneurial culture and trust-building measures.

As almost all ecosystems deal with missing or unincisive resources, the findings of this study stimulate EE builders to promote connectivity to other EEs. Having those relationships is likely to provide new ventures access to a broad range of specific resources, especially important for nascent and smaller ecosystems. Furthermore, internationalization strategies and transnational entrepreneurship have to be a core dimension of strategic planning to build onramps to global markets. Nevertheless, the insights of the research articles indicate that it is at least as important to enhance the collaborations between local EE actors to create well-functioning networks.

Another critical lesson of this dissertation is that, in practice, EEs cannot be fully governed by public policy. Hence, policymakers should enable all EE actors to contribute with their respective share and within the limits of their possibilities to the further development of the EE framework conditions. Thereby, this implies that the complexity of actions requires strong guidance by the local support infrastructure on multiple levels and even through an international lens (Theodoraki & Catanzaro, 2022).

As policymakers have frequently failed to build supportive framework conditions due to a lack of an adequate diagnosis approach (Leendertse et al., 2022), this study developed a valuable tool to measure EEs. Addressing the evolutionary dynamics of EEs, public policy is instructed to evaluate their ecosystem continuously to analyze how individual actions affect entrepreneurial activities. In doing so, longitudinal empirical evidence

becomes available that can be used to learn from previous mistakes and permanently redefine the framework conditions to the changing dynamics.

Finally, another important implication is that policymakers should actively deepen collaboration with EE research. Through this kind of cooperation, short-term and long-term strategic planning could be improved based on the current insights from thriving EE literature, aiming to understand the local startups and their needs as best as possible.

8.3 Limitations and Outlook

The applied mixed-method research design covers diverse perspectives to answer the underlying central research issue of this thesis. However, at one point or another, good research has to make compromises, leading to various limitations. In particular, to raise the awareness that a single thesis is not able to address all known shortcomings in the current literature at once. Those issues are an entirely normal process but need to be documented. Hence, the specific limitations of this thesis and the implications for a future research agenda are discussed and summarized in an overlapping manner. Limitations related to the particular scientific methods utilized in the individual studies have been adequately described in the previous subsections (cf. Section 4.6.5, Section 5.6.3, Section 6.2.5, Section 7.6.3).

First of all, from the EE viewpoint, a limitation concerns the nature of the conceptual framework and the inclusion of single elements into the design. Although a high number of further developed EE models and related research articles have been analyzed, the list of elements influencing entrepreneurial activities at a specific place is not exhaustive so far. As every EE evolves in a somewhat different context, the list of potential factors having an impact on local productive entrepreneurship is just about infinite, and maybe never will be described completely. Therefore, future research has to permanently rethink the completeness of EE determinants and weigh up between exceptional nature and generality. Furthermore, the importance of differentiation of elements between systemic conditions and framework conditions and how both categories influence each other plays a minor role in practice, and no substantial deviations could be observed in the studies. Hence, it is relevant to further investigate the relationship between the framework and the systemic elements to strengthen the conceptualization.

Although this research project has adopted a regional perspective, comparing multiple EEs in different geographical contexts, the definition of an EE and its boundaries remains fuzzy. In practice, geographical boundaries are difficult to define, and the influence of actors, factors, and spatial scale differs in any area of investigation. The conceptual framework of EEs needs to be strengthened concerning the adaptability to unique characteristics. Following such a systemic approach, network analysis methods could support the identification and measurement of all kinds of links connecting actors and institutions beyond the boundaries of single EEs. Additionally, future research needs to take a closer look at how those elements are likely to change during the evolution of EEs to address the dynamics of the EE approach.

A further limitation of this thesis is that the empirical investigations do not include all diverse kinds of EEs. Whereas the multi-national qualitative study was based on expert interviews with actors from emerging markets in Latin America, the quantitive analysis was conducted in a medium-sized EE located in a highly developed country with one of the most advanced economies. Although more differentiating work has to be done to increase the generalizability, the findings from the studies are valuable and representative of the EEs and their evolutionary dynamics. However, future research should focus additionally on the resilient growth of EEs in rural areas as well as developed, emerging, and developing economies and distinguishing between countries with smaller or larger markets (Guerrero et al., 2021). In doing so, those insights can be compared to the theoretical foundation developed within this thesis to confirm the line of argument or further improve the conceptualization of local EEs and their impact on resilient growth. In particular, it could be insightful to analyze the internationalization strategies of EEs with large markets such as the US, China, India, and Brazil. Subsequently, differences compared to the necessity-driven development of global business models of smaller ecosystems such as the Netherlands, Sweden, and Israel should be discussed. These insights can strengthen the role of geography and territorial features in the transformation of EEs from a local perspective toward an understanding of the impact on early internationalization.

Another path for future research should include further investigations of the connectivity between single EEs. Having identified transnational linkages as an important EE characteristic and a well-functioning strategy to deal with missing resources, a

comparative approach analyzing relationships EEs in the same country could be used to generate novel insights relevant to a cooperative dynamic approach. While the findings of this thesis highlight the importance of the international perspective in the context of extending the dynamics of the EE model, the research should be repeated in other geographical contexts to increase its generalizability (Theodoraki & Catanzaro, 2022). In particular, EEs in nations that are highly decentralized such as the US, China, and Germany, could benefit from consolidated knowledge and resource exchange, preventing new ventures from leaving the local ecosystems.

Although the quantitative analysis included three data collection periods to examine the evolutionary dynamics of an EE over time, not all of the survey constructs are covered longitudinally. Whereas the descriptive data analysis illustrates the development trends thoroughly, the hypothesis testing part has been based on only a single time point. The adaption of the questionnaire to the topic of resilient growth through integrating the findings from the previous studies was a necessary procedure but has led to this limitation. Therefore, the questionnaire should be conducted regularly in the next years to strengthen the understanding of the long-term dynamics. The focus of the quantitative data collection has been on only one EE, based on a small sample of responding companies. To increase the robustness of the evaluation tool, the study should be repeated in more regions to reveal different relations between the EE and its output (Stam & van de Ven, 2021). Aiming to address the gap of missing measurement approaches to evaluate EEs this research project presented a tool to identify metrics that need to be improved. Although the previous studies provide an understanding of how improvements can be achieved to increase the resilient growth of local EEs, the evaluation of startup data is not automatically leading to clear suggestions. Therefore, it is essential to combine these insights with the findings from the qualitative studies conducted in the particular EE (Leendertse et al., 2022). Nevertheless, another limitation of this thesis is that it is not covering the measurement of networks and the connectivity of individual elements. However, these questions are highly relevant and future EE research should work on that thematic area to gain a more concrete, in-depth understanding of the systemic approach and its effects (Fernandes & Ferreira, 2022).

8.4 Concluding Remarks

The objective of this dissertation was to develop an understanding of how EEs and their framework conditions can enhance resilient growth within a region. Thereby, the EE approach can be seen as a driver for regional economic development, fostering lasting and long-term structural change. Relying on a well-functioning entrepreneurial community can be one part of a solution against poverty, especially in the Global South. Aiming to support researchers, policymakers, and EE builders around the globe in their forthcoming projects, the findings of this thesis provide a guideline to deal with the challenges and barriers in developing those sustainable and more resilient EEs. In doing so, the insights of this study enable local EE actors to act well-founded and thoughtfully based on their local characteristics. Having the knowledge as well as the capability to understand how context, composition, and interactions between the individual EE elements can influence the outcome of an ecosystem is beneficial for decision-making and strategic planning. Apart from only the success of startups, increasing the entrepreneurial culture and mindset within a region can be beneficial for establishing a more open-minded and innovative society, leading to a comparative advantage in a highly global economic world. These aspects can lead to additional side effects such as environmental, social, and economic prosperity as a new path of collective rethinking the power of local economies.

Nevertheless, as this thesis has highlighted multiple times, building and establishing EE resilience is not a short-term equilibrium. It is a dynamic process that has to be evaluated permanently from a systemic perspective and adapted to upcoming changes, trends, and forecasts continuously. In doing so, the EE approach is indispensable to impact entrepreneurial activities, providing entrepreneurs, startups, high-growth firms, and entrepreneurial institutions and organizations the mandatory framework conditions to unleash their full potential. Referring to the introductory quote, economic development should not only aim to create jobs for people to have a salary, ensuring their daily survival. It is about educating human beings with the necessary competencies to enable them to follow their dreams and put their ideas into practice so that they can shape their lives and positively impact the well-being of society. In the end, entrepreneurs should keep in mind that “being genius is not enough, it takes courage to change people's hearts” (Green Book,

2018) and the ultimate purpose of EEs should be to provide them with wholehearted support to do so.

Finally, it is about time to conclude with a further quote that accompanied the whole journey of this dissertation, providing the sincere values, endurance, strength, and resilience to complete the project successfully.

> "Sometimes it is necessary to do the wrong thing for the right reasons. The important thing is to be sure that our reasons are right, and that we admit the wrong - that we do not lie to ourselves, and convince ourselves that what we do is right." **Gregory David Roberts, Shantaram*

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Appendix

A1 Final Sample of Identified Literature

No	Author	Year	Title	Journal	Method
1	Spilling	1996	The entrepreneurial system: On entrepreneurship in the context of a mega-event	Journal of Business Research	Empirical / Qualitative
2	Neck et al.	2004	An Entrepreneurial System View of New Venture Creation	Journal of Small Business Management	Empirical / Qualitative
3	Venkataraman	2004	Regional transformation through technological entrepreneurship	Journal of Business Venturing	Conceptual
4	Cohen	2006	Sustainable Valley Entrepreneurial Ecosystems	Business Strategy and the Environment	Empirical / Qualitative
5	Dawley et al.	2010	Towards the resilient region?	Local Economy	Conceptual
6	Hassink	2010	Regional resilience: a promising concept to explain differences in regional economic adaptability?	Cambridge Journal of Regions, Economy and Society	Conceptual
7	Isenberg	2010	How to Start an Entrepreneurial Revolution	Harvard Business Review	Conceptual
8	Pitelis	2012	Clusters, entrepreneurial ecosystem, co-creation, and appropriability: a conceptual framework	Industrial and Corporate Change	Conceptual
9	Suresh & Ramraj	2012	Entrepreneurial Ecosystem: Case Study on the Influence of Environmental Factors on Entrepreneurial Success	European Journal of Business and Management	Empirical / Qualitative
10	Williams et al.	2013	Economic resilience and entrepreneurship: A case study of the Thessaloniki City Region	Local Economy	Empirical / Qualitative
11	Brown & Mason	2014	Inside the high-tech black box: A critique of technology Entrepreneurship policy	Technovation	Empirical / Qualitative
12	Williams & Vorley	2014	Economic resilience and entrepreneurship: lessons from the Sheffield City Region	Entrepreneurship and Regional Development	Empirical / Qualitative
13	Boschma	2015	Towards an Evolutionary Perspective on Regional Resilience	Regional Studies	Conceptual
14	Markley et al.	2015	Creating entrepreneurial communities: building community capacity for ecosystem development	Community Development	Empirical / Qualitative
15	Martin & Sunley	2015	On the notion of regional economic resilience: conceptualization and explanation	Journal of Economic Geography	Conceptual
16	Stam	2015	Entrepreneurial Ecosystems and Regional Policy: A Sympathetic Critique	European Planning Studies	Conceptual
17	Isenberg	2016	Applying the Ecosystem Metaphor to Entrepreneurship: Uses and Abuses	The Antitrust Bulletin	Conceptual
18	Mack & Mayer	2016	The evolutionary dynamics of entrepreneurial ecosystems	Urban Studies	Empirical / Qualitative
19	Roundy	2016	Start-up community narratives: the discursive construction of entrepreneurial ecosystems	The Journal of Entrepreneurship	Conceptual
20	Stough	2016	Entrepreneurship and Regional Economic Development: Some reflections	Journal of Regional Research	Conceptual
21	Acs et al.	2017	The lineages of the entrepreneurial ecosystem approach	Small Business Economics	Literature Review

22	Alvedalen & Boschma	2017	A critical review of entrepreneurial ecosystems research: towards a future research agenda	European Planning Studies	Literature Review
23	Audretsch & Belitski	2017	Entrepreneurial ecosystems in cities: Establishing the framework conditions	The Journal of Technology Transfer	Empirical / Quantitative
24	Auerswald & Dani	2017	The adaptive life cycle of entrepreneurial ecosystems: the biotechnology cluster	Small Business Economics	Conceptual
25	Brown & Mason	2017	Looking inside the spiky bits: a critical review and conceptualisation of entrepreneurial ecosystems	Small Business Economics	Conceptual
26	Kuratko et al.	2017	The paradox of new venture legitimation within an entrepreneurial ecosystem	Small Business Economics	Conceptual
27	McNaughton & Gray	2017	Entrepreneurship and resilient communities – introduction to the special issue	Journal of Enterprising Communities	Conceptual
28	Motoyama & Knowlton	2017	Examining the Connections within the Startup Ecosystem: A Case Study of St. Louis	Entrepreneurship Research Journal	Empirical / Qualitative
29	Nylund & Cohen	2017	Collision density: driving growth in urban entrepreneurial ecosystems	International Entrepreneurship and Management Journal	Empirical / Quantitative
30	Roundy	2017	"Small town" entrepreneurial ecosystems: implications for developed and emerging economies	Journal of Entrepreneurship in Emerging Economies	Conceptual
31	Roundy et al.	2017	The resilience of entrepreneurial ecosystems	Journal of Business Venturing Insights	Conceptual
32	Spigel	2017	The relational organization of entrepreneurial ecosystems	Entrepreneurship Theory and Practice	Empirical / Qualitative
33	Theodoraki & Messeghem	2017	Exploring the entrepreneurial ecosystem in the field of entrepreneurial support: A multi-level approach	International Journal of Entrepreneurship and Small Business	Empirical / Qualitative
34	Acs et al.	2018	Entrepreneurship, institutional economics, and economic growth: an ecosystem perspective	Small Business Economics	Empirical / Quantitative
35	Carayannis et al.	2018	The ecosystem as helix: an exploratory theory-building study of regional co-opetitive entrepreneurial ecosystems as Quadruple/Quintuple Helix Innovation Models	R&D Management	Conceptual
36	Cowell et al.	2018	It takes all kinds: understanding diverse entrepreneurial ecosystems	Journal of Enterprising Communities	Empirical / Mixed-Method
37	Gherhes et al.	2018	Entrepreneurship and local economic resilience: the impact of institutional hysteresis in peripheral places	Small Business Economics	Empirical / Qualitative
38	Korber & McNaughton	2018	Resilience and entrepreneurship: A systematic literature review	International Journal of Entrepreneurial Behaviour and Research	Literature Review
39	Malecki	2018	Entrepreneurship and entrepreneurial ecosystems	Geography Compass	Literature Review
40	Maroufkhani et al.	2018	Entrepreneurial ecosystems: a systematic review	Journal of Enterprising Communities	Literature Review
41	Muldoon et al.	2018	Entrepreneurial ecosystem: do you trust or distrust?	Journal of Enterprising Communities	Conceptual
42	Nicotra et al.	2018	The causal relation between entrepreneurial ecosystem and productive entrepreneurship: a measurement framework	The Journal of Technology Transfer	Conceptual

43	Scaringella & Radziwon	2018	Innovation, entrepreneurial, knowledge and business ecosystems: Old wine in new bottles?	Technological Forecasting and Social Change	Literature Review
44	Spigel & Harrison	2018	Toward a process theory of entrepreneurial ecosystems	Strategic Entrepreneurship Journal	Conceptual
45	Theodoraki et al.	2018	A social capital approach to the development of sustainable entrepreneurial ecosystems: an explorative study	Small Business Economics	Empirical / Qualitative
46	Thompson et al.	2018	How entrepreneurial ecosystems take form: evidence from social impact initiatives in Seattle	Strategic Entrepreneurship Journal	Empirical / Qualitative
47	Velt et al.	2018	The entrepreneurial ecosystem and born globals: The estonian context	Journal of Enterprising Communities	Empirical - Quantitative
48	Audretsch & Link	2019	Embracing an entrepreneurial ecosystem: an analysis of the governance of research joint ventures	Small Business Economics	Empirical / Quantitative
49	Audretsch et al.	2019	Entrepreneurial ecosystems: economic, technological, and societal impacts	The Journal of Technology Transfer	Conceptual
50	Bishop	2019	Knowledge diversity and entrepreneurship following an economic crisis: an empirical study of regional resilience in Great Britain	Entrepreneurship and Regional Development	Empirical / Quantitative
51	Cavallo et al.	2019	Entrepreneurial ecosystem research: present debates and future directions	International Entrepreneurship and Management Journal	Literature Review
52	Colombelli et al.	2019	Hierarchical and relational governance and the life cycle of entrepreneurial ecosystems	Small Business Economics	Empirical / Mixed-Method
53	Colombo et al.	2019	The governance of entrepreneurial ecosystems	Small Business Economics	Conceptual
54	Content et al.	2019	Entrepreneurial ecosystems, entrepreneurial activity and economic growth: new evidence from European regions	Regional Studies	Empirical / Quantitative
55	Cunningham et al.	2019	Entrepreneurial ecosystem governance: a principal investigator-centered governance framework	Small Business Economics	Conceptual
56	Kuckertz	2019	Let's take the entrepreneurial ecosystem metaphor seriously	Journal of Business Venturing Insights	Conceptual
57	Liguori et al.	2019	Development of a multi-dimensional measure for assessing entrepreneurial ecosystems	Entrepreneurship and Regional Development	Empirical / Quantitative
58	Manimala et al.	2019	Perception of Entrepreneurial Ecosystem: Testing the Actor–Observer Bias	The Journal of Entrepreneurship	Empirical / Quantitative
59	Neumeyer et al.	2019	Who is left out: exploring social boundaries in entrepreneurial ecosystems	The Journal of Technology Transfer	Empirical / Quantitative
60	Roundy & Bayer	2019	To Bridge or Buffer? A Resource Dependence Theory of Nascent Entrepreneurial Ecosystems	Journal of Entrepreneurship in Emerging Economies	Conceptual
61	Shwetzer et al.	2019	Entrepreneurial ecosystems: a holistic and dynamic approach	Journal of Industry-University Collaboration	Literature Review
62	Sternberg et al.	2019	A new framework to measure entrepreneurial ecosystems at the regional level	Zeitschrift für Wirtschaftsgeographie	Conceptual
63	Szerb et al.	2019	The relevance of quantity and quality entrepreneurship for regional performance: the	Regional Studies	Empirical / Quantitative

			moderating role of the entrepreneurial ecosystem		
64	Tsvetkova et al.	2019	Beyond global hubs: Broadening the application of systems approaches	Local Economy	Conceptual
65	Walsh	2019	Regional capability emergence in an entrepreneurial ecosystem	Journal of Entrepreneurship and Public Policy	Empirical / Quantitative
66	Walsh & Winsor	2019	Socio-cultural barriers to developing a regional entrepreneurial ecosystem	Journal of Enterprising Communities	Empirical / Qualitative
67	Xu & Dobson	2019	Challenges of building entrepreneurial ecosystems in peripheral places	Journal of Entrepreneurship and Public Policy	Conceptual
68	Donaldson	2020	Culture in the entrepreneurial ecosystem: a conceptual framing	International Entrepreneurship and Management Journal	Conceptual
69	Kansheba & Wald	2020	Entrepreneurial ecosystems: a systematic literature review and research agenda	Journal of Small Business and Enterprise Development	Literature Review
70	Lange & Schmidt	2020	Entrepreneurial ecosystems as a bridging concept? A conceptual contribution to the debate on entrepreneurship and regional development	Growth and Change	Conceptual
71	Lux et al.	2020	Putting the entrepreneur back into entrepreneurial ecosystems	International Journal of Entrepreneurial Behavior and Research	Empirical / Quantitative
72	Roundy	2020	Do we Lead Together? Leadership Behavioral Integration and Coordination in Entrepreneurial Ecosystems	Journal of Leadership Studies	Conceptual
73	Spigel et al.	2020	A manifesto for researching entrepreneurial ecosystems	Local economy	Literature Review
74	Velt et al.	2020	Entrepreneurial Ecosystem Research: Bibliometric Mapping of the Domain	Journal of Business Ecosystems	Literature Review
75	Adams	2021	From orchards to chips: Silicon Valley's evolving entrepreneurial ecosystem	Entrepreneurship and Regional Development	Empirical / Qualitative
76	Belitski & Büyükbalci	2021	Uncharted waters of the entrepreneurial ecosystems research: Comparing Greater Istanbul and Reading ecosystems	Growth and Change	Empirical / Qualitative
77	Belitski et al.	2021	Political entrepreneurship: entrepreneurship ecosystem perspective	International Entrepreneurship and Management Journal	Empirical / Mixed-Method
78	Bouncken & Kraus	2021	Entrepreneurial ecosystems in an interconnected world: emergence, governance and digitalization	Review of Managerial Science	Conceptual
79	Cantner et al.	2021	Entrepreneurial ecosystems: a dynamic lifecycle model	Small Business Economics	Conceptual
80	Cao & Shi	2021	A systematic literature review of entrepreneurial ecosystems in advanced and emerging economies	Small Business Economics	Literature Review
81	De Brito & Leitão	2021	Mapping and defining entrepreneurial ecosystems: a systematic literature review	Knowledge Management Research and Practice	Literature Review
82	Guerrero & Espinoza-Benavides	2021	Does entrepreneurship ecosystem influence business re-entries after failure?	International Entrepreneurship and Management Journal	Conceptual
83	Guerrero et al.	2021	The influence of ecosystems on the entrepreneurship process: a comparison across developed and developing economies	Small Business Economics	Literature Review

84	Harima et al.	2021	The injection of resources by transnational entrepreneurs: towards a model of the early evolution of an entrepreneurial ecosystem	Entrepreneurship and Regional Development	Empirical / Qualitative
85	Iacobucci & Perugini	2021	Entrepreneurial ecosystems and economic resilience at local level	Entrepreneurship and Regional Development	Empirical / Quantitative
86	Kang et al.	2021	Entrepreneurial ecosystems: analysing the status quo	Knowledge Management Research and Practice	Literature review
87	Roundy	2021	Leadership in startup communities: how incubator leaders develop a regional entrepreneurial ecosystem	Journal of Management Development	Empirical / Qualitative
88	Ryan et al.	2021	The role of MNEs in the genesis and growth of a resilient entrepreneurial ecosystem	Entrepreneurship and Regional Development	Empirical / Quantitative
89	Schäfer	2021	Spatialities of entrepreneurial ecosystems	Geography Compass	Conceptual
90	Scott et al.	2021	Towards a network-based view of effective entrepreneurial ecosystems	Review of Managerial Science	Empirical / Qualitative
91	Spigel & Vinodrai	2021	Meeting its Waterloo? Recycling in entrepreneurial ecosystems after anchor firm collapse	Entrepreneurship and Regional Development	Empirical / Quantitative
92	Stam & van de Ven	2021	Entrepreneurial ecosystem elements	Small Business Economics	Conceptual
93	Sternberg	2022	Entrepreneurship and geography-some thoughts about a complex relationship	The Annals of Regional Science	Conceptual
94	Tavassoli et al.	2021	Entrepreneurship in Cities	Research Policy	Empirical / Quantitative
95	Buratti et al.	2022	The dynamics of entrepreneurial ecosystems: an empirical investigation	R&D Management	Empirical / Quantitative
96	Cho et al.	2022	Evolutionary entrepreneurial ecosystems: a research pathway	Small Business Economics	Literature Review
97	Cloutier & Messeghem	2022	Whirlwind model of entrepreneurial ecosystem path dependence	Small Business Economics	Conceptual
98	Fernandes & Ferreira	2022	Entrepreneurial ecosystems and networks: a literature review and research agenda	Review of Managerial Science	Literature Review
99	Fernandes & Franco	2022	The role of entrepreneurial resilience in forms of collaboration: a systematic literature review with bibliometric analyses	EuroMed Journal of Business	Literature Review
100	Leendertse et al.	2022	Measure Twice, Cut Once: Entrepreneurial Ecosystem Metrics	Research Policy	Empirical / Quantitative
101	O'Connor & Audretsch	2022	Regional entrepreneurial ecosystems: learning from forest ecosystems	Small Business Economics	Conceptual
102	Perugini	2022	Space–time analysis of entrepreneurial ecosystems	The Journal of Technology Transfer	Empirical / Quantitative
103	Theodoraki & Catanzaro	2022	Widening the borders of entrepreneurial ecosystem through the international lens	The Journal of Technology Transfer	Empirical / Qualitative
104	Theodoraki et al.	2022	Building sustainable entrepreneurial ecosystems: A holistic approach	Journal of Business Research	Literature review
105	Wurth et al.	2022	Toward an Entrepreneurial Ecosystem Research Program	Entrepreneurship Theory and Practice	Conceptual

A2 Survey Questionnaire

Dear founder!

A warm welcome to the survey of startups from Karlsruhe.

As part of my doctoral thesis, I am investigating how startups develop at a specific place and how the local entrepreneurial ecosystem influences successful startup growth. The aim is to show which framework conditions create the environment for successful startups and in which areas there is potential for improvements.

For this, I am dependent on your assistance.

By participating in the survey (max. 10min) you actively contribute to improving the local conditions in Karlsruhe for you and future start-ups.

Thank you very much for your support and for the trust you have placed in us.

Yours Ralph

E-Mail: ralph.henn@kit.edu

Data Protection Declaration

1. Die Teilnahme an der Befragung ist freiwillig. Auch die Angaben zu den jeweiligen Fragen erfolgen freiwillig, so dass Sie als Teilnehmer selbst entscheiden können, ob Sie alle Fragen beantworten oder die eine oder andere Frage auslassen.

2. Auch ist die Angabe Ihres Namens ist absolut freiwillig. Die Angabe des Unternehmensnamens soll dazu dienen, die Entwicklung Ihres Start-ups abzubilden. Zu diesem Zweck wird die Befragung in regelmäßigen Abständen wiederholt werden (Langzeitstudie). Durch Angabe Ihres Unternehmensnamens ermöglichen Sie uns die Zuordnung Ihrer Umfragedaten aus verschiedenen Erhebungsjahren. Die IP-Adresse wird zu statistischen Zwecken und in anonymisierter Form auf dem Webserver und nicht in der Datenbank bei den Umfrageergebnissen gespeichert.

3. Die Auswertungsergebnisse werden ausschließlich in anonymisierter Form (in Tabellen und /oder Graphiken) veröffentlicht, so dass Rückschlüsse auf Einzelpersonen/ Unternehmen nicht möglich sind.

Part A - General Information

1. Please provide the name of your company.

2. In which year was your company legally founded?

[Please choose]

3. In which phase is your company currently?

[Please choose]

4. What is the current legal status of your company?

[Please choose]

5. In which of the following industries is your company active?

- [ ] Biotechnology
- [ ] Mechanical Engineering / Vehicle Manufacturing
- [ ] Trade Sector
- [ ] Electrical Engineering / Telecommunications
- [ ] Consulting
- [ ] Chemical / Pharmaceuticals
- [ ] Energy Sector
- [ ] Marketing / Media
- [ ] Art / Culture
- [ ] Environmental Technology / Water
- [ ] Research
- [ ] IT / Internet / Web 2.0
- [ ] Education
- [ ] Medical Technology
- [ ] Construction / Architecture / Planning
- [ ] Social / Health Sector
- [ ] Others, namely:

6. Has your company already achieved operating profits in one of the previous fiscal years?

- ○ Yes
- ○ No

7. Please state your company's amount of turnover for your last fiscal year [in EUR].

[Please choose]

8. Please state the average annual growth of your company [in percent].

0%	1-25%	26-50%	51-75%	76-100%	101-150%	151-200%	200-300%	>300%
○	○	○	○	○	○	○	○	○

9. Please state, how your turnover is distributed between the provision of products and services (a total of 100 %).

Products

Services

10. Please state, how your turnover is distributed between consumers (B2C) and other businesses (B2B) (a total of 100 %).

B2C (Business to Customer)

B2B (Business to Business)

Part B - Founder and Team

11. Please provide the total number of members of the founding team.

[Please choose]

12. Please provide the total number of female members of the founding team.

[Please choose]

13. Please state which course of studies the founding team has attended (mark all that apply).

- [ ] Architecture
- [ ] Civil Engineering, Geo- and Environmental Sciences
- [ ] Chemistry and Biosciences
- [ ] Chemical and Process Engineering
- [ ] Humanities and Social Sciences
- [ ] Electrical Engineering and Information Technology
- [ ] Informatics
- [ ] Mechanical Engineering
- [ ] Mathematics
- [ ] Economics and Business Engineering
- [ ] Physics
- [ ] Others, namely:

14. Please indicate to which extent the foundation of your company has been influenced by the university context.

Very low	Low	Neither high nor low	High	Very high
○	○	○	○	○

15. Please provide information about the average experience available within your team at the date of foundation.

	Very low	Low	Neither high nor low	High	Very high
Working Experience	○	○	○	○	○
Industry Experience	○	○	○	○	○
Project Experience	○	○	○	○	○
Management Experience	○	○	○	○	○
Entrepreneurial Experience	○	○	○	○	○

16. Had at least one of the founders started a business previously?

- ○ Yes
- ○ No

17. Please state your current number of employees in full-time equivalents (including you, excluding freelancers).

[Please choose] ∨

18. Please state the number of employees your company is planning to hire in the next year.

[Please choose] ∨

19. Have any persons joined the management of the company who were not part of the founding team, and if so, in which unit?

- ☐ No external members
- ☐ General Management (CEO)
- ☐ Research & Development (CTO)
- ☐ Marketing and Sales (CMO)
- ☐ Finance (CFO)
- ☐ Business Development (CBDO)

Part C - Financing

20. Have you raised external equity capital (e.g. venture capitalist, business angel) for the financing of your company?

- ○ Yes
- ○ No

21. If not, why has no equity capital been raised?

- ○ No equity capital could be acquired.
- ○ It is planned to raise equity capital.
- ○ It was not necessary to raise equity capital, e.g. bootstrapping

22. If yes, which kind of equity capital have you raised?

- ☐ Family, Friends, and Fools
- ☐ Business Angel Investment
- ☐ Crowdfunding
- ☐ Incubator Funding
- ☐ Private Venture Capital
- ☐ Corporate Venture Capital
- ☐ Public Venture Capitalist (e.g. KfW ERP-Kapital or HTGF)

23. Please state the amount of equity capital your company has raised in total [in EUR].

_____ €

24. Please state the total share all founders owned at the end of the last fiscal year.

[Please choose] ⌄

25. Did you or your company receive public funding?

- ○ Yes
- ○ No

26. If yes, please state which kind of public funding (without equity capital) you or your company received.

EXIST Programs

- [ ] EXIST-Gründerstipendium
- [ ] EXIST-Forschungstransfer
- [ ] EXIST-Seed

KfW Programs

- [ ] KfW-Gründercoaching
- [ ] KfW-Gründerkredit

Regional Programs

- [ ] Junge Innovatoren
- [ ] EXI Gründungsgutschein
- [ ] Startup BW Pre-Seed
- [ ] Others namely:

Other programs

- [ ] Helmholtz Enterprise
- [ ] Fraunhofer Venture Program
- [ ] Others namely:

Part D - Business Model, Technology, and Market Strategy

27. On what basis has your business concept been developed?

- ○ An identified product or service idea was developed further into a business model.
- ○ It was a conscious and deliberate sought for a business opportunity, which then has been realized.
- ○ Research results or self-developed technologies were transformed into a product or service.

28. Did any patents underly your company's foundation?

- ○ Yes
- ○ No

29. Please state which of the following categories your business model belongs.

○ Digital	○ Hybrid	○ Analog

30. Please indicate which of the following business models your company uses.

- ☐ Platform / Marketplace
- ☐ Software Development
- ☐ E-Commerce
- ☐ Pay-per-use
- ☐ Solution Provider
- ☐ Licensing
- ☐ Freeminium
- ☐ Subsciption
- ☐ SaaS (Software-as-a-Service)
- ☐ Direct Selling
- ☐ Analog Services
- ☐ Technology Development and Production
- ☐ Stationary Trade
- ☐ Others, namely:

31. Please rate the level of digitalization concerning your business model.

○ Very low	○ Low	○ Neither high nor low	○ High	○ Very high

32. Please rate the scalability of your business model.

Very low	Low	Neither high nor low	High	Very high
○	○	○	○	○

33. Please state which of the following fields is currently a major challenge for your company.

- ☐ Sales and Customer acquisition
- ☐ Product Development
- ☐ Cashflow / Liquidity
- ☐ Human Capital
- ☐ Purchasing and Procurement
- ☐ Raising of capital

34. Please state, which market is the most important one to your company as measured by the share of turnover.

- ○ Local (< 20 km)
- ○ Regional (< 50 km)
- ○ National
- ○ International

35. Please indicate what percentage of turnover you achieved in international markets.

0%	1 – 5%	6 – 25%	26 – 50%	51 – 75%	76 – 99%	100%
○	○	○	○	○	○	○

36. Please rate, the importance of international markets for your business model.

Very low	Low	Neither high nor low	High	Very high
○	○	○	○	○

37. Which international markets are the most significant ones for your business?

Part E - Connections to the Entrepreneurial Ecosystem

38. Please indicate if you agree with the following statements.

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
"The actors in the entrepreneurial ecosystem are trustworthy and you can talk openly about business ideas, strategies, and challenges."	○	○	○	○	○	○	○
"At least one person of the founding team participates in events of the entrepreneurial community frequently."	○	○	○	○	○	○	○
"The exchange with mentors is valuable and leads to opportunities we have not been aware of before."	○	○	○	○	○	○	○
"We meet with other entrepreneurs and startups regularly to discuss current challenges."	○	○	○	○	○	○	○
"From the beginning, we actively established a personal network within the entrepreneurial community."	○	○	○	○	○	○	○
"There are no barriers to access the local entrepreneurial ecosystem easily."	○	○	○	○	○	○	○
"The local government actively seeks to create and promote entrepreneurship-friendly legislation."	○	○	○	○	○	○	○
"Internationalization strategies have been integrated into business model development early on."	○	○	○	○	○	○	○
"Through the support of dealmakers, contacts with customers could be established and the number of sales increased."	○	○	○	○	○	○	○
"Bureaucracy has been an issue that wasted resources and negatively influenced company growth."	○	○	○	○	○	○	○
"With our business model, access to markets could be achieved without any constraints."	○	○	○	○	○	○	○
"In the local entrepreneurial ecosystem, it is possible to hire the required skilled employees at any time."	○	○	○	○	○	○	○

Part F - Evaluation of the local Entrepreneurial Ecosystem

39. Please state, if you do agree with the following statements.

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
"There is a strong focus on growth-oriented and productive entrepreneurship activity in my region."	○	○	○	○	○	○	○
"There is a sufficient formal network to support entrepreneurship in my region."	○	○	○	○	○	○	○
"There is a sufficient number of government entrepreneurship support programs in my region."	○	○	○	○	○	○	○
"There is a strong entrepreneurship culture and orientation in my region and I personally know entrepreneurs who started a business in the previous years."	○	○	○	○	○	○	○
"There is a sufficient informal network to entrepreneurship in my region."	○	○	○	○	○	○	○
"There is a high status of entrepreneurs in my region as well as a sufficient support of independent mass media to entrepreneurship in my region."	○	○	○	○	○	○	○
"There is sufficient private equity capital (business angels, venture capital, crowdfunding) in my region to support entrepreneurship."	○	○	○	○	○	○	○
"There is a strong awareness for sustainability in my city (healthy lifestyle, veganism, energy efficiency, sustainability, corporate social responsibility) in my city."	○	○	○	○	○	○	○

Last Page

Vielen Dank für deine Teilnahme!

Ich möchte mich ganz herzlich für deine Mithilfe bedanken.

Falls es irgendwelche Anliegen bzgl. eures Startups gibt bei denen ihr Unterstützung gebrauchen könnt oder ihr Kontakte in die Gründerszene weltweit benötigt, kannst du mich jederzeit kontaktieren. Ich helfe euch sehr gerne persönlich und mit meinem Netzwerk weiter.

Schreibt mir dazu einfach eine Nachricht unter ralph.henn@kit.edu

Deine Antworten wurden gespeichert, du kannst das Browser-Fenster nun schließen.

A3 Declaration

Eidesstattliche Versicherung

gemäß § 6 Abs. 1 Ziff. 4 der Promotionsordnung des Karlsruher Instituts für Technologie für die Fakultät für Wirtschaftswissenschaften

1. Bei der eingereichten Dissertation zu dem Thema *„The Evolutionary Nature of Entrepreneurial Ecosystems and its Impact on Resilient Growth - An Empirical Investigation on the Role of Entrepreneurial Ecosystems in Facilitating Productive Entrepreneurship in Regional Economies“* handelt es sich um meine eigenständig erbrachte Leistung.

2. Ich habe nur die angegebenen Quellen und Hilfsmittel benutzt und mich keiner unzulässigen Hilfe Dritter bedient. Insbesondere habe ich wörtlich oder sinngemäß aus anderen Werken übernommene Inhalte als solche kenntlich gemacht.

3. Die Arbeit oder Teile davon habe ich ~~*wie folgt*~~*/ bislang nicht** an einer Hochschule des In- oder Auslands als Bestandteil einer Prüfungs- oder Qualifikationsleistung vorgelegt.

Titel der Arbeit: XXXX
Hochschule und Jahr: XX, XX
Art der Prüfungs- oder Qualifikationsleistung: XXXX

4. Die Richtigkeit der vorstehenden Erklärungen bestätige ich.

5. Die Bedeutung der eidesstattlichen Versicherung und die strafrechtlichen Folgen einer unrichtigen oder unvollständigen eidesstattlichen Versicherung sind mir bekannt. Ich versichere an Eides statt, dass ich nach bestem Wissen die reine Wahrheit erklärt und nichts verschwiegen habe.

Karlsruhe, den 1*2.05.2023*

** Nicht Zutreffendes streichen. Bei Bejahung sind anzugeben: der Titel der andernorts vorgelegten Arbeit, die Hochschule, das Jahr der Vorlage und die Art der Prüfungs- oder Qualifikationsleistung.*